



THE CITY OF WINNIPEG

BID OPPORTUNITY

BID OPPORTUNITY NO. 49-2006

**WINNIPEG WATER TREATMENT PROGRAM – SUPPLY OF ONSITE
HYPOCHLORITE GENERATION EQUIPMENT**

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PART B - BIDDING PROCEDURES

B1. PROJECT TITLE

B1.1 WINNIPEG WATER TREATMENT PROGRAM – SUPPLY OF ONSITE HYPOCHLORITE GENERATION EQUIPMENT

B2. SUBMISSION DEADLINE

B2.1 The Submission Deadline is 4:00 p.m. Winnipeg time, April 6, 2006.

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

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

B3. SITE INVESTIGATION

B3.1 Further to GC.2.01, the Contract Administrator or an authorized representative will be available at the City Warehouse from 11:00 a.m. to 11:30 a.m. on March 28, 2006 to provide Bidders access to the City Warehouse.

B3.2 The Bidder is advised that the delivery for Goods shall be made at the City Warehouse noted in B3.1, and limited City supplied off loading facilities exist at this location.

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

B4. ENQUIRIES

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

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

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

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

B4.5 The Bidder shall not be entitled to rely on any response or interpretation received pursuant to B3 unless that response or interpretation is provided by the Contract Administrator in writing.

B5. ADDENDA

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

- B5.2 The Contract Administrator will issue each addendum at least two (2) Business Days prior to the Submission Deadline, or provide at least two (2) Business Days by extending the Submission Deadline.
- B5.2.1 Addenda will be available on the Bid Opportunities page at The City of Winnipeg, Corporate Finance, Materials Management Branch internet site at <http://www.winnipeg.ca/matmgt>.
- B5.2.2 The Bidder is responsible for ensuring that he has received all addenda and is advised to check the Materials Management Branch internet site for addenda shortly before submitting his Bid.
- B5.3 The Bidder shall acknowledge receipt of each addendum in Paragraph 10 of Form A: Bid. Failure to acknowledge receipt of an addendum may render a Bid non-responsive.

B6. SUBSTITUTES

- B6.1 The Work is based on the materials, equipment, methods and products specified in the Bid Opportunity.
- B6.2 Substitutions shall not be allowed unless application has been made to and prior approval has been granted by the Contract Administrator in writing.
- B6.3 Requests for approval of a substitute will not be considered unless received in writing by the Contract Administrator at least seven (7) Business Days prior to the Submission Deadline.
- B6.4 The Bidder shall ensure that any and all requests for approval of a substitute:
- (a) provide sufficient information and details to enable the Contract Administrator to determine the acceptability of the material, equipment, method or product as either an approved equal or alternative;
 - (b) identify any and all changes required in the applicable Work, and all changes to any other Work, which would become necessary to accommodate the substitute;
 - (c) identify any anticipated cost or time savings that may be associated with the substitute;
 - (d) certify that, in the case of a request for approval as an approved equal, the substitute will fully perform the functions called for by the general design, be of equal or superior substance to that specified, is suited to the same use and capable of performing the same function as that specified and can be incorporated into the Work, strictly in accordance with the Contract;
 - (e) certify that, in the case of a request for approval as an approved alternative, the substitute will adequately perform the functions called for by the general design, be similar in substance to that specified, is suited to the same use and capable of performing the same function as that specified and can be incorporated into the Work, strictly in accordance with the Contract.
- B6.5 The Contract Administrator, after assessing the request for approval of a substitute, may in his sole discretion grant approval for the use of a substitute as an "approved equal" or as an "approved alternative", or may refuse to grant approval of the substitute.
- B6.6 The Contract Administrator will provide a response in writing, at least two (2) Business Days prior to the Submission Deadline, only to the Bidder who requested approval of the substitute.
- B6.6.1 The Bidder requesting and obtaining the approval of a substitute shall be entirely responsible for disseminating information regarding the approval to any person or persons he wishes to inform.

- B6.7 If the Contract Administrator approves a substitute as an “approved equal”, any Bidder may use the approved equal in place of the specified item.
- B6.8 If the Contract Administrator approves a substitute as an “approved alternative”, any Bidder bidding that approved alternative shall base his Total Bid Price upon the specified item but may also indicate an alternative price based upon the approved alternative. Such alternatives will be evaluated in accordance with B16.
- B6.9 No later claim by the Contractor for an addition to the price(s) because of any other changes in the Work necessitated by the use of an approved equal or an approved alternative will be considered.

B7. BID SUBMISSION

- B7.1 The Bid Submission consists of the following components:
- (a) Form A: Bid;
 - (b) Form B: Prices;
 - (c) Form N: Salient Features;
 - (d) Form G1: Bid Bond and Agreement to Bond, or
Form G2: Irrevocable Standby Letter of Credit and Undertaking, or
a certified cheque or draft;
- B7.2 All components of the Bid Submission shall be fully completed or provided, and submitted by the Bidder no later than the Submission Deadline, with all required entries made clearly and completely in ink, to constitute a responsive Bid.
- B7.3 The Bid Submission shall be submitted enclosed and sealed in an envelope clearly marked with the Bid Opportunity number and the Bidder's name and address.
- B7.3.1 Samples or other components of the Bid Submission which cannot reasonably be enclosed in the envelope may be packaged separately, but shall be clearly marked with the Bid Opportunity number, the Bidder's name and address, and an indication that the contents are part of the Bidder's Bid Submission.
- B7.4 Bid Submissions submitted by facsimile transmission (fax) or internet electronic mail (e-mail) will not be accepted.
- B7.5 Bid Submissions shall be submitted to:
- The City of Winnipeg
Corporate Finance Department
Materials Management Branch
185 King Street, Main Floor
Winnipeg, MB R3B 1J1

B8. BID

- B8.1 The Bidder shall complete Form A: Bid, making all required entries.
- B8.2 Paragraph 2 of Form A: Bid shall be completed in accordance with the following requirements:
- (a) if the Bidder is a sole proprietor carrying on business in his own name, his name shall be inserted;
 - (b) if the Bidder is a partnership, the full name of the partnership shall be inserted;
 - (c) if the Bidder is a corporation, the full name of the corporation shall be inserted;

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

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

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

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

- (a) if the Bidder is a sole proprietor carrying on business in his own name, it shall be signed by the Bidder;
- (b) if the Bidder is a partnership, it shall be signed by the partner or partners who have authority to sign for the partnership;
- (c) if the Bidder is a corporation, it shall be signed by its duly authorized officer or officers and the corporate seal, if the corporation has one, should be affixed;
- (d) if the Bidder is carrying on business under a name other than his own, it shall be signed by the registered owner of the business name, or by the registered owner's authorized officials if the owner is a partnership or a corporation.

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

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

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

B9. PRICES

B9.1 The Bidder shall state the lump sum price in Canadian funds for the Work on Form B: Prices.

B9.1.1 The price on Form B: Prices shall include:

- (a) duty;
- (b) freight and cartage;
- (c) Provincial and Federal taxes [except the Goods and Services Tax (GST) and Manitoba Retail Sales Tax (MRST, also known as PST), which shall be extra where applicable] and all charges governmental or otherwise paid;
- (d) profit and all compensation which shall be due to the Contractor for the Work and all risks and contingencies connected therewith.

B9.2 Payment of the lump sum price will be made to the Contractor in accordance with the payment schedule set out in D21.

B10. SALIENT FEATURES

B10.1 The Bidder shall complete Form N: Salient Features indicating the operating specification which the Bidder guarantees for each item or category of equipment identified thereon.

B10.2 When completing items 1.1, 1.2 and 1.3 of Form N: Salient Features, the Bidder shall use the following assumptions:

- (a) For item 1.1 on Form N: Salient Features, the guaranteed average Salt consumption shall be calculated as follows:

$$M_{\text{AVERAGE}} = M_{\text{TOT}} \div 278500 \text{ [kg of Chlorine/year]}$$

Where:

M_{AVERAGE} = the average consumption [kg] of Salt required to produce one kg of the chlorine based on an average annual demand of 278500 kg of chlorine.

M_{TOT} = the total mass of Salt [kg] required to produce the average annual chlorine demand of 278500 kg of chlorine.

- (b) For item 1.2 on Form N: Salient Features, the guaranteed average electrolyzer electrical power demand shall be calculated as follows:

$$Q_{\text{AVERAGE}} = P_{\text{TOT}} \div 8760 \text{ [hours/year]}$$

Where:

Q_{AVERAGE} = the average electrical power [kW] demand of all electrical equipment supplied under this Contract required to produce the average annual chlorine demand of 278500 kg of chlorine.

P_{TOT} = the total electrical energy consumed [kWh] by all electrical equipment supplied under this Contract as required to produce the average annual chlorine demand of 278500 kg of chlorine.

- (c) For item 1.3 on Form N – Salient Features the minimum guaranteed WTP service water temperature shall be the WTP service water temperature required to achieve the electrolyzer Salt and power consumption guaranteed in items 1.1 and 1.2 of Form N: Salient Features: Prices, averaged over a five (5) year period.

B10.2.2 Heat reclaim equipment is not a requirement of this Bid Opportunity, however, the Bidder may include the supply of such equipment in his Lump Sum Price if he feels this would be advantageous in the evaluation of his Bid pursuant to B16. Item 2.0 of Form N: Salient Features shall be completed only if the Bidder includes heat reclaim equipment in his Bid Submission, and shall be based on a WTP service water flow rate of 1.102 litres per second at the temperatures specified in B16.4.4.

B11. QUALIFICATION

B11.1 The Bidder shall:

- (a) undertake to be in good standing under The Corporations Act (Manitoba), or properly registered under The Business Names Registration Act (Manitoba), or otherwise properly registered, licensed or permitted by law to carry on business in Manitoba, or if the Bidder does not carry on business in Manitoba, in the jurisdiction where the Bidder does carry on business;
- (b) be responsible and not be suspended, debarred or in default of any obligation to the City;
- (c) be financially capable of carrying out the terms of the Contract;
- (d) have all the necessary experience, capital, organization, and equipment to perform the Work in strict accordance with the terms and provisions of the Contract;
- (e) have successfully carried out work, similar in nature, scope and value to the Work;
- (f) employ only Subcontractors who:
 - (i) are responsible and not suspended, debarred or in default of any obligation to the City (a list of suspended or debarred individuals and companies is available on the Information Connection page at The City of Winnipeg, Corporate Finance, Materials Management Branch internet site at <http://www.winnipeg.ca/matmgt>); and

- (ii) have successfully carried out work similar in nature, scope and value to the portion of the Work proposed to be subcontracted to them, and are fully capable of performing the Work required to be done in accordance with the terms of the Contract;
 - (g) have a written workplace safety and health program in accordance with The Workplace Safety and Health Act (Manitoba);
- B11.2 The Bidder shall be prepared to submit, within three (3) Business Days of a request by the Contract Administrator, proof satisfactory to the Contract Administrator of the qualifications of the Bidder and of any proposed Subcontractor.
- B11.2.1 Proof satisfactory to the Contract Administrator may include (but is not limited to):
 - (a) Evidence that equipment of similar capacity and service capability has been successfully supplied to at least five (5) installations and has operated successfully for at least five (5) years; and
 - (b) Current NSF/ANSI Standard 61 Certification (Drinking Water Additives – Health Effects) or satisfactory evidence of a current application for said certification and/or other credible evidence from an independent testing laboratory for equipment of the same design and components that indicate that by-products are within acceptable limits.
- B11.3 The Bidder shall provide, on the request of the Contract Administrator, full access to any of the Bidder's equipment and facilities to confirm, to the Contract Administrator's satisfaction, that the Bidder's equipment and facilities are adequate to perform the Work.
- B12. BID SECURITY**
- B12.1 The Bidder shall provide bid security in the form of:
 - (a) a bid bond, in the amount of at least ten percent (10%) of the Total Bid Price, and agreement to bond of a company registered to conduct the business of a surety in Manitoba, in the form included in the Bid Submission (Form G1: Bid Bond and Agreement to Bond); or
 - (b) an irrevocable standby letter of credit, in the amount of at least ten percent (10%) of the Total Bid Price, and undertaking issued by a bank or other financial institution registered to conduct business in Manitoba and drawn on a branch located in Winnipeg, in the form included in the Bid Submission (Form G2: Irrevocable Standby Letter of Credit and Undertaking); or
 - (c) a certified cheque or draft payable to "The City of Winnipeg", in the amount of at least fifty percent (50%) of the Total Bid Price, drawn on a bank or other financial institution registered to conduct business in Manitoba.
- B12.1.1 If the Bidder submits alternative bids, the bid security shall be in the amount of the specified percentage of the highest Total Bid Price submitted.
- B12.2 The bid security of the successful Bidder and the next two lowest evaluated responsive and responsible Bidders will be released by the City when a Contract for the Work has been duly executed by the successful Bidder and the performance security furnished as provided herein. The bid securities of all other Bidders will be released when a Contract is awarded.
- B12.2.1 Where the bid security provided by the successful Bidder is in the form of a certified cheque or draft pursuant to B12.1(c), it will be deposited and retained by the City as the performance security and no further submission is required.
- B12.2.2 The City will not pay any interest on certified cheques or drafts furnished as bid security or subsequently retained as performance security.

B12.3 The bid securities of all Bidders will be released by the City as soon as practicable following notification by the Contract Administrator to the Bidders that no award of Contract will be made pursuant to the Bid Opportunity.

B13. OPENING OF BIDS AND RELEASE OF INFORMATION

B13.1 Bid Submissions will not be opened publicly.

B13.2 Within two (2) Business Days following the Submission Deadline, the names of the Bidders and their Total Bid Prices (unevaluated, and pending review and verification of conformance with requirements) will be available on the Closed Bid Opportunities (or Public/Posted Opening & Award Results) page at The City of Winnipeg, Corporate Finance, Materials Management Branch internet site at <http://www.winnipeg.ca/matmgt>.

B13.3 After award of Contract, the name(s) of the successful Bidder(s) and the Contract Amount(s) will be available on the Closed Bid Opportunities (or Public/Posted Opening & Award Results) page at The City of Winnipeg, Corporate Finance, Materials Management Branch internet site at <http://www.winnipeg.ca/matmgt>.

B13.4 The Bidder is advised that any information contained in any Bid Submission may be released if required by City policy or procedures, by The Freedom of Information and Protection of Privacy Act (Manitoba), by other authorities having jurisdiction, or by law.

B14. IRREVOCABLE BID

B14.1 The Bid(s) submitted by the Bidder shall be irrevocable for the time period specified in Paragraph 11 of Form A: Bid.

B14.2 The acceptance by the City of any Bid shall not release the Bids of the next two lowest evaluated responsive Bidders and these Bidders shall be bound by their Bids on such Work for the time period specified in Paragraph 11 of Form A: Bid.

B15. WITHDRAWAL OF BIDS

B15.1 A Bidder may withdraw his Bid without penalty by giving written notice to the Manager of Materials at any time prior to the Submission Deadline.

B15.1.1 Notwithstanding GC.7.05(2), the time and date of receipt of any notice withdrawing a Bid shall be the time and date of receipt as determined by the Manager of Materials.

B15.1.2 The City will assume that any one of the contact persons named in Paragraph 3 of Form A: Bid or the Bidder's authorized representatives named in Paragraph 12 of Form A: Bid, and only such person, has authority to give notice of withdrawal.

B15.1.3 If a Bidder gives notice of withdrawal prior to the Submission Deadline, the Manager of Materials shall:

- (a) retain the Bid Submission until after the Submission Deadline has elapsed;
- (b) open the Bid Submission to identify the contact person named in Paragraph 3 of Form A: Bid and the Bidder's authorized representatives named in Paragraph 12 of Form A: Bid; and
- (c) if the notice has been given by any one of the persons specified in B15.1.3(b), declare the Bid withdrawn.

B15.2 A Bidder who withdraws his Bid after the Submission Deadline but before his Bid has been released or has lapsed as provided for in B14.2 shall be liable for such damages as are imposed upon the Bidder by law and subject to such sanctions as the Chief Administrative

Officer considers appropriate in the circumstances. The City, in such event, shall be entitled to all rights and remedies available to it at law, including the right to retain the Bidder's bid security.

B16. EVALUATION OF BIDS

B16.1 Award of the Contract shall be based on the following bid evaluation criteria:

- (a) compliance by the Bidder with the requirements of the Bid Opportunity (pass/fail);
- (b) qualifications of the Bidder and the Subcontractors, if any, pursuant to B11 (pass/fail);
- (c) Evaluated Bid Price, pursuant to B16.4;
- (d) economic analysis of any approved alternative pursuant to B6.

B16.2 Further to B16.1(a), the Award Authority may reject a Bid as being non-responsive if the Bid Submission is incomplete, obscure or conditional, or contains additions, deletions, alterations or other irregularities. The Award Authority may reject all or any part of any Bid, or waive technical requirements if the interests of the City so require.

B16.3 Further to B16.1(b), the Award Authority shall reject any Bid submitted by a Bidder who does not demonstrate, in his Bid Submission or in other information required to be submitted, that he is responsible and qualified.

B16.4 Further to B16.1(c), the evaluated Bid Price shall be the Total Bid Price from Form B: Prices adjusted for the comparison of Bids only, by adding operating costs based on a ten (10) year net present value analysis with a 4% discount rate.

B16.4.1 The operating cost adjustment will be the operating cost of the equipment based on the Contract Administrator's estimate of :

- (a) The process electrical and natural gas costs based on the information submitted by the Bidder in Form N: Salient Features.
- (b) The Salt consumption based on the information submitted by the Bidder in Form N: Salient Features.

B16.4.2 Energy costs used in the operating cost adjustment will be based on current utility rates applicable to services of a size and type expected for the completed WTP. The utility rates, equipment efficiencies and power factors determined by the Contract Administrator will be used to establish the Evaluated Bid Price.

B16.4.3 Bulk Salt costs used in the operating cost adjustment will be based on current supply costs for contracts of the size and type expected for the completed WTP. The rates determined by the Contract Administrator will be used to establish the Evaluated Bid Price.

B16.4.4 For the purposes of the Evaluated Bid Price, the Contract Administrator will assume:

- (a) The WTP service water system operates under the following conditions over the course of a year:
 - (i) Average City of Winnipeg water temperature from June 1 to September 30 (122 days total) is 20.1°C.
 - (ii) Average City of Winnipeg water temperature from October 1 to October 31 and from May 1 to May 31 (62 days total) is 10.1°C.
 - (iii) Average City of Winnipeg water temperature from November 1 to April 30 (181 days total) is 2.3°C.
 - (iv) Sodium hypochlorite generation system average daily WTP service water requirement is 95,250 litres/day.
 - (v) Boiler efficiency for the WTP service water is 80%.

- (b) If the WTP service water temperature assumed in B16.4.4(a) is lower than the required WTP service water temperature guaranteed in item 1.3 of Form N: Salient Features then the Contract Administrator will assume:
 - (i) That the WTP service water will be heated (by the City) to achieve the minimum required WTP service water temperature and these energy charges will become part of the Evaluated Bid Price in accordance with B16.4.2.
 - (ii) The amount of WTP service water heating required will be the difference between the minimum monthly City of Winnipeg water temperature averages specified in B16.4.4(a) and the minimum required WTP service water temperature guaranteed by the Bidder in Form N: Salient Features.
 - (iii) The minimum WTP service water temperature increase via optional heat exchanger will be the difference in temperature between the minimum monthly City of Winnipeg water temperature averages specified in B16.4.4(a) and the minimum heat exchanger temperature rise guaranteed by the Bidder in Form N: Salient Features.

B16.4.5 The adjustment to the Total Bid Price are for the purposes of evaluating and comparing Bids and will not affect the Contract Price. The Bidder is, however, advised to consider the provisions of D20. Liquidated Damages.

B16.5 This Contract will be awarded as a whole.

B17. AWARD OF CONTRACT

B17.1 The City will give notice of the award of the Contract or will give notice that no award will be made.

B17.2 The City will have no obligation to award a Contract to a Bidder, even though one or all of the Bidders are determined to be responsible and qualified, and the Bids are determined to be responsive.

B17.2.1 Without limiting the generality of B17.2, the City will have no obligation to award a Contract where:

- (a) the prices exceed the available City funds for the Work;
- (b) the prices are materially in excess of the prices received for similar work in the past;
- (c) the prices are materially in excess of the City's cost to perform the Work, or a significant portion thereof, with its own forces;
- (d) only one Bid is received; or
- (e) in the judgment of the Award Authority, the interests of the City would best be served by not awarding a Contract.

B17.3 Where an award of Contract is made by the City, the award shall be made to the responsible and qualified Bidder submitting the lowest evaluated responsive Bid.

PART C - GENERAL CONDITIONS

C1. GENERAL CONDITIONS

C1.1 The *General Conditions for the Supply and Delivery of Goods* (Form 21: 88 03) are applicable to the Work of the Contract.

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

PART D - SUPPLEMENTAL CONDITIONS

GENERAL

D1. GENERAL CONDITIONS

- D1.1 In addition to the *General Conditions for the Supply and Delivery of Goods*, these Supplemental Conditions are applicable to the Work of the Contract.
- D1.2 The General Conditions are amended by striking out "The City of Winnipeg Act" wherever it appears in the General Conditions and substituting "The City of Winnipeg Charter".
- D1.3 The General Conditions are amended by striking out "Board of Commissioners" or "Commissioner" wherever it appears in the General Conditions and substituting the "Chief Administrative Officer".
- D1.4 The General Conditions are amended by striking out "Tender Package" wherever it appears in the General Conditions and substituting "Bid Opportunity".
- D1.5 The General Conditions are amended by striking out "Tender Submission" wherever it appears in the General Conditions and substituting "Bid Submission".
- D1.6 The General Conditions are amended by striking out "Bidding Instructions" wherever it appears in the General Conditions and substituting "Bidding Procedures".

D2. SCOPE OF WORK

- D2.1 The Work to be done under the Contract shall consist of the supply of on-site hypochlorite generation equipment.
- D2.2 The major components of the Work are as follows:
- (a) Supply and delivery to the City Warehouse of one complete hypochlorite generation system including (but not limited to) the scope specified generation system, storage tanks, pumps, motors, drives, spare parts and other accessories as specified in clause 1.5 of Section 11242.
 - (b) Installation and Performance Verification support as specified herein.
 - (c) Electrical scope as specified in Section 16015.
 - (d) Instrumentation and Controls scope as specified in Section 17015.

D3. DEFINITIONS

- D3.1 When used in this Bid Opportunity:
- (a) "**Business Day**" means any Calendar Day, other than a Saturday, Sunday, or a Statutory or Civic Holiday;
 - (b) "**Submission Deadline**" and "**Time and Date Set for the Final Receipt of Bids**" mean the time and date set out in the Bidding Procedures for final receipt of Bids;
 - (c) "**Installation Contractor and/or Installer**" means the General Contractor retained by the City, under a separate contract, to install the equipment supplied under this contract
 - (d) "**Substantial Performance**" shall have the meaning attributed to it in the Builders' Lien Act (Manitoba), or any successor legislation thereto.
 - (e) "**ANSI**" means American National Standards Institute

- (f) **ASME** means American Society of Mechanical Engineers
- (g) **ASTM** means American Society for Testing and Materials
- (h) **AWWA** means American Water Works Association
- (i) **CSA** means Canadian Standards Association
- (j) **DAF** means Dissolved Air Flotation
- (k) **IEC** means International Electrotechnical Commission
- (l) **ISO** means International Organization for Standardization
- (m) **NACE** means National Association of Corrosion Engineers
- (n) **NEMA** means National Electrical Manufacturers Association
- (o) **NSF** means National Sanitation Foundation
- (p) **SAE** means Society of Automotive Engineers
- (q) **Manufacturer** means the person, partnership or corporation responsible for the manufacture and fabrication of equipment supplied by the Contractor to the City for the completion of the Work.
- (r) **Manufacturer's Representative** means a trained serviceman empowered by the Manufacturer to provide installation, testing, and commissioning assistance to the City in his performance of those functions.
- (s) **IEEE** means Institute of Electrical and Electronics Engineers
- (t) **NEMA** means National Electrical Manufacturer's Association
- (u) **Furnish** means supply
- (v) **ISA** means the Instrumentation Systems and Automation Society
- (w) **Total Performance** means that the entire Work, except those items arising from the Provision of GC.10.01 have been performed in accordance with this Contract
- (x) **AGMA** means American Gear Manufacturer's Association.
- (y) **API** means American Petroleum Institute
- (z) **EEMAC** means Electrical and Electronic Manufacturer of Canada
- (aa) **VFD** means variable frequency drive
- (bb) **VSD** means variable speed drive
- (cc) **TPSH** means twisted pair shielded cable
- (dd) **RTD** means resistance temperature detector
- (ee) **SHG** means sodium hypochlorite generation
- (ff) **NaCl** means sodium chloride
- (gg) **Salt** means a material containing a minimum of 96.3% NaCl and conforming to the specification of clause 2.9.3 of Section 11242
- (hh) **Contract Work Schedule** means a Gantt Charter developed by the Contractor developed using the critical path method which shows the proposed progress of the major items of work which are to be performed under this Contract
- (ii) **Project Master Schedule** means a schedule developed by the Contract Administrator which includes and coordinates the Contract Work Schedules of several City contracts, including this Contract
- (jj) **Professional Engineer** means a professional engineer registered in the Province of Manitoba.

- (kk) **Major Equipment** means all equipment for which shop drawing submittals are required as specified herein.
- (ll) **Performance Verification** means all factory and field tests, demonstrations and other activities required from the Contractor to complete all required Forms 103 – Certificate of Satisfactory Performance and to demonstrate to the Contract Administrator's satisfaction that the equipment installed under this Contract is performing as specified herein.
- (mm) **Certified Shop Drawings** means Shop Drawings prepared by the Contractor after all required Shop Drawings have been "reviewed" or "reviewed as modified" in accordance with Section 01300 of this Bid Opportunity and which incorporate all modifications to the Shop Drawings, comments and notations made by the Contract Administrator in the course of the review.
- (nn) **Acceptable Shop Drawings** means all required Shop Drawings have been reviewed by the Contract Administrator and have been annotated and stamped as "reviewed" or "reviewed as modified" in accordance with Section 01300 of this Bid Opportunity.
- (oo) **Commissioning Period** means the time between the completion of Performance Verification and Total Performance during which a system is operated under Commissioning Operations Agent's control to demonstrate to the City that it operates in conformance with the design intent.
- (pp) **Commissioning Operations Agent** means a qualified maintenance/operations team that takes primary responsibility for operation and maintenance of the WTP during the Commissioning Period.
- (qq) **Control System Integrator** means a contractor retained by the City (under a different contract) to program and configure the water treatment plant SCADA system.
- (rr) **Systems Integrator** means Control Systems Integrator.
- (ss) **Process Unit** means the Manufacturer's complete equipment package including individual process components, skid mounted equipment and any related appurtenances.
- (tt) **SCADA** means supervisor control and data acquisition.
- (uu) **TGS** means Manitoba Transportation and Government Service.
- (vv) **MV** means medium voltage.
- (ww) **WTP** means the Winnipeg Water Treatment Plant and includes the structure and all equipment and materials supplied and installed into the building, under multiple construction contracts, including portions of the Work provided under this Contract.
- (xx) **City Warehouse** means the enclosed and heated City owned warehouse located at 1500 Plessis Road, Winnipeg, Manitoba.
- (yy) **IPCEA** means Insulated Power Cable Engineers Association
- (zz) **EMT** means Electrical Metal Tubing
- (aaa) **ENT** means Electrical Non-Metal Tubing
- (bbb) **Fhp** means fractional horsepower
- (ccc) **XLPE** means Cross-Linked Polyethylene
- (ddd) **TVSS** means Total Volatile Suspended Solids
- (eee) **MCOV** means Maximum Continuous Operating Voltage

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

- D3.3 The Manufacturer and Manufacturer's Representative are not parties to this Contract. All work required from the Manufacturer and Manufacturer's Representative shall be provided and coordinated by the Contractor.
- D3.4 The technical terms related to pump operation shall be as defined in Section 11300 and the nomenclature of the Hydraulics Institute Standards.
- D3.5 Specialized terms relating to instrumentation and control and which are not explicitly defined herein shall be as defined in The Instrumentation Systems and Automation Society (ISA) S51.1, National Electrical Manufacturer's Association (NEMA) Industrial Control and Systems (ICS) 1, American National Standards Institute (ANSI)/Institute of Electrical and Electronic Engineers (IEEE) Std 100, and the Communications Standard Dictionary, by Martin H. Weik.

D4. CONTRACT ADMINISTRATOR

- D4.1 The Contract Administrator is UMA Projects (CM) Ltd., represented by:
Bill Richert, P. Eng.
Deacon Reservoir WTP Project Offices
RM of Springfield
Telephone No. (204) 986-6053
Facsimile No. (204) 986-8393
- D4.2 At the pre-construction meeting, the Contract Administrator will identify additional personnel representing the Contract Administrator and their respective roles and responsibilities for the Work.

D5. NOTICES

- D5.1 GC.7.05 is hereby amended to delete reference to "registered mail" and to replace same with "ordinary mail".
- D5.2 GC.7.05 is further amended hereby to include delivery by facsimile transmission (fax) as an acceptable means of delivering notices, consents, approvals, statements, authorizations, documents or other communications required or permitted to be given under this Contract. Deliveries by fax will be deemed to have been received on the day of delivery, if a business day, or if not a business day, on the business day next following the day of delivery.
- D5.3 Further to GC.7.05, all notices, consents, approvals, statements, authorizations, documents or other communications to the City, except as expressly otherwise required in D5.4, D5.5 or elsewhere in the Contract, shall be sent to the attention of the Contract Administrator at the address or facsimile number identified in D4.1.
- D5.4 All notices of appeal to the Chief Administrative Officer shall be sent to the following address or facsimile number:
The City of Winnipeg
Chief Administrative Officer Secretariat
Administration Building, 3rd Floor
510 Main Street
Winnipeg MB R3B 1B9
Facsimile No.: (204) 949-1174
- D5.5 All notices, requests, nominations, proposals, consents, approvals, statements, authorizations, documents or other communications required to be submitted or returned to the City Solicitor shall be sent to the following address or facsimile number:

The City of Winnipeg
Corporate Services Department
Legal Services Division
185 King Street, 3rd Floor
Winnipeg MB R3B 1J1
Facsimile No.: (204) 947-9155

D6. INDEMNITY

- D6.1 Notwithstanding GC.7.03, the Contractor shall save harmless and indemnify the City for twice the contract price plus two (2) million dollars against all costs, damages or expenses arising from actions, claims, demands and proceedings, by whomsoever brought, made or taken as a result of acts or omissions of the Contractor, his/her Subcontractors, employees or agents in the performance or purported performance of the Work, and more particularly from:
- (a) accidental injury to or death of any person whether retained by or in the employ of the Contractor or not, arising directly or indirectly by reason of the performance of the Work, or by reason of any trespass on or damage to property;
 - (b) damage to any property owned in whole or in part by the City, or which the City by duty or custom is obliged, directly or indirectly, in any way or to any degree, to construct, repair or maintain;
 - (c) damage to, or trespass or encroachment upon, property owned by persons other than the City;
 - (d) failure to pay and obtain a discharge of a notice of claim for lien served upon the City in accordance with the requirements of The Builder's Liens Act;
 - (e) failure to pay a Workers Compensation assessment, or Federal or Provincial taxes;
 - (f) unauthorized use of any design, device, material or process covered by letters patent, copyright, trademark or trade name in connection with the Work;
 - (g) inaccuracies in any information provided to the City by the Contractor.

SUBMISSIONS

D7. AUTHORITY TO CARRY ON BUSINESS

- D7.1 The Contractor shall be in good standing under The Corporations Act (Manitoba), or properly registered under The Business Names Registration Act (Manitoba), or otherwise properly registered, licensed or permitted by law to carry on business in Manitoba, or if the Contractor does not carry on business in Manitoba, in the jurisdiction where the Contractor does carry on business, throughout the term of the Contract, and shall provide the Contract Administrator with evidence thereof upon request.

D8. WORKERS COMPENSATION

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

D9. INSURANCE

- D9.1 The City will provide and maintain the following Project Insurance Coverages:
- (a) Builder's Risk Insurance in the amount of one hundred percent (100%) of the total project cost.

- (i) The Contractor shall be responsible for deductibles up to \$10,000.00 maximum of any one loss.
 - (b) Wrap-Up Liability Insurance in an amount of no less than 10 million dollars (\$10,000,000.00)
 - (i) The Contractor shall be responsible for deductibles up to \$10,000.00 maximum of any one loss.
 - (c) The City of Winnipeg will carry such insurance to cover all parties engaged in the Work in this Contract. Provision of this insurance by the City of Winnipeg is not intended in any way to relieve the Contractor from his obligations under the terms of the Contract. Specifically, losses relating to deductibles for insurance, as well as losses in excess of limits of coverage and any risk of loss that is not covered under the terms of the insurance provided by the City of Winnipeg remains with the Contractor.
- D9.2 The Contractor shall provide and maintain the following insurance coverage at all times during the performance of the Work:
 - (a) Automobile liability insurance for owned and non-owned automobiles used for or in connection with the work in the amount of at least two million dollars (\$2,000,000.00).
 - (i) Deductibles shall be borne by the Contractor;
 - (ii) The Contractor shall not cancel, materially alter, or cause the policy to lapse without providing at least fifteen (15) Calendar Days prior written notice to the Contract Administrator;
 - (iii) The Contractor shall provide the Contract Administrator with evidence of insurance of the policy at least two (2) Business Days prior to the commencement of any Work on the Site but in no event later than seven (7) Calendar Days from notification of the award of Contract.
- D9.3 The Contractor shall not cancel, materially alter, or cause each policy to lapse without providing at least fifteen (15) Calendar Days prior written notice to the Contract Administrator.

D10. MATERIAL SAFETY DATA SHEETS

- D10.1 The Contractor shall provide the Contract Administrator with one (1) copy of Material Safety Data Sheets (MSDS's) for each product to be supplied under the Contract at least two (2) Business Days prior to the commencement of Work but in no event later than the date specified in GC.3.01 for the return of the executed Contract.
- D10.2 Throughout the term of the Contract, the Contractor shall provide the Contract Administrator with revisions or updates of the MSDS's as soon as may be reasonably possible.

D11. PERFORMANCE SECURITY

- D11.1 The Contractor shall provide and maintain performance security until the expiration of the warranty period in the form of:
 - (a) a performance bond of a company registered to conduct the business of a surety in Manitoba, in the form attached to these Supplemental Conditions (Form H1: Performance Bond), in the amount of fifty percent (50%) of the Contract Price; or
 - (b) an irrevocable standby letter of credit issued by a bank or other financial institution registered to conduct business in Manitoba and drawn on a branch located in Winnipeg, in the form attached to these Supplemental Conditions (Form H2: Irrevocable Standby Letter of Credit), in the amount of fifty percent (50%) of the Contract Price; or

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

- D11.1.1 Where the performance security is in the form of a certified cheque or draft, it will be deposited by the City. The City will not pay any interest on certified cheques or drafts furnished as performance security.
- D11.2 If the bid security provided in his Bid Submission was not a certified cheque or draft pursuant to B12.1(c), the Contractor shall provide the City Solicitor with the required performance security within seven (7) Calendar Days of notification of the award of the Contract by way of letter of intent and prior to the commencement of any Work on the Site but in no event later than the date specified in GC.3.01 for the return of the executed Contract.

D12. SUBCONTRACTOR LIST

- D12.1 The Contractor shall provide the Contract Administrator with a complete list of the Subcontractors whom the Contractor proposes to engage (Form J: Subcontractor List) at least two (2) Business Days prior to the commencement of any Work on the Site but in no event later than the date specified in GC.3.01 for the return of the executed Contract.

D13. WORK SCHEDULE

- D13.1 The Contract Administrator has developed a Project Master Schedule for the project. This schedule will be available in the offices of the Contract Administrator and will be updated as required as the work progresses.
- D13.2 The Contractor shall, within 5 business days of award of contract, prepare a detailed Contract Work Schedule for his work based on a critical path method (CPM) approach.
- D13.3 The schedule shall conform to the Project Master Schedule and show, in a clear graphical manner, through the use of Gantt charts, in a maximum of weekly stages, the proposed progress of the main items, structures and subtrades of the contract and indicate the labour, construction crews, plant and equipment to be employed. Indicate the delivery date of major pieces of equipment to be supplied. The schedule shall be predicated on the completion of all work on or before the date of Total Performance.
- D13.4 Upon acceptance by the Contract Administrator, distribute copies of the revised schedule to Subcontractors and other concerned parties.
- D13.5 The Contract Work Schedule shall be updated as the work requires and submitted to the Contract Administrator.
- D13.6 The Contractor shall instruct recipients to report to the Contractor immediately any problems anticipated by the timetable shown in the Contract Work Schedule.
- D13.7 While it is intended that the Contractor shall be allowed, in general, to carry on the Contract in accordance with such general plans as may appear to him to be most desirable, the Contract Administrator, at his discretion, may direct the order in which, and points at which, the work shall be undertaken.
- D13.8 This control shall be exercised in the interests of the City so that the work or other Contractors who may be working on the site may be coordinated with the work on this Contract. A program of work will be drawn up and agreed to before the commencement of the Contract.
- D13.9 The Contract Administrator shall be notified immediately when the work under the Contract Work Schedule will adversely affect the work of other Contractors and the critical path of the

Project Master Schedule as the work under the Contractor's Contract Work Schedule is an integral part of the Project Master Schedule.

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

D14. SECURITY CLEARANCE

- D14.1 Each individual proposed to perform Work on the Site shall be required to obtain a Criminal Record Search Certificate from the police service having jurisdiction at his place of residence.
- D14.2 Prior to the commencement of any Work on the Site, and during the term of the Contract if additional or replacement individuals are proposed to perform Work, the Contractor shall supply the Contract Administrator with a Criminal Record Search Certificate obtained not earlier than one (1) year prior to the Submission Deadline, or a certified true copy thereof, for each individual proposed to perform Work within City facilities or on private property.
- D14.3 Any individual for whom a Criminal Record Search Certificate is not provided, or for whom a Criminal Record Search Certificate indicates any convictions or pending charges related to property offences or crimes against another person, will not be permitted to perform any Work within City facilities or on private property.
- D14.4 Any Criminal Record Search Certificate obtained thereby will be deemed valid for the duration of the Contract subject to a repeated records search as hereinafter specified.
- D14.5 Notwithstanding the foregoing, at any time during the term of the Contract, the City may, at its sole discretion and acting reasonably, require an updated criminal records search. Any individual who fails to provide a satisfactory Criminal Record Search Certificate as a result of a repeated criminal records search will not be permitted to continue to perform Work under the Contract within City facilities or on private property.

D15. INSTRUMENTATION AND CONTROLS

- D15.1 Within ten (10) business days of the notification of the Award of Contract by the way of Letter of Intent, the Contractor shall provide a list of products to be provided under Division 17

SCHEDULE OF WORK

D16. COMMENCEMENT

- D16.1 The Contractor shall not commence any Work until he is in receipt of a letter of intent from the Award Authority authorizing the commencement of the Work.
- D16.2 The Contractor shall not commence any Work on the Site until:
- (a) the Contract Administrator has confirmed receipt and approval of:
 - (i) evidence that the Contractor is in good standing under The Corporations Act (Manitoba), or properly registered under The Business Names Registration Act (Manitoba), or otherwise properly registered, licensed or permitted by law to carry on business in Manitoba;
 - (ii) evidence of the workers compensation coverage specified in D8;
 - (iii) evidence of the insurance specified in D9;
 - (iv) the Material Safety Data Sheets specified in D10;
 - (v) the performance security specified in D11;
 - (vi) the Subcontractor list specified in D12;

- (vii) the detailed work schedule specified in D13; and
 - (viii) the security clearances specified in D14.
- (b) the Contractor has attended a post-award meeting with the Contract Administrator, or the Contract Administrator has waived the requirement for a meeting. This meeting shall take place in Winnipeg, Manitoba approximately 10 days after the Award.

D17. CRITICAL STAGES

D17.1 The Contractor shall achieve critical stages of the Work in accordance with the following requirements:

- (a) Shop Drawings:
 - (i) Acceptable Shop Drawings for all Major Equipment shall be completed within 50 Business Days of the Award of the Contract. Shop Drawing completion shall not be achieved until drawings are reviewed by the Contract Administrator.
- (b) Delivery:
 - (i) Delivery of Goods to the Site shall begin no earlier than March 1, 2007 and be completed no later than March 31, 2007,
 - (ii) The detailed delivery schedule will be based on the Installation Contractor's and the City's requirements and will be coordinated by the Contract Administrator, and included in the Contract Work Schedule.
 - (iii) Delivery of the Goods shall be considered complete upon the issuance of Form 100: Certificate of Equipment Delivery and Form 101: Certificate of Readiness to Install. A separate form shall be provided for each major component. These forms are included in Section 01650. Form 101. Upon completion of Form 101, custody of the Goods will transfer to the Installation Contractor.
- (c) Satisfactory Installation: The Contractor shall provide support to the Installation Contractor as required to achieve satisfactory installation of all Goods by August 31, 2007.
 - (i) This support shall include (but is not limited to) providing a qualified representative on Site as required to assist the Installation Contractor in achieving satisfactory installation of the Goods supplied under this Contract.
 - (ii) Satisfactory installation shall be considered complete upon the issuance of Form 102: Certificate of Satisfactory Installation. A single form is required for the entire system.
- (d) Equipment Satisfactory Performance: Performance Verification shall begin no earlier than December 1, 2007 and shall be completed on or before achieving Substantial Performance.
 - (i) The Contract Administrator will coordinate the performance verification to coincide with the project commissioning schedule and will provide the Contractor a minimum of thirty (30) Calendar Days written notification of the acceptable date for the start of performance verification and training.
 - (ii) During the performance verification period the Contractor shall provide qualified representation on Site as required to assist the Installation Contractor in achieving and demonstrating satisfactory performance of the Goods supplied under this Contract.
 - (iii) Equipment satisfactory performance shall be considered complete upon the issuance of Form 103: Certificate of Equipment Satisfactory Performance
- (e) Satisfactory Training: Training for equipment supplied under this Contract shall begin after the completion of Form 103: Certificate of Equipment Satisfactory Performance for all equipment supplied under this Contract and prior to Total Performance. The detailed

schedule for this training will be prepared and provided by the Contract Administrator upon completion of Form 103: Certificate of Equipment Satisfactory Performance for all equipment supplied under this Contract. Training shall not be considered complete until Form T1 is completed for all equipment supplied under this Contract.

D17.2 The Contract Administrator will endeavour to review Shop Drawings within ten (10) Business Days upon their submission. If review is not made within that time period, Contract dates specified in D17.1(a) will be extended by an equivalent number of Business Days.

D17.3 All Shop Drawings submitted pursuant to D17.1(a) shall be provided in a single submission.

D18. SUBSTANTIAL PERFORMANCE

D18.1 The Contractor shall achieve Substantial Performance by January 31, 2008.

D18.2 When the Contractor considers the Work to be substantially performed, the Contractor shall arrange, attend and assist in the inspection of the Work with the Contract Administrator for purposes of verifying Substantial Performance. Any defects or deficiencies in the Work noted during that inspection shall be remedied by the Contractor at the earliest possible instance and the Contract Administrator notified so that the Work can be reinspected.

D18.3 The date on which the Work has been certified by the Contract Administrator as being substantially performed to the requirements of the Contract through the issue of a certificate of Substantial Performance is the date on which Substantial Performance has been achieved. .

D18.4 Satisfactory Performance cannot be achieved without the completion of Form 103 Certificate of Equipment Satisfactory Performance for all equipment supplied under this Contract.

D19. TOTAL PERFORMANCE

D19.1 The Contractor shall achieve Total Performance by December 31, 2008.

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

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

D19.4 Total Performance cannot be achieved without the completion of Form T1: Certificate of Satisfactory Training for all equipment supplied under this Contract.

D20. LIQUIDATED DAMAGES

D20.1 If the Contractor fails to achieve critical stages, Substantial Performance or Total Performance in accordance with the Contract by the days fixed herein for same, the Contractor shall pay the City the following amounts per Calendar Day for each and every Calendar Day following the days fixed herein for same during which such failure continues:

- (a) Acceptable Shop Drawings in accordance with D17.1(a) – two thousand, six hundred dollars (\$2,600.00);
- (b) Delivery in accordance with D17.1(b) – two thousand, six hundred dollars (\$2,600.00);
- (c) Satisfactory installation in accordance with D17.1(c) - zero dollars (\$0.00);

- (d) Substantial Performance – two thousand, six hundred dollars (\$2,600.00);
- (e) Total Performance – six hundred dollars (\$600).

D20.2 Guarantees provided by the Contractor in Form N: Salient Features, submitted with his Bid Submission shall be verified by the Contractor during Performance Verification by operating the equipment supplied under this Contract as specified in article 3.3 of Section 11242.

D20.2.1 If the Contractor fails to meet the performance guarantees of item 1.1 of Form N: Salient Features when the system is operated in accordance with D20.2, the Contractor shall pay the City \$17,000 for each 0.1 kg of Salt (per kg of chlorine produced) required above the guaranteed Salt consumption.

D20.2.2 If the Contractor fails to meet the performance guarantees of item 1.2 of Form N: Salient Features when the system is operated in accordance with D20.2, the Contractor shall pay the City \$13,500 for every 0.1 kW/kg of chlorine required above the guaranteed average electrical power demand.

D20.2.3 The Contract Administrator will monitor and measure the performance of the Goods during the performance verification tests specified in D20.2 for the purposes of assessing the liquidated damages.

D20.3 The amounts specified for liquidated damages in D20.1 and D20.2 are based on a genuine pre-estimate of the City's losses in the event that the Contractor does not achieve critical stages, Substantial Performance or Total Performance by the days fixed herein for same.

D20.4 The City may reduce any payment to the Contractor by the amount of any liquidated damages assessed.

D20.5 The City will not pay a bonus if the Contractor reaches critical stages, Substantial Performance or Total Performance earlier than the dates specified herein.

MEASUREMENT AND PAYMENT

D21. PAYMENT SCHEDULE

D21.1 Further to GC.9.01 and GC.9.03, payment shall be in accordance with the following payment schedule:

- (a) Measurement and payment for the Lump Sum Price as listed in Form B: Prices, shall include all Shop Drawings, equipment, accessories, spare parts, delivery, installation support, performance verification and training.
 - (i) Two (2) percent of the Lump Sum Price will be paid upon the issuance of Certified Shop Drawings.
 - (ii) Seventy-three (73) percent of the Lump Sum Price will be paid upon issuance of Forms 100: Certificate of Equipment Delivery and 101: Certificate of Readiness to Install and for transference of title to the City of Winnipeg for all major equipment.
 - (iii) A further ten (10) percent of the Lump Sum Price will be paid upon issuance of Form 102: Certificate of Satisfactory Installation.
 - (iv) A further ten (10) percent of the Lump Sum Price will be paid upon the issuance of Form 103: Certificate of Equipment Satisfactory Performance and
 - (v) A further five (5) percent of the Lump Sum Price will be paid upon the issuance of Form T1: Certificate of Satisfactory Training.
- (b) Further to GC.9.03:
 - (i) Any payment made by the City to the Contractor on account of a progress estimate shall be less any holdback required to be made by The Builders' Liens Act, and such

holdbacks or other amounts which the City is entitled to withhold pursuant to the Contract;

- D21.2 Payment on account of the final progress estimate, including the holdback made by the City pursuant to The Builders' Liens Act, shall be paid to the Contractor when the time for filing liens or trust claims has elapsed, unless the City is in receipt of a lien or trust claim.

WARRANTY

D22. WARRANTY

- D22.1 Further to GC.10.01, if a defect or deficiency prevents the full and normal use or operation of the Work or any portion thereof, for purposes of calculating the warranty period, time shall be deemed to cease to elapse for the defective or deficient portion, and for any portion of the Work whose use or operation is prevented by such defect or deficiency, as of the date on which the defect or deficiency is observed or the use or operation is prevented and shall begin to run again when the defect or deficiency has been corrected or the Work may be used or operated to the satisfaction of the Contract Administrator.
- D22.2 Notwithstanding GC.10.01, GC.10.02 and D22.1, if any law of Manitoba or of the jurisdiction in which the Work was manufactured requires, or if the manufacturer provides, a longer warranty period or a warranty which is more extensive in its nature, then the provisions of such law or manufacturer's warranty shall apply.
- D22.3 The warranty period for all Goods specified in Section 16815 shall be two years from Total Performance.
- D22.3.1 Prior to Substantial Performance, the Contractor shall provide written approval from the VFD and motor manufacturers certifying that both pieces of equipment are compatible when used together and maintain their individual warranties. One such written approval shall be provided for each different VFD and motor pair.
- D22.3.2 For the purpose of Performance Security, the warranty period shall be one (1) year from Total Performance.
- D22.4 New components which replace defective components under warranty shall have a warranty period identical to the warranty period that replaced component had at Total Performance. The warranty period for the new components shall begin on the date that they are performance tested and accepted by the City.

CONTROL OF WORK

D23. PRIME CONTRACTOR – THE WORKPLACE SAFETY AND HEALTH ACT

- D23.1 Further to GC6.26, UMA Projects (CM) Ltd. shall be the Prime Contractor and shall serve as, and have the duties of the Prime Contractor in accordance with The Workplace Safety and Health Act (Manitoba).
- D23.2 As Prime Contractor, UMA Projects (CM) Ltd. will administer a Project Safety and Health Management Plan. Compliance with this Plan will be mandatory for all personnel on the construction site and training and certification of all staff by the Prime Contractor's Safety Officer will be required.
- D23.3 The Water Treatment Program Project Health and Safety Management Plan is available on the City of Winnipeg, Corporate Finance, Materials Management Branch internet site at <http://www.winnipeg.ca/matmgt/projects>

FORM H1: PERFORMANCE BOND
(See D11)

KNOW ALL MEN BY THESE PRESENTS THAT

_____ ,
(hereinafter called the "Principal"), and

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

_____ dollars (\$_____)

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

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

_____ day of _____, 20____, for:

BID OPPORTUNITY NO. 49-2006

WINNIPEG WATER TREATMENT PROGRAM – SUPPLY OF ONSITE HYPOCHLORITE GENERATION EQUIPMENT

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

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

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

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

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

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

_____ day of _____, 20____ .

SIGNED AND SEALED
in the presence of:

(Witness)

(Name of Principal)

Per: _____ (Seal)

Per: _____

(Name of Surety)

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

**FORM H2: IRREVOCABLE STANDBY LETTER OF CREDIT
(PERFORMANCE SECURITY)**
(See D11)

(Date)

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

RE: PERFORMANCE SECURITY - BID OPPORTUNITY NO. 49-2006

WINNIPEG WATER TREATMENT PROGRAM – SUPPLY OF ONSITE HYPOCHLORITE GENERATION EQUIPMENT

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

(Name of Contractor)

(Address of Contractor)

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

_____ Canadian dollars.

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

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

Partial drawings are permitted.

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

(Address)

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

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

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

(Date)

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

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

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

(Name of bank or financial institution)

Per: _____
(Authorized Signing Officer)

Per: _____
(Authorized Signing Officer)

PART E - SPECIFICATIONS

GENERAL

E1. GENERAL

E1.1 These Specifications shall apply to the Work.

E1.2 The following are applicable to the Work:

Specification Sections

Division 01 – General Requirements

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

Division 11 – Process

11000	Equipment General Provisions
11242	Sodium Hypochlorite Generation System
11300	Process Pump General Requirements
11901	Factory Applied Maintenance and Corrosion Protection Coatings

Division 13 – Special Construction

13205	Fiberglass Reinforced Storage Tanks
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Division 16 - Electrical

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

Division 17 – Instrumentation and Controls

17010	Instrumentation and Control General Requirements
17015	Scope of Supply
17110	Enclosures
17124	Instrumentation Cable
17130	Power Supplies
17140	Instrument Air Supply and Transmission
17211	Process Taps and Primary Elements
17212	Transmitters and Indicators
17213	Powered Actuators
17216	Switches and Relays
17274	Panel Instruments
17275	Miscellaneous Panel Devices
17300	Gas Detection Systems
17500	PLC and Operator Interface Requirements
17501	Operator Interface Requirements

Drawings

<u>City Drawing No.</u>	<u>Consultant Drawing No.</u>	<u>Description</u>
1-0601J-G-P0001-001-00D	WJ-P0001	Process & Instrumentation Diagram – Salt Offloading and Brine Tanks – Sodium Hypochlorite Onsite Generation
1-0601J-G-P0002-001-00D	WJ-P0002	Process & Instrumentation Diagram – Brine Pumps 1 to 4 – Sodium Hypochlorite Onsite Generation
1-0601J-G-P0003-001-00D	WJ-P0003	Process & Instrumentation Diagram – Electrolytic Cells 1 to 3 – Sodium Hypochlorite Onsite Generation
1-0601J-G-P0004-001-00D	WJ-P0004	Process & Instrumentation Diagram – 12% Bulks Sodium Hypochlorite Blending Station – Sodium Hypochlorite Onsite Generation
1-0601J-G-P0005-001-00D	WJ-P0005	Process & Instrumentation Diagram – 0.8% Bulks Sodium Hypochlorite Tanks – Sodium Hypochlorite Onsite Generation
1-0601J-G-P0006-001-00D	WJ-P0006	Process & Instrumentation Diagram – Sodium Hypochlorite Feed Pumps 1 to 4 – Sodium Hypochlorite Onsite Generation
1-0601M-D-P0001-001-00D	WM-P0001	Construction Standards – Process and Instrumentation - Identification
1-0601M-D-P0002-001-00D	WM-P0002	Construction Standards – Process and Instrumentation - Symbols

E2. GOODS

E2.1 The Contractor shall supply hypochlorite generation equipment in accordance with the requirements hereinafter specified.

SUBMITTALS

1. SHOP DRAWINGS

1.1 General

- .1 Arrange for the preparation of clearly identified Shop Drawings as specified or as the Contract Administrator may reasonably request. Shop Drawings are to clearly indicate materials, methods of construction, and attachment or anchorage, erection diagrams, connections, explanatory notes, and other information necessary for completion of the Work. Where articles or equipment attach or connect to other articles or equipment, clearly indicate that all such attachments and connections have been properly coordinated, regardless of the trade under which the adjacent articles or equipment will be supplied and installed. Shop Drawings are to indicate their relationship to design Drawings and Specifications. Notify the Contract Administrator of any deviations in Shop Drawings from the requirements of the Contract Documents to allow the Contract Administrator to assess the deviations.
- .2 Where all or part of the Shop Drawings are to be prepared under the stamp and seal of a Professional Engineer registered in the Province of Manitoba, the Contract Administrator will limit that review to an assessment of the completeness of the part of the submission so stamped and sealed.

1.2 Electrical and Controls Installation Information

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

1.3 Submission Requirements

- .1 Coordinate each submission with requirements of the Work and Contract Documents. Individual submissions will not be reviewed until all related information is available.
- .2 Accompany submissions with a transmittal letter, in duplicate, containing:
 - .1 Date
 - .2 Project title and number
 - .3 Contractor's name and address
 - .4 Identification and quantity of each Shop Drawing product
 - .5 Equipment tag number
 - .6 Other pertinent data
- .3 Submissions shall include:
 - .1 Date and revision dates

SUBMITTALS

- .2 Project title and number
- .3 Name and address of:
 - .1 Contractor
 - .2 Manufacturer
- .4 Contractor's stamp, signed by Contractor's authorized representative, certifying approval of submissions, verification of field measurements and compliance with Contract Documents.
- .5 As required in the specifications, the seal and signature of a Professional Engineer registered in the Province of Manitoba.
- .4 Details of appropriate portions of work as applicable:
 - .1 Fabrication
 - .2 Layout showing dimensions including identified field dimensions and clearances
 - .3 Setting or erection details
 - .4 Capacities
 - .5 Performance characteristics
 - .6 Standards
 - .7 Operating weight
 - .8 Wiring diagrams
 - .9 Single line and schematic diagrams
 - .10 Method of control of equipment and its communication with the City's SCADA system

1.4 Drawings

- .1 Original Drawings or modified standard Drawings provided by the Contractor to illustrate details of portions of Work which are specific to project requirements.
- .2 Maximum sheet size: 850 x 1050 mm.
- .3 Submit six (6) prints and one (1) reproducible copy of Shop Drawings. The Contract Administrator will return the reproducible copy with comments transcribed.
- .4 Cross-reference Shop Drawing information to applicable portions of the Contract Documents.

SUBMITTALS

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

1.5 Product Data

- .1 Product Data; Manufacturer's catalogue sheets, brochures, literature, performance charts, and diagrams used to illustrate standard manufactured products.
- .2 Submit six (6) copies of product data.
- .3 Sheet size: 215 x 280 mm.

1.6 Electronic Submittals

- .1 Provide electronic copies of all submittals within sixty (60) business days of stamped "REVIEWED" or "REVIEWED AS MODIFIED".

1.7 Shop Drawing Review

- .1 Shop Drawing review by the Contract Administrator is solely to ascertain conformance with the general design concept. Responsibility for the approval of detail design inherent in Shop Drawings rests with the Contractor and review by the Contract Administrator shall not imply such approval.
- .2 Review by the Contract Administrator shall not relieve the Contractor of his responsibility for errors or omissions in Shop Drawings or for proper completion of the Work in accordance with the Contract Documents.
- .3 Shop Drawings will be returned to the Contractor with one of the following notations:
 - .1 When stamped "REVIEWED", distribute additional copies as required for execution of the Work.
 - .2 When stamped "REVIEWED AS MODIFIED", ensure that all copies for use are modified and distributed, same as specified for "REVIEWED".
 - .3 When stamped "REVISE AND RE-SUBMIT", make the necessary revisions, as indicated, consistent with the Contract Documents and submit again for review.
 - .4 When stamped "NOT REVIEWED", submit other drawings, brochures, etc., for review consistent with the Contract Documents.
 - .5 Only Shop Drawings bearing "REVIEWED" or "REVIEWED AS MODIFIED" shall be used on the Work unless otherwise authorized by the Contract Administrator.
- .4 After submittals are stamped "REVIEWED" or "REVIEWED AS MODIFIED", no further revisions are permitted unless re-submitted to the Contract Administrator for further review.

SUBMITTALS

- .5 Any adjustments made on Shop Drawings by the Contract Administrator are not intended to change the Contract Price. If it is deemed that such adjustments affect the Contract Price, clearly state as such in writing prior to proceeding with fabrication and installation of Work.
- .6 Make changes in Shop Drawings which the Contract Administrator may require consistent with Contract Documents. When re-submitting, notify the Contract Administrator in writing of any revisions other than those requested by the Contract Administrator.
- .7 Shop Drawings indicating design requirements not included in the Contract Documents require the seal of a Professional Engineer, registered in the Province of Manitoba. If requested, submit engineering calculations for review, sealed by a Professional Engineer.

1.8 Operating and Maintenance Manuals

- .1 Refer to Section 01730 – Operation and Maintenance Manuals.

END OF SECTION

QUALITY CONTROL

1. CODES AND STANDARDS

- .1 In the case of a conflict or discrepancy between the Contract Documents and the governing standards, the more stringent requirements shall apply.
- .2 Unless the edition number and date are specified, the reference to the Manufacturer's and published codes, standards, and Specifications are to be the latest edition published by the issuing authority, current at the Submission Deadline.
- .3 Reference standards and Specifications are quoted in this Specification to establish minimum standards. Work in quality exceeding these minimum standards conforms to the Contract.
- .4 Where reference is made to a Manufacturer's direction, instruction, or Specification, it is deemed to include full information on storing, handling, preparing, mixing, installing, erecting, applying, or other matters concerning the products pertinent to their use and their relationship to the products with which they are incorporated.
- .5 Confine apparatus, the storage of products, and the operations of workers to limits indicated by laws, ordinances, permits, and by directions of the Contract Administrator. Do not unreasonably encumber the premises with products.
- .6 Where reference is made to regulatory authorities, it includes all authorities who have, within their constituted powers, the right to enforce the laws of the place of Work.

2. TESTING AND QUALITY CONTROL

- .1 Provide to the Contract Administrator, when requested and consistent with progress of the Work, test results and designs specified in the Contract Documents or required by by-laws, statutes, and regulations relating to the Work and the preservation of public health, including the following:
 - .1 Inspection and testing performed exclusively for the Contractor's convenience.
 - .2 Testing, adjusting, and balancing of process equipment and systems, conveying equipment and systems, mechanical, electrical, and I&C equipment and systems.
 - .3 Mill tests and certificates of compliance.
 - .4 Tests for reinforcing steel unidentified by mill test reports.
- .2 The Contract Administrator will select and the City will pay for the services of a testing agency or laboratory for material quality control tests that are required but not specified. Tests required by by-laws, statutes, and regulations applicable to the Work are the responsibility of the Contractor.
- .3 Compliance and performance testing of equipment, pipe, conduit, wiring, and other items covered in other Divisions of this Specification are the responsibility of the Contractor,

QUALITY CONTROL

- unless specified otherwise. The City may replicate any series of tests to provide random checks on the compliance and performance tests at the City's cost.
- .4 Remove and replace products indicated in inspection and test reports as failing to comply with the Contract Documents.
 - .5 Correct improper installation procedures reported in the inspection and test reports.
 - .6 Pay the costs for the re-inspection and re-testing of replaced Work.
 - .7 It is not the responsibility of the inspection and testing agents to supervise, instruct in current methods or accept or reject a part of the Work, but only to inspect, test, and to report conditions.
 - .8 Notify the Contract Administrator and the appropriate inspection and testing agent not less than forty eight (48) hours prior to the commencement of the part of the Work to be inspected and tested.
 - .9 Ensure the presence of the authorized inspection and testing agent at the commencement of the part of the Work specified to be inspected or tested.
 - .10 Ensure the inspection and testing reports are issued within forty eight (48) hours, and that the Contract Administrator is notified forthwith if the report indicates improper conditions or procedures.
 - .11 Cooperate with and provide facilities for the inspection and testing agents to perform their duties.
 - .12 Provide proper facilities for the storage of specimens or samples at correct temperature, free from vibration or damage in accordance with the instruction of the inspection and testing agent and the governing standard.
 - .13 Submit four (4) copies of each laboratory test report, unless specified otherwise, each copy signed by a responsible officer of the inspection and testing laboratory. Each report is to include:
 - .1 Date of issue.
 - .2 Contract name and number.
 - .3 Name and address of inspection and testing company.
 - .4 Name and signature of inspector or tester.
 - .5 Date of inspection or test.
 - .6 Identification of the product and Specification Section covering inspected or tested Work.

QUALITY CONTROL

- .7 Location of the inspection or the location from which the tested product was derived.
- .8 Type of the inspection or test.
- .9 The remarks and observations on compliance with the Contract Documents.
- .14 Correct defective Work within the Contract Time; the performing of such Work is not a cause for an extension of the Contract Time.

END OF SECTION

EQUIPMENT INSTALLATION

1. INTENT

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

2. EXPERTISE AND RESPONSIBILITY

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

3. EQUIPMENT DELIVERY

- .1 The Contractor shall be responsible for receiving, off-loading, and placing into storage all equipment at the City Warehouse. Form 100 shall be completed.

4. INSTALLATION ASSISTANCE

- .1 The Contractor shall arrange for the attendance of the Manufacturer's Representative to meet with the Installation Contractor to provide instructions in the methods, techniques, precautions, and any other information relevant to the successful installation of the equipment prior to commencing installation of equipment.
- .2 The Contractor shall inform the Contract Administrator, in writing, of the attendance at the Site of any Manufacturer's Representative for installation training at least fourteen (14) days prior to arrival.
- .3 When the Manufacturer's Representative is satisfied that the Installation Contractor is aware of all installation requirements, he shall so certify by completing Form 101 attached to this Specification.
- .4 The completed form shall be delivered to the Contract Administrator prior to departure of the Manufacturer's Representative from the Site.
- .5 Installation of the equipment shall not commence until the Contract Administrator has advised that he has received the completed Form 101.
- .6 Separate copies of Form 101 shall be used for each individual unit process item of equipment.

EQUIPMENT INSTALLATION

5. INSTALLATION

- .1 If necessary, or if so directed by the Contract Administrator during the course of installation, the Installer may contact the Manufacturer to receive clarification of installation procedures, direction, or any other additional information necessary to continue or complete the installation in an appropriate manner. The Contractor shall provide this installation assistance at his own cost.
- .2 If it is found necessary, or if so directed by the Contract Administrator, the Installer may contact the Contractor who shall arrange for the Manufacturer's Representative to visit the Site to provide assistance during installation, all at the Contractor's cost.
- .3 Prior to completing installation, the Installer will inform the Contractor who shall arrange for the attendance at the Site of the Manufacturer's Representative to verify successful installation.
- .4 The Manufacturer's Representative shall conduct a detailed inspection of the installation including alignment, electrical connections, belt tensions, rotation direction, running clearances, lubrication, workmanship, and all other items as required to ensure successful operation of the equipment.
- .5 The Manufacturer's Representative shall identify any outstanding deficiencies in the installation.
- .6 The deficiencies shall be rectified by the Installer and the Manufacturer's Representative shall re-inspect the installation, at the Installation Contractor's cost.
- .7 When the Manufacturer's Representative accepts the installation, he shall certify the installation by completing Form 102, attached to this Specification.
- .8 Deliver the completed Form 102 to the Contract Administrator prior to departure of the Manufacturer's Representative from the Site.
- .9 Tag the equipment with a 100 mm x 200 mm card stating "EQUIPMENT CHECKED. DO NOT RUN." stencilled in large black letters. Sign and date each card.

6. OPERATION AND PERFORMANCE VERIFICATION

- .1 Equipment shall be subjected to a demonstration and performance tests after the installation has been verified and any identified deficiencies have been remedied and after completion of Form 102.
- .2 Inform the Contract Administrator at least fourteen (14) days in advance of conducting the tests and arrange for the attendance of the Manufacturer's Representative. The tests may be concurrent with the inspection of satisfactory installation if mutually agreed by the Installer, Contractor, and the Contract Administrator. All testing shall conform to the project schedule as directed by the Contract Administrator.

EQUIPMENT INSTALLATION

- .3 All operation and performance verification testing shall conform to the project master schedule.
- .4 The Manufacturer's Representative shall conduct all necessary checks to equipment and if necessary, advise the Installer of any further checking, flushing, cleaning, or other Work needed prior to confirming the equipment is ready to run.
- .5 The Contractor shall then operate the equipment for at least one (1) hour to demonstrate to himself the operation of the equipment and any required ancillary services. Any remedial measures required to ensure satisfactory operation shall be promptly undertaken.
- .6 The Contractor shall then notify the Contract Administrator of his readiness to demonstrate the operation of the equipment. The Contract Administrator will attend, as expeditiously as possible.
- .7 Demonstration:
 - .1 The Contractor shall then operate the equipment for at least one (1) hour to demonstrate to himself the operation of the equipment and any required ancillary services. Any remedial measures required to ensure satisfactory operation shall be promptly undertaken.
 - .2 The Contractor shall then notify the Contract Administrator of his readiness to demonstrate the operation of the equipment. The Contract Administrator shall attend, as expeditiously as possible.
 - .3 With the assistance of the Manufacturer's Representative, the Contractor will demonstrate that the equipment is properly installed. Alignment, piping connections, electrical connections, etc. will be checked and if appropriate, code certifications provided.
 - .4 The equipment shall then be run for one (1) hour. Local controls shall be satisfactorily verified by cycling the equipment through several start-stop operations, modulating its output, or some combination. Operating parameters such as temperature, pressure, voltage, vibration, etc., will be checked to ensure that they are within the specified or Manufacturer's recommended limits, whichever is more stringent.
 - .5 On satisfactory completion of the one (1) hour demonstration, the equipment will be stopped and critical parameters, such as alignment, will be rechecked.
- .8 Performance Test:
 - .1 The process performance test shall be in accordance with Section 11242 – Sodium Hypochlorite Generation System
- .9 All water, temporary power, heating, or any other ancillary services required to complete the initial demonstration, running test, and performance tests are the responsibility of the Installer. Chemicals are to be provided by the City.

EQUIPMENT INSTALLATION

- .10 Should the initial demonstration or performance tests reveal any defects, then those defects shall be promptly rectified and the demonstration, running tests, and/or performance tests shall be repeated to the satisfaction of the Contract Administrator. If the defects are attributed to the Contractor, additional costs incurred by the Installer, the Contract Administrator, or the City, due to repeat demonstration, running tests, and/or performance tests shall be the responsibility of the Contractor.
- .11 On successful completion of the demonstration and performance tests, Form 103 attached to this Specification shall be signed by the Manufacturer's Representative, the Installer, and the Contract Administrator.
- .12 When the Contract Administrator confirms that Forms have been completed for all unit processes in the WTP and they are ready to be operated in concert, the twenty eight (28) day performance testing period shall commence. The equipment supplied under this Contract shall operate continuously over the twenty eight (28) day period without experiencing a critical failure. A critical failure is defined as one that prevents the equipment from operating for an eight (8) hour period or that presents a safety hazard. For equipment that is designed not to operate on a daily basis, the performance testing period shall be defined as twenty eight (28) consecutive days over which the piece of equipment is operated. Upon completion of the twenty eight (28) day performance testing period, the equipment shall be deemed to have been handed-over and accepted by the Contract Administrator, unless the Contractor or Manufacturer's Representative is notified otherwise.

7. OPERATOR TRAINING

- .1 For equipment specified to include training, arrange for the attendance of the Manufacturer's Representative to provide classroom training session(s) to O&M staff.
- .2 The training sessions shall last two (2) days each unless otherwise specified. The training sessions shall be given twice, to allow the City's staff to attend either session. The training sessions shall be given after Form 103 has been completed but before Total Performance has been achieved.
- .3 Coordinate the training session(s) with the Contract Administrator.
- .4 Prepare a draft handout taking the form of the relevant sections of the O&M Manual supplemented with any other information needed to fully explain the equipment operation.
- .5 Prepare a draft agenda outlining the content of the training sessions. Allow half an hour at the beginning of the first period for the Contract Administrator to provide a summary of the design intent relating to that equipment. Following the engineering design overview, provide (as a minimum) information covering major equipment operation, mechanical and instrumentation engineering.
- .6 Submit the draft handout and draft agenda to the Contract Administrator for review. Upon obtaining the Contract Administrator's acceptance, prepare ten (10) copies of the handout and submit to the Contract Administrator.

EQUIPMENT INSTALLATION

- .7 Inform the Contract Administrator of any requirements for audio-visual aids five (5) days before the training session.
- .8 The Manufacturers' Representative shall provide five (5) sets of training seminar manuals in similar format to the O&M Manuals prior to the training session. In addition, the Manufacturers' Representative shall be responsible to document each training session with a detailed set of minutes.
- .9 Upon completion of training, the Contractor shall issue Form T1: Certificate of Satisfactory Training, complete with all required signatures.

EQUIPMENT INSTALLATION

**CERTIFICATE OF EQUIPMENT DELIVERY
FORM 100**

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

PROJECT: _____

ITEM OF EQUIPMENT: _____

TAG NO: _____

**REFERENCE
SPECIFICATION:** _____

(Authorized Signing Representative of the Contractor)

Date

(Authorized Signing Representative of Installer)

Date

(Authorized Signing Representative of the Contract Administrator)

Date

EQUIPMENT INSTALLATION

**CERTIFICATE OF READINESS TO INSTALL
FORM 101**

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

PROJECT: _____

ITEM OF EQUIPMENT: _____

TAG NO: _____

**REFERENCE
SPECIFICATION:** _____

(Authorized Signing Representative of the Manufacturer)

_____ Date

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

(Authorized Signing Representative of the Installer)

_____ Date

EQUIPMENT INSTALLATION

**CERTIFICATE OF SATISFACTORY INSTALLATION
FORM 102**

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

PROJECT: _____

ITEM OF EQUIPMENT: _____

TAG NO: _____

**REFERENCE
SPECIFICATION:** _____

OUTSTANDING DEFECTS: _____

(Authorized Signing Representative of the Manufacturer)

Date

(Authorized Signing Representative of the Installer)

Date

EQUIPMENT INSTALLATION

**CERTIFICATE OF EQUIPMENT SATISFACTORY PERFORMANCE
FORM 103**

We certify that the equipment listed below has been continuously operated for at least five (5) consecutive days and that the equipment operates satisfactorily and meets its specified operating criteria. No defects in the equipment were found. The equipment is therefore classed as "conforming".

PROJECT: _____

ITEM OF EQUIPMENT: _____

TAG NO: _____

**REFERENCE
SPECIFICATION:** _____

(Authorized Signing Representative of the Manufacturer)

Date

(Authorized Signing Representative of the Installer)

Date

(Authorized Signing Representative of the Contract Administrator)

Date

1. Acknowledgement of Receipt of O&M Manuals.

(Authorized Signing Representative of the City)

Date

EQUIPMENT INSTALLATION

**CERTIFICATE OF SATISFACTORY TRAINING
FORM T1**

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

PROJECT: _____

ITEM OF EQUIPMENT: _____

TAG NO: _____

**REFERENCE
SPECIFICATION:** _____

(Trainer)

Date

(Authorized Signing Representative of the Installer)

Date

(Authorized Signing Representative of the Contract Administrator)

Date

END OF SECTION

OPERATION AND MAINTENANCE MANUALS

1. DESCRIPTION

- .1 This Section supplements the requirements for the provision of O&M Manuals as described in Section 01300 – Submittals.
- .2 Furnish complete operations manuals and maintenance information as specified in this Section for installation, check-out, operation, maintenance, and lubrication requirements for each unit of mechanical, electrical, and instrumentation equipment or system and each instrument.
- .3 Customize the operations manuals and maintenance information to describe the equipment actually furnished. Do not include extraneous data for models, options, or sizes not furnished (cross out or remove if required). When more than one model or size of equipment type is furnished, show the information pertaining to each model, option, or size.
- .4 Assemble, coordinate, bind, and index required data into an O&M Manual.
- .5 Three (3) draft copies of the manuals shall be submitted a minimum of sixty (60) days prior to Substantial Performance of the Work for review and comments. A maximum of eight (8) weeks after review, twelve (12) copies of the final manuals shall be supplied.
- .6 In addition to the twelve (12) hard copies, submit an electronic version of the O&M Manual.
- .7 Materials: Label each Section with tabs protected with celluloid covers, fastened to hard paper dividing sheets.
- .8 Type lists and notes.
- .9 Drawings, diagrams and Manufacturer's literature must be legible. Drawings larger than 280 mm x 430 mm must be folded and placed inside plastic pockets.

2. OPERATION AND MAINTENANCE MANUAL CONTENTS AND ORGANIZATION

- .1 Provide the Manufacturer's standard O&M manuals for the equipment or instruments supplied. If the Manufacturer's standard manuals do not contain all the required information, provide the missing information in supplementary documents and Drawings inserted behind appropriate tabs in the manual binder.
- .2 When more than one (1) piece of identical equipment or instruments are supplied, provide only one (1) set of operations manuals.
- .3 One (1) set of operations manuals may be provided when more than one (1) piece of similar equipment or instruments are supplied, such as different sizes of the same model, and all similar pieces are covered in the same standard Manufacturer's O&M manual.
- .4 When similar equipment or instruments are provided by the same Manufacturer, but are not covered in the same standard Manufacturer's O&M manual, their specific manuals may be

OPERATION AND MAINTENANCE MANUALS

bound in the same three (3)-ring binder. Separate specific manuals with tab dividers labelled with the appropriate equipment numbers.

- .5 Provide a cover sheet, bound as the first page of each manual, with the following information:
 - .1 Contract name and number.
 - .2 Equipment number or, if more than one (1) piece of equipment is provided, equipment numbers for equipment or instruments covered by the manual. Include functional description of equipment after each number.
- .6 Provide a table of contents listing the contents of the manual and identifying where specific information can be located.
- .7 Insert the specific information described below in the O&M manuals in a format similar to that listed:
 - .1 Tab 1 – General Information
 - .1 Functional title of the system, equipment, material, or instrument.
 - .2 Relevant Specification Section number and Drawing reference.
 - .3 Address and telephone number of the Manufacturer and the nearest Manufacturer's Representative.
 - .2 Tab 2 - Equipment Data
 - .1 Insert Specification Section and completed Equipment and Instrumentation Data sheets for equipment supplied. Attach all Addenda, Change Orders, and change directives that refer to that specific item of equipment.
 - .3 Tab 3 – Operation Information
 - .1 Include the Manufacturer's recommended step-by-step procedures for starting and stopping under normal and emergency operation. Include all specified modes of operation including recommended operation after the assembly or equipment has been in long-term storage.
 - .2 Provide control diagrams with data and information to explain operation and control of systems and specific equipment. Identify normal operating setpoints and alarm conditions.
 - .3 Provide technical information on all alarms and monitoring devices provided with the equipment.
 - .4 Provide troubleshooting information. Clearly identify which problems to look for and how to solve them.

OPERATION AND MAINTENANCE MANUALS

- .4 Tab 4 - Technical Data
 - .1 Insert Manufacturer's Technical Specification and data sheets.
 - .2 Insert Manufacturer's certified performance and calibration curves for the equipment and instruments.
- .5 Tab 5 - Maintenance Information
 - .1 Include the description and schedule for all Manufacturers' recommended routine preventative maintenance procedures including specific lubrication recommendations. Indicate whether procedure is to be done daily, weekly, monthly, quarterly, semi-annually, annually, or fill in hours of operation.
- .6 Tab 6 - Maintenance Instructions
 - .1 Provide requirements to set up and check out each system for use. Include all required and recommended step-by-step inspections, lubrications, adjustments, alignments, balancing, and calibrations. Include protective device settings, warnings, and cautions to prevent equipment damage and to insure personnel safety.
 - .2 Provide Manufacturer's description of routine preventive maintenance, inspections, tests, and adjustments required to ensure proper and economical operation and to minimize corrective maintenance and repair.
 - .3 Provide Manufacturer's recommendations on procedures and instructions for correcting problems and making repairs.
 - .4 Provide step-by-step procedures to isolate the cause of typical malfunctions. Describe clearly why the checkout is performed and what conditions are to be sought. Identify tests or inspections and test equipment required to determine whether parts and equipment may be reused or require replacement.
 - .5 Provide step-by-step procedures and list special required tools and supplies for removal, replacement, disassembly, and assembly of components, assemblies, subassemblies, accessories, and attachments. Provide tolerances, dimensions, settings, and adjustments required.
- .7 Tab 7 - Assembly Drawings
 - .1 Provide Drawings which completely document the equipment, assembly, subassembly, or material for which the instruction is written. Provide the following Drawings as applicable: fabrication details, wiring and connection diagrams, electrical and piping schematics, block or logic diagrams, Shop Drawings, installation Drawings, layout and dimension Drawings, and electrical component fabrication Drawings.

OPERATION AND MAINTENANCE MANUALS

.2 Provide clear and legible illustrations, Drawings, and exploded views to enable easy identification of the items. When illustrations omit the part numbers and description, both the illustrations and separate listing shall show the index, reference, or key number which will cross-reference the illustrated part to the listed part. Parts shown in the listings shall be grouped by components, assemblies, and subassemblies.

.8 Tab 8 - Bills of Materials

.1 Provide a clear, legible copy of the Bill of Materials that was shipped with the equipment. The Bill of Materials should list all equipment, instruments, components, accessories, tools, and other items that were shipped with the equipment.

.9 Tab 9 - Lubrication Data

.1 Provide a table showing recommended lubricants for specific temperature ranges and applications.

.2 Provide charts with a schematic diagram of the equipment showing lubrication points, recommended types and grades of lubricants, and capacities.

.3 If the equipment or instrument is not lubricated, add a sheet under this Tab with the words "Not Applicable".

3. FIELD CHANGES

.1 Following the acceptable installation and operation of an equipment item, modify and supplement the item's instructions and procedures to reflect any field changes or information requiring field data.

4. PERFORMANCE TESTING DATA

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

.1 All completed equipment testing and performance testing forms.

.2 All completed equipment checklists and performance reports, including noise and vibration analysis, instrumentation calibration data, and all other relevant information.

.3 All system performance reports.

OPERATION AND MAINTENANCE MANUALS

5. WARRANTIES

- .1 Provide in hard cover three 3-ring binders for 215 x 280 mm paper labelled "Warranties" one (1) copy of:
 - .1 Manufacturers' standard Warrants and Guarantees. Include the name and telephone number of the contact person. Indicate the time frame of each Warrant or Guarantee on the list.

END OF SECTION

EQUIPMENT GENERAL PROVISIONS

1. GENERAL

1.1 Background

- .1 The City of Winnipeg treats and supplies potable water to a population of approximately 632,000 people. The source of supply for the City of Winnipeg is surface water originating from Shoal Lake. The water is chlorinated at the intake and is conveyed via an Aqueduct to the Deacon reservoir, located just east of the City. The Deacon reservoir consists of four (4) open cells and holds approximately fourteen (14) to twenty eight (28) days supply for the City. Water is rechlorinated as it leaves the reservoir through two (2) branch Aqueducts. The Water Distribution System contains three (3) regional distribution reservoirs and pumping stations.
- .2 The City of Winnipeg wishes to enhance the treatment of its potable water. Currently the City is in the process of working toward the commissioning of UV disinfection equipment, which will be located after the Deacon reservoir to assist in inactivation of *Giardia* and *Cryptosporidium*. Chlorine will continue to be used with ammonia to form a residual disinfectant in the distribution system.
- .3 The treatment process will be further enhanced by the construction of a filtration plant scheduled for completion in late 2007. The new filtration plant will consist of coagulation with ferric chloride, flocculation, clarification using DAF, ozonation, filtration, followed by disinfection using chlorine, UV light, and chloramination. The purpose of this tender document is to select and pre-purchase the SHG equipment. The selected equipment will be used as the basis to finalize the design prior to construction with an Installer(s) selected through the public tendering process.

1.2 Requirements

- .1 The provisions of this Section shall apply to all equipment except where otherwise specified.
- .2 Substantiating calculations and Drawings shall be submitted at the time of submittal.

1.3 Reference Specifications, Codes, and Standards

- .1 Equipment shall be in accordance with the latest edition of the following standards, as applicable and as specified in each equipment Specification:
 - .1 American Society for Testing and Materials (ASTM).
 - .2 American National Standards Institute (ANSI).
 - .3 American Society of Mechanical Engineers (ASME).
 - .4 American Water Works Association (AWWA).
 - .5 American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE).

EQUIPMENT GENERAL PROVISIONS

- .6 American Welding Society (AWS).
- .7 National Fire Protection Association (NFPA).
- .8 Federal Specifications (FS).
- .9 National Electrical Manufacturers Association (NEMA).
- .10 Manufacturer's published recommendations and Specifications.
- .11 General Industry Safety Orders (OSHA).
- .12 Canadian Standards Association (CSA).
- .13 Underwriters Laboratories of Canada (ULC).
- .2 The following standards are referenced in this Section:
 - .1 ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.
 - .2 ANSI B16.5 - Pipe Flanges and Flanged Fittings, Steel, Nickel Alloy and other Special Alloys.
 - .3 ANSI B46.1 - Surface Texture.
 - .4 ASME B1.20.1 - General Purpose Pipe Threads (Inch).
 - .5 ASME B31.1 - Power Piping.
 - .6 AWWA C206 - Field Welding of Steel Water Pipe.
 - .7 AWWA C207 - Steel Pipe Flanges for Waterworks Service - Sizes 4 In. Through 144 In. (100 mm through 3,600 mm).
 - .8 AWWA D100 - Welded Steel Tanks for Water Storage.
 - .9 ASTM A 48 - Gray Iron Castings.
 - .10 ASTM A 108 - Steel Bars, Carbon, Cold-Finished, Standard Quality.

1.4 Contractor Submittals

- .1 Shop Drawings: Furnish submittals in accordance with Section 01300 - Submittals.
- .2 Equipment Installation: Complete all documentation as required within Section 01650 – Equipment Installation.
- .3 Manuals: Provide manuals as specified within Section 01730 – Operation & Maintenance Manuals.

EQUIPMENT GENERAL PROVISIONS

- .4 Spare Parts List: A spare parts list complete with the name, address, and telephone number of the nearest distributor for each piece of equipment shall be provided.

1.5 Quality Assurance

- .1 Costs: Pay all costs of inspection, testing, adjustment, and instruction services performed by Manufacturer's representatives. The City will pay for power and water.
- .2 Quality and Tolerances: Tolerances and clearances shall be as shown on the Shop Drawings and shall be closely adhered to.
 - .1 Machine Work shall in all cases be of high-grade workmanship and finish, with due consideration to the special nature or function of the parts. Members without milled ends and which are to be framed to other steel parts of the structure may have a variation in the detailed length of not greater than 1.5 mm for members 10 m or less in length, and not greater than 3 mm for members over 10 m in length.
 - .2 Castings shall be homogeneous and free from non-metallic inclusions and defects. Surfaces of castings which are not machined shall be cleaned to remove foundry irregularities. Casting defects not exceeding 12.5% of the total thickness and where defects will not affect the strength and serviceability of the casting may be repaired by approved welding procedures.
 - .3 All materials shall meet the physical and mechanical properties in accordance with the reference standards.
- .3 Machine Finish: The type of finish shall be the most suitable for the application and shall be shown in micro-inches in accordance with ANSI B46.1. The following finishes shall be used:
 - .1 Surface roughness not greater than 63 micro-inches shall be required for all surfaces in sliding contact.
 - .2 Surface roughness not greater than 250 micro-inches shall be required for surfaces in contact where a tight joint is not required.
 - .3 Rough finish not greater than 500 micro-inches shall be required for other machined surfaces.
 - .4 Contact surfaces of shafts and stems which pass through stuffing boxes and contact surfaces of bearings shall be finished to not greater than 32 micro-inches.

2. PRODUCTS

2.1 General Requirements

- .1 Noise Level: When in operation, no single piece of equipment shall exceed the OSHA noise level requirement of 85 dBA for one (1) hour exposure per day.

EQUIPMENT GENERAL PROVISIONS

- .2 Drive Trains and Service Factors: Service factors shall be applied in the selection or design of mechanical power transmission components. All components of drive train assemblies between the prime mover and the driven equipment shall be designed and rated to deliver the maximum peak or starting torque, speed, and horsepower. All of the applicable service factors shall be considered, such as mechanical motors, load class, start frequency, ventilation, ambient temperature, and fan factors. Drive train components include couplings, shafts, gears and gear drives, drive chains, sprockets, and V-belt drives. Unless otherwise specified, the following load classifications shall apply in determining service factors:

Type of Equipment	Service Factor	Load Classification
Blowers centrifugal or vane lobe	1.0	Uniform
	1.25	Moderate Shock
Pumps peristaltic or hose	1.0	Uniform

- .3 Mechanical Service Factors

	Mechanical Service Factors
	Electric Motor
Uniform	1.25
Moderate Shock	1.50
Heavy Shock	2.00

- .4 For thermal rating adjustments such as start frequency, ambient temperature, and hourly duty cycle factor, ventilation factor, and fan factor, refer to gear Manufacturer sizing information.
- .5 Where load classifications are not specified, service factors based on AGMA 514.02 shall be used for standard load classifications and service factors for flexible couplings.
- .6 Welding: Unless otherwise specified, welding shall conform to the following:
- .1 Latest revision of AWWA D100.
 - .2 Latest revision of AWWA C206.
 - .3 Composite fabricated steel assemblies that are to be erected or installed inside a hydraulic structure, including any fixed or movable structural components of mechanical equipment, shall have continuous seal welds to prevent entrance of air or moisture.
 - .4 Welding shall be by the metal-arc method or gas-shielded arc method as described in the AWS "Welding Handbook" as supplemented by other pertinent standards of the AWS. Qualification of welders shall be in accordance with the AWS Standards.

EQUIPMENT GENERAL PROVISIONS

- .5 In assembly and during welding, the component parts shall be adequately clamped, supported, and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall be as specified by the AWS code. Upon completion of welding, weld splatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a workmanlike appearance, with uniform weld contours and dimensions. Sharp corners of material that is to be painted or coated shall be ground to a minimum of 0.8 mm ($1/32$ -inch) on the flat.
- .7 Protective Coating: Equipment shall be painted or coated as specified within each equipment Specification unless otherwise specified. Non-ferrous metal and corrosion-resisting steel surfaces shall be coated with food grade grease or lubricating oil. Coated surfaces shall be protected from abrasion or other damage during handling, testing, storing, assembly, and shipping.
- .8 Protection of Equipment: Equipment shall be boxed, crated, or otherwise protected from damage and moisture during shipment, handling, and storage. Equipment shall be protected from exposure to corrosive fumes and shall be kept thoroughly dry at all times. Equipment delivered to the Site with rust or corroded parts shall be rejected.
- .9 Vibration Isolators: Air compressors, blowers, engines, inline fans shall be provided with restrained spring-type vibration isolators or pads per Manufacturer's written recommendations. Vibration isolations shall be provided with seismic restraint.
- .10 Controls: Equipment and system controls shall be in accordance with Division 17 - Instrumentation.

2.2 Equipment Supports

- .1 Equipment Supports: Unless otherwise specified, equipment supports, anchors, and restrainers shall be adequately designed for static, dynamic, wind, and seismic loads. The design horizontal seismic force shall be the greater of: that noted in the general structural notes or as required by the governing building code, or 10% of gravity. Submitted design calculations for equipment supports shall bear the signature and seal of an engineer registered in Manitoba, unless otherwise specified.

EQUIPMENT GENERAL PROVISIONS

2.3 Couplings

- .1 Mechanical couplings shall be provided between the driver and the driven equipment. Flexible couplings shall be provided between the driver and the driven equipment to accommodate slight angular misalignment, parallel misalignment, end float, and to cushion shock loads. Unless otherwise specified or recommended by the Manufacturer, coupling type shall be furnished with the respective equipment as follows:

Equipment Type	Coupling Type
Single stage centrifugal blowers	Flexible disc pack

- .2 Each coupling size shall be determined based on the rated horsepower of the motor, speed of the shaft, and the load classification service factor. The equipment Manufacturer shall select or recommend the size and type of coupling required to suit each specific application.
- .3 Differential Settlement: Where differential settlement between the driver and the driven equipment may occur, two (2) sets of universal type couplings shall be provided.
- .4 Taper-Lock or equal bushings may be used to provide for easy installation and removal of shafts of various diameters.

2.4 Shafting

- .1 General: Shafting shall be continuous between bearings and shall be sized to transmit the power required. Keyways shall be accurately cut in line. Shafting shall not be turned down at the ends to accommodate bearings or sprockets whose bore is less than the diameter of the shaft. Shafts shall rotate in the end bearings and shall be turned and polished, straight, and true.
- .2 Design Criteria: All shafts shall be designed to carry the steady state and transient loads suitable for unlimited number of load applications, in accordance with ASME B106.1M, - Design of Transmission Shafting. Where shafts are subjected to fatigue stresses, such as frequent start and stop cycles, the mean stress shall be determined by using the modified Goodman Diagram. The maximum torsional stress shall not exceed the endurance limit of the shaft after application of the factor of safety of two (2) in the endurance limit and the stress concentration factor of the fillets in the shaft and keyway. Stress concentration factor shall be in accordance with ASME Standard B17.1 - Keys and Keyseats.
- .3 Materials: Shafting materials shall be appropriate for the type of service and torque transmitted. Environmental elements such as corrosive gases, moisture, and fluids shall be taken into consideration. Materials shall be as specified unless furnished as part of an equipment assembly.
 - .1 Low carbon cold-rolled steel shafting shall conform to ASTM A108, Grade 1018.
 - .2 Medium carbon cold-rolled shafting shall conform to ASTM A108, Grade 1045.
 - .3 Other grades of carbon steel alloys shall be suitable for service and load.

EQUIPMENT GENERAL PROVISIONS

- .4 Corrosion-resistant shafting shall be stainless steel or Monel, whichever is most suitable for the intended service.
- .4 Differential Settlement: Where differential settlement between the driver and the driven equipment may occur, a shaft of sufficient length with two (2) sets of universal type couplings shall be provided.

2.5 Gears & Gear Drives

- .1 Unless otherwise specified, gears shall be of the spur, helical, or spiral-bevel type, designed and manufactured in accordance with AGMA Standards, with a service factor suitable for load class, mechanical service and thermal rating adjustment, a minimum L-10 bearing life of 60,000 hours, and a minimum efficiency of 94%. Peak torque, starting torque, and shaft overhung load shall be checked when selecting the gear reducer. Worm gears shall not be used.
- .2 Gear speed reducers or increasers shall be of the enclosed type, oil- or grease-lubricated and fully sealed, with a breather to allow air to escape but keep dust and dirt out. The casing shall be of cast iron or heavy-duty steel construction with lifting lugs and an inspection cover for each gear train. An oil level sight glass and an oil flow indicator shall be provided, located for easy reading.
- .3 Gears and gear drives that are part of an equipment assembly shall be shipped fully assembled for field installation.
- .4 Material selections shall be left to the discretion of the Manufacturer, provided the above AGMA values are met. Input and output shafts shall be adequately designed for the service and load requirements. Gears shall be computer-matched for minimum tolerance variation. The output shaft shall have two (2) positive seals to prevent oil leakage.
- .5 Oil level and drain locations shall be easily accessible. Oil coolers or heat exchangers with all required appurtenances shall be provided when necessary.
- .6 Where gear drive input or output shafts from one Manufacturer connect to couplings or sprockets from a different Manufacturer, gear drive Manufacturer shall furnish a matching key taped to the shaft for shipment.

2.6 Bearings

- .1 General: Bearings shall conform to the standards of the Anti-Friction Bearing Manufacturers Association, Inc. (AFBMA).
- .2 To assure satisfactory bearing application, fitting practice, mounting, lubrication, sealing, static rating, housing strength, and lubrication shall be considered in bearing selection.
- .3 Re-lubricatable type bearings shall be equipped with hydraulic grease fitting in an accessible location and shall have sufficient grease capacity in the bearing chamber.

EQUIPMENT GENERAL PROVISIONS

- .4 Lubricated-for-life bearings shall be factory-lubricated with the Manufacturer's recommended grease to insure maximum bearing life and best performance.
- .5 Anti-Friction Type Bearing Life: Except where otherwise specified, bearings shall have a minimum L-10 life expectancy of five (5) years or 20,000 hours, whichever occurs first. Where so specified, bearings shall have a minimum rated L-10 life expectancy corresponding to the type of service, as follows:

Type of Service	Design Life (years)	L-10 Design Life (hours)
	(whichever comes first)	
8 hour shift	10	20,000
16 hour shift	10	40,000
Continuous	10	60,000

- .6 Bearing housings shall be of cast iron or steel and bearing mounting arrangement shall be as specified or as recommended in the published standards of the Manufacturer. Split-type housings may be used to facilitate installation, inspection, and disassembly.
- .7 Sleeve Type Bearings: Sleeve-type bearings shall have a cast iron or ductile iron housing and Babbitt or bronze liner. Bearing housing shall be bolted and doweled to the lower casing half. These housings shall be provided with cast iron caps bolted in place and the bearing end caps shall be bored to receive the bearing shells. Sleeve bearings shall be designed on the basis of the maximum allowable load permitted by the bearing Manufacturer. If the sleeve bearing is connected to an equipment shaft with a coupling, the coupling transmitted thrust will be assumed to be the maximum motor or equipment thrust. Lubricant, lubrication system, and cooling system shall be as recommended by the bearing Manufacturer.
- .8 Plate Thrust Bearings: Thrust bearings shall be the Kingsbury Type, designed and manufactured to maintain the shaft in the fixed axial position without undue heating or the necessity of adjustment or attention. Bearings shall be oil lubricated to suit the Manufacturer's standard method of lubrication for the specific bearing. If bearing cooling is required, the Manufacturer shall provide necessary piping, filters, and valves.
- .9 Ensure adequate process stream protection from bearing lubricant leaks.

2.7 Piping Connections

- .1 Flanges and Pipe Threads: Flanges on equipment and appurtenances shall conform to ANSI B16.1, Class 125, or B16.5, Class 150, unless otherwise specified. Pipe threads shall be in accordance with ANSI/ASME B1.20.1.
- .2 Flexible Connectors: Flexible connectors shall be provided in all piping connections to engines, blowers, compressors, and other vibrating equipment and in piping systems. Flexible connectors shall be harnessed or otherwise anchored to prevent separation of the pipe where required by the installation.

EQUIPMENT GENERAL PROVISIONS

- .3 Insulating Connections: Insulating bushings, unions, couplings, or flanges, as appropriate, shall be used.

2.8 Gaskets and Packings

- .1 Packing around valve stems and reciprocating shafts shall be of compressible material, compatible with the fluid being used. Chevron-type "V" packing shall be Garlock No. 432, John Crane "Everseal".
- .2 Packing around rotating shafts (other than valve stems) shall be "O"-rings, stuffing boxes, or mechanical seals, as recommended by the Manufacturer.

2.9 Nameplates

- .1 Equipment nameplates of stainless steel shall be engraved or stamped and fastened to the equipment in an accessible location with No. 4 or larger oval head type 316L stainless steel screws or drive pins. Nameplates shall contain the Manufacturer's name, model, serial number, size, characteristics, and appropriate data describing the machine performance ratings.

2.10 Tools and Spare Parts

- .1 Tools: Furnish one (1) complete set of special wrenches and other special tools necessary for the assembly, adjustment, and dismantling of the equipment. Tools shall be of best quality hardened steel forgings with bright finish. Wrench heads shall have work faces dressed to fit nuts. Tools shall be suitable for professional Work and manufactured by Snap On, Crescent, Stanley, or equal. The set of tools shall be neatly mounted in a labelled toolbox of suitable design provided with a hinged cover.
- .2 Spare parts shall be furnished as specified in the individual equipment Sections. All spare parts shall be suitably packaged in a metal box and labelled with equipment numbers by means of stainless steel or solid plastic nametags attached to the box.

2.11 Equipment Lubricants

- .1 Install food grade lubricants for all equipment during storage and prior to initial testing of the equipment.

3. EXECUTION

3.1 Manufacturer's Representative Field Services

- .1 Verify satisfactory delivery of the equipment by completing Form 100, illustrated in Section 01650 – Equipment Installation.
- .2 Instruct Installer in the methods and precautions to be followed in the installation of the equipment. Certify the Installation Contractor's understanding by completing Form 101, illustrated in Section 01650 – Equipment Installation.

EQUIPMENT GENERAL PROVISIONS

- .3 Arrange for a technically qualified Manufacturer's Representative to certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.
- .4 The minimum periods of attendance are identified in Section 11242 – Onsite Hypochlorite Generation System, along with the form to be completed on each of these trips.
- .5 The total number of trips will depend on the Contractor's schedule. The cost of additional trips, to be determined by the Contract Administrator, will be borne by the Contractor. Arrange for a technically qualified Manufacturer's Representative to attend the installation work, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.

3.2 Installation Witnessing

- .1 The Installation Contractor shall ensure that equipment is installed plumb, square and true within tolerances specified by the Manufacturer's Representative and as specified in the Contract Documents.
- .2 The Manufacturer's Representative shall ensure the equipment is installed as required to provide satisfactory service.
- .3 The Manufacturer's Representative and the Installation Contractor are to cooperate to fulfill the requirements for a successful installation as documented by Form 102, illustrated in Section 01650 – Equipment Installation.

3.3 Equipment Performance Testing

- .1 The Manufacturer's Representative shall ensure that each piece of equipment, including all component parts, operates as intended.
- .2 The Manufacturer's Representative shall demonstrate process equipment accordance with Section 11242 – Sodium Hypochlorite Generation System.
- .3 The Contract Administrator will coordinate the attendance of the Manufacturer's Representative and the Installation Contractor for the performance testing. The Manufacturer's Representative and the Installer shall cooperate to fulfill the requirements for successful testing as required to complete Form 103, illustrated in Section 01650 – Equipment Installation.

EQUIPMENT GENERAL PROVISIONS

3.4 Training

- .1 The Manufacturer's Representative shall provide the services of factory trained instructors for the purpose of training the City's personnel in the proper operation and maintenance of the equipment as documented by Form T1. Conform to the requirements of Section 01650 – Equipment Installation.

END OF SECTION

SODIUM HYPOCHLORITE GENERATION SYSTEM

1. GENERAL

1.1 References

- .1 The following is a list of standards with may be referenced in this Section:
 - .1 OSHA, Safety standards concerning personnel protection against machinery and the handling of dangerous chemicals.
 - .2 NSF International, Standard 61 - Drinking Water System Components.
 - .3 Instrument Society of America (ISA).
 - .4 American Society for Testing and Materials (ASTM).
 - .5 Joint Industrial Council (JIC).
 - .6 American National Standards Institute (ANSI).
 - .7 National Electric Manufacturer's Association (NEMA).
 - .8 Canadian Electrical Code (CEC).
 - .9 Canadian Standards Association (CSA)
 - .10 Institute of Electrical and Electronic Engineers (IEEE).
 - .11 American Welding Society (AWS).
 - .12 American National Standards Institute (ANSI).
 - .13 Anti-Friction Bearing Manufacturers Association (AFBMA).
 - .14 Standards of American Water Works Association (AWWA).
 - .15 Electrical and Electronic Manufacturers Association of Canada (EEMAC).
 - .16 National Science Foundation (NSF).
 - .17 Manitoba Building Code.
 - .18 Canadian Plumbing Code (CPC).
 - .19 Occupational Safety & Health Act (OSHA).

SODIUM HYPOCHLORITE GENERATION SYSTEM

- .2 A SHG system shall be furnished to enable on-site production of a 0.8% (+/- 0.05%) sodium hypochlorite solution through the electrolysis of brine. The total installed generation capacity shall be 2,040 kilograms of equivalent chlorine per day (4,500 ppd).
- .3 Work Included: This Section covers the work necessary to design, supply and installation and Performance Verification support for operation an on-site SHG system. The system shall include, but is not limited to, the sodium hypochlorite generators, water softeners, pumps, salt storage/brine saturator tanks, hypochlorite solution storage tanks, piping, valves, control equipment as specified herein, related testing, start-up and training services.

1.2 Contractor Submittals

- .1 Shop Drawings:
 - .1 Make, model, and weight of each equipment assembly.
 - .2 Complete catalog information, descriptive literature, Specifications, and identification of materials of construction.
 - .3 Detailed mechanical Drawings showing the equipment location and dimensions, size and locations of connections, weights of associated equipment, and construction details.
 - .4 Performance Specifications of all items of equipment.
 - .5 Process schematics associated with all items of equipment.
 - .6 Instrument layout of the control panel.
 - .7 Power and control wiring diagrams, including terminals and numbers.
 - .8 Complete motor nameplate data, as defined by NEMA, motor Manufacturer, and including any motor modifications.
 - .9 Metals factory finish system.
 - .10 Size, length and spacing of anchor bolts or attachment to the foundations or supports.
 - .11 External utility requirements air, water, power, etc for each component.
- .2 Submittal of Interface Material: The following materials, defining the interface between the system specified herein and the remainder of the WTP, plus any additional information called for in these Specifications, shall be submitted to the Contract Administrator within 90 days following execution of Contract, and prior to any construction or fabrication that requires interfacing with the system.
 - .1 Identification, description, and envelope dimensions for each separately installed subassembly or piece of equipment and the associated connection dimensions to permit incorporation of the system selected into the design of the WTP.

SODIUM HYPOCHLORITE GENERATION SYSTEM

- .2 Information on field and installation requirements, including mounting requirements, access, and approximate total weight of each piece of equipment.
 - .3 A detailed description of the instrumentation and control system, including a list of all functions monitored, controlled and/or alarmed. Describe all automatic shutdown features and interfaces with the WTP instrumentation and control systems. The description of the instrumentation and control system shall be in both word and schematic form. The Shop Drawing P&IDs will be used as the base for all schematics produced.
 - .4 Clearly identify the tag name, model numbers and catalogue numbers for each piece of equipment, component, device, etc., within the product's technical literature. Use tag numbers as indicated on P&IDs. Clearly identify these model numbers using red ink on all of the Manufacturer's technical literature, such as but not limited to, instruction manuals, technical bulletins, and Manufacturer's Specification Sheets (i.e., Manufacturer's Cut Sheets).
 - .5 All Drawing submittals shall conform to Drawing number and tagging conventions as indicated on the P&IDs. Use same equipment tags as indicated on P&ID on all Drawing submittals. The Shop Drawing P&IDs will be used as the base for all schematics produced.
 - .6 Electric motor control schematics and location/plant layout drawings. Include locations of control stations, and any special control to be provided by others. Coordinate onsite sodium hypochlorite controls with WTP control system.
 - .7 A complete description of all interfaces between the system components and between the system and other plant components. Provide a summary by interface link for the following:
 - .1 Number, size, and type of all process and auxiliary connections.
 - .2 Number, size, and type of electronic or electrical signal wires.
 - .3 Number, size, and type of electrical power wires.
 - .8 Control panel envelope dimensions, mounting requirements, and access requirements (doors, louvers, etc.).
 - .9 Fully commented ladder logic listings, I/O printouts and cross-reference printouts documenting Programmable Controller software program.
 - .10 Fully documented HMI programming.
- .3 Informational Submittals:
- .1 Field Performance Test Report.
 - .2 Special shipping, storage and protection, and handling instructions.

SODIUM HYPOCHLORITE GENERATION SYSTEM

- .3 Manufacturer's printed installation instructions.
- .4 Suggested spare parts list to maintain the equipment in service for a period of one (1) year. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
- .5 List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
- .6 O&M Manuals: As specified in Section 01730, Operation and Maintenance Manuals.
- .7 As specified in Division 17.

1.3 Spare Parts and Special Tools

- .1 Tools: Provide a complete set of any special tools and accessories required to maintain and repair the equipment and/or appurtenances specified herein. Such tools and accessories shall be suitably stored in metal tool boxes, identified by the tag number(s) of the equipment for which they are intended by means of stainless steel or plastic name tags attached to the box.
- .2 Spare Parts: The Contractor shall assemble a list of suggested spare parts of all items of each piece of equipment subject to wear, such as seals, packings, gaskets, nuts, bolts, washers. Wear rings, etc., as well as a set of spare bearings.
 - .1 Additional spare parts to be furnished include:
 - .1 Two (2) complete sets of fuses.
 - .2 One (1) automatic dilution water shutoff valve.
 - .3 One (1) electrolytic cell level temperature switch assembly.
 - .4 Two (2) sets of metering pump recommended spare parts for each pump type.
 - .5 One (1) complete set of gaskets for all gasketed covers and connections.
 - .6 One (1) complete set of electrodes for each cell.
 - .7 Two (2) hydrogen vent orifice plate and flow switch assemblies.

1.4 Preparation for Shipment

- .1 Insofar as is practical, equipment specified herein shall be factory assembled and tested. Parts and assemblies that are of necessity shipped unassembled shall be packaged and tagged in a manner that will protect equipment from damage and facilitate final assembly in the field. Machined and unpainted parts shall be protected from damage by elements with application of a strippable protective coating.

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1.5 Scope

- .1 The Contractor shall furnish, test, and place into satisfactory operation one complete sodium hypochlorite generation, storage system and feed pumps as specified herein. The Contractor shall be responsible for the design of all equipment specified herein and for sizing all equipment. The process equipment and controls shall be furnished by one Contractor as an integrated system.
- .2 Items to be supplied by the SHG Contractor shall include but are not limited to:
 - .1 Water softening system.
 - .2 Sodium hypochlorite storage tanks and level indicators.
 - .3 Dilution air blowers, air flow sensors, valves, orifice plates and all blower appurtenances.
 - .4 Salt/brine tanks and level indicators.
 - .5 Sodium hypochlorite generators.
 - .6 Brine pumps or a brine venture eductor system and all related appurtenances.
 - .7 Feed pumps, motors, drives, and all related appurtenances.
 - .8 All instrumentation and control equipment, including all software programming.
 - .9 Cabinet-mounted valves, solenoid control valves and accessories.
 - .10 All equipment associated with emergency operation of system as defined herein.
 - .11 All other equipment marked as “Contractor Package” as indicated on Drawings.
- .3 Items to be supplied by the SHG Installer shall include but are not limited to:
 - .1 Design of all electrical components for a complete operational system; including boxes, raceways, conductors, busbars, and ancilliary devices.
 - .2 Design of all piping system for a complete, operational system; including pipe support, valves, and appurtenances.
- .4 Additional Equipment/Accessories to be supplied by Installer:
 - .1 The Installer shall furnish all other equipment, including but not limited, to piping, valves, raceways, and conduit, conductors, electrical panels, and all accessories for a complete operational system.

SODIUM HYPOCHLORITE GENERATION SYSTEM

1.6 General

- .1 All electrical, mechanical, metal, painting and instrumentation work included herein shall conform to the applicable sections or Divisions of this Project, except as otherwise specified.
- .2 The Drawings show an outline of the various components of the SHG system and their overall relationships. Not all items incidental to the sodium hypochlorite generator feed system are shown or specified. It is the intent of these Specifications that the Contractor is to provide a complete and workable system whether or not any specific component is shown or specified.

1.7 Related Sections

- .1 Section 11901 – Factory Applied Maintenance and Corrosion Protection Coatings

2. PRODUCTS

2.1 Acceptable Manufacturers

- .1 Severn Trent Services ClorTec
- .2 US Filter / Wallace and Tiernan

2.2 Service Conditions

- .1 Feed Points: Under normal operating conditions, site generated sodium hypochlorite (nominally 0.8 percent) shall be injected into the process at locations shown on the Drawings. Under emergency conditions the system shall allow commercially available sodium hypochlorite (12 to 15 percent solution) to be used in lieu of the generated sodium hypochlorite solution.
- .2 All equipment specified herein shall conform to all the requirements of a Class II corrosive area environment.
- .3 Functional Requirements:
 - .1 Instrumentation, controls, logic, programming, interlocks and valving shall be provided as a package.
 - .2 General arrangement, piping sizes and accessories are shown on the Drawings.
- .4 Jobsite Elevation: 235 meters above MSL.
- .5 Capacities and Performance

SODIUM HYPOCHLORITE GENERATION SYSTEM

.1 Design Criteria

Minimum Chlorine Dose (mg/L)	2.0
Average Chlorine Dose (mg/L)	3.0
Maximum Chlorine Dose (mg/L)	5.0
Minimum WTP Flow (ML/d)	100
Average WTP Flow (ML/d)	254
Maximum WTP Flow (ML/d)	407
Minimum Consumption (kg/d)	200
Average Consumption (kg/d)	762
Maximum Consumption (kg/d)	2,000
Number of Duty Feed Pumps	2
Number of Stand-by Feed Pumps	2
Minimum Volumetric Feed Rate Each Pump (lph)	1,042
Maximum Volumetric Feed Rate Each Pump (lph)	10,420
Required Metering Pump Flow Turndown Ratio	10:1
Design Point Total Dynamic Head, excludes losses internal to pump, (m)	45

2.3 Water Softeners

.1 Functional Requirements

- .1 Raw water fed to the generators shall first pass through a water softener to reduce the potential of hardness fouling of electrode surfaces inside the electrolyzer cells. The softened water shall be dispensed to both brine saturator tank and hypochlorite generator.
- .2 Each water softener shall be sized to reduce hardness from 100 to 15 mg/L as CaCO₃ for a minimum flow rate of 11,000 L/hr.
- .3 The softeners shall be appropriate for continuous use with water of the following quality:
 - .1 Water pressure: 175 – 420 kPa

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- .2 Water temperature: 0.5 – 25 °C
- .3 Water pH 5 – 10
- .4 Chlorine residual 5 mg/L (max)
- .4 Each softener shall ensure uninterrupted supply of softened water. The softener shall include two twin tanks. Regeneration of one tank shall be accomplished while the other is in use.
- .5 The Regeneration cycle shall be based on water flow. Electric timers and gear motors are not acceptable.
- .6 Each softener shall use brine from the saturator tank for the regeneration cycle. The regeneration waste shall be disposed to a sanitary drain.
- .2 Materials
 - .1 The softener vessels material shall be polyglass.
 - .2 Softener connections shall be PVC.
- .3 Features
 - .1 The softener shall not require power to operate.
- .4 Acceptable Manufactures
 - .1 Kinetico or approved equal

2.4 Water Supply Pressure Control Valve

- .1 The Contractor shall size the pressure control valve on the main potable water supply pipe to meet the system flow and pressure requirements. The WTP potable water supply pressure will be provided during the Shop Drawing submittal process.

2.5 Water Hardness Monitor

- .1 Provide water hardness monitor on water supply from water softeners to generators.
- .2 Output: 4-20 mA analog signal to generator control panel for continuous monitoring.
- .3 Manufacturer: Hach.

2.6 Brine Saturator Tank and Accessories

- .1 Functional Requirements
 - .1 Two (2) brine saturator tanks shall be furnished to:

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- .1 Store bulk solar salt and keep an acceptable salt inventory level.
- .2 Prepare a saturated brine solution by exposing softened water to the bed of solar salt inside the saturator tank.
- .2 Each brine saturator tank shall be sized to store a 7-day inventory of solar salt for a total of 14 days solar salt storage when two (2) brine tanks are supplied.
- .3 Each brine saturator tank to be supplied with dust bag collection system and related appurtenances.
- .4 Each brine saturator tank to be supplied with salt fill line, salt fill connection and any related appurtenances.
- .2 Materials
 - .1 Brine saturator tanks shall be constructed as per Section 13205, Fiberglass Reinforced Storage Tanks.
- .3 Accessories:
 - .1 Analog brine level controller and indicator instrument with interlocked solenoid valve.
 - .2 Salt level indication system to measure and display salt level.
 - .3 All other equipment required for a complete and operational brine system, compatible with the SHG system.
- .4 Acceptable Manufacturer
 - .1 Manufacturer shall be Plas-Tanks Industries, Inc., or approved equal.

2.7 Brine Conveyance

- .1 General
 - .1 A venturi eductor or brine pump system shall be used to transfer the brine solution from the brine tanks to the electrolytic cells.
- .2 Venturi System
 - .1 Functional Requirements
 - .1 The saturated brine shall be conveyed from the brine saturator tank to the hypochlorite generator at constant flow rate to ensure stable and efficient production of sodium hypochlorite.

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- .2 The number and size of venture eductors shall be sized appropriately for the intended application.
- .3 The brine venturi eductor's feed rate shall be easily adjusted and calibrated in the field to ensure efficient operation of electrolyzer cells.

.3 Brine Pumping System

.1 Functional Requirements

- .1 The saturated brine shall be pumped from the brine saturator tank to the hypochlorite generator at constant flow rate to ensure stable and efficient production of sodium hypochlorite.
- .2 The number and size of brine pumps shall be sized appropriately for the intended application.
- .3 The brine feed pump's flow rate shall be easily adjusted and calibrated in the field to ensure efficient operation of electrolyzer cells.

.2 Features

- .1 The brine feed pump shall be controlled only by the system control panel to ensure the safe operation of the system and compliance with start-up and shut-down sequences.
- .2 Each brine pump shall be supplied with a control enclosure housing electronic VFD's. All pumps shall be supplied with motor starters.
- .3 The following accessories shall be furnished for each brine feed pump: calibration column, pulsation dampener and pressure relief valve.

.3 Acceptable Manufacturer

- .1 USFilter/Wallace & Tiernan or approved equal

2.8 Power Transformer/Rectifier

.1 Functional Requirements

- .1 A transformer/rectifier shall be furnished to provide DC power to each Hypochlorite Generator. A total of three (3) transformer/rectifiers shall be furnished.
- .2 Each rectifier power supply shall be 600V ac, three-phase, three-wire, 60 Hertz and shall be equipped with soft start constant current with built-in DC volt and amp display, emergency shut-off switch and disconnect.

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- .3 The transformer rectifier shall be designed for a 100% duty cycle (24 hrs/day & 7 days per week).
- .4 The transformer rectifier shall be appropriate for use at altitudes of less than 1,000 meter above sea level.
- .2 Materials
 - .1 Main enclosure shall be heavy gauge steel with corrosion resistant paint, NEMA 1 rated for indoor use.
 - .2 Termination connections shall be protected with machined PVC end caps. Bare connections or the use of electrical shrink-wrap shall not be permitted.
- .3 Features
 - .1 The transformer/rectifier shall be air cooled. Maximum room temperature shall be 40 °C. Cooling air shall be free from corrosion fumes.
 - .2 The transformer rectifier shall include the following protection features
 - .1 SCR heat sink over-temperature.
 - .2 Transformer winding over-temperature.
 - .3 Current limiting fuse on each power semi-conductor.
 - .4 D.C. current and voltage limit.
 - .5 Fan failure detection.
 - .6 Door interlock switch.
 - .7 Input phase monitor.
 - .8 The power supply to rectifier will automatically shut down in the event of a fault.
- .4 Accessories
 - .1 Output voltage and current shall be indicated by in-built voltmeter and ammeter. These instruments shall have accuracy of 1% or better.
 - .2 Bus bars shall be furnished to connect transformer/rectifier to hypochlorite generator. Bus bars shall be silver plated copper.

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2.9 Sodium Hypochlorite Generator

- .1 Provide three (3) sodium hypochlorite generator systems, each capable of producing 680 kg per day chlorine equivalent to a total of 250,000 liters per day of 0.8 percent sodium hypochlorite solution.
- .2 The electrolytic system shall generate an aqueous solution of a minimum concentration of 0.8 percent (plus or minus .05 percent) by weight sodium hypochlorite expressed as chlorine.
- .3 The hypochlorite generator shall consume a maximum of 3.5 kg of salt per kg of equivalent chlorine, using solar salt containing no organic binders, flow control agents or resin cleaning material, and meeting the following specifications:

Maximum ppm (mg/kg)	Weight
NaCl: Dry basis	96.3 percent minimum
Wet	93.3 percent minimum
Calcium Sulfate	0.30 percent maximum
Magnesium Chloride	0.06 percent maximum
Calcium Chloride	0.10 percent maximum
Magnesium Sulfate	0.02 percent maximum
Insolubles	0.1 percent maximum
Moisture (as H ₂ O)	3.0 percent maximum
Lead	0.0007 percent maximum
Copper	0.0003 percent maximum
Iron (as Fe)	0.002 percent maximum

- .4 The electrolytic cell shall consume a maximum of 5.5 kWh AC kilowatt-hours of electricity per kg of chlorine equivalent output.
- .5 The electrolytic cell shall consume a maximum of 125 L of water per kg of chlorine equivalent output.
- .6 The generator shall have no waste products associated with its use other than hydrogen gas which is to be vented to the atmosphere.
- .7 The hypochlorite generator shall operate at constant capacity, and automatically start and stop based on the low and high level signals at the hypochlorite storage tank. The constant capacity of the generator shall be at 100%.

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- .8 The hypochlorite generation control system shall measure and record level and temperature at the electrolyzer cells.
- .9 The generator package shall be mounted in the general location shown on the Drawings and shall be factory wired, plumbed, assembled and tested.
- .10 The generator package shall consist of the electrolytic cell(s), flow control panel, rectifier cabinet, control panel containing system controls, water softener with flow meter and all necessary hardware.
- .11 All components mounted on the generator shall be pre-plumbed and pre-wired.
- .12 Electrolytic Cell:
 - .1 The electrolytic cell shall be constructed of clear acrylic materials, allowing for full visual inspection of electrodes from top, bottom, back and front during normal operation.
 - .2 Cell construction shall be tubular, allowing for electrodes to be removed as a single assembly.
 - .3 The tubular cells shall be factory tested to 100 psi, for a period of 30 minutes, prior to final assembly and shipment.
 - .4 The electrodes shall be titanium and the anodes coated with a mixed metal oxide catalytic coating for electrical efficiency and maximum longevity. They shall be vertically oriented to maximize the high velocity gas lift between electrodes.
- .13 The generator package shall have the following redundant interlocked safety features:
 - .1 Cell high temperature switch, for each cell.
 - .2 Cell low level switch, for each cell.
 - .3 Water flow switch.
 - .4 Rectifier over voltage switch.
 - .5 Transformer high temperature switch.
 - .6 Automatic Voltage and Current Regulation: All of the above safety features shall be interlocked so as to prevent operation if any of the normal parameters are exceeded. In the event of a trip condition an alarm contact set shall be made signaling a shutdown condition. Each alarm condition, along with normal operating status, shall be communicated to the WTP SCADA system as specified in Division 17.
- .14 The process shall operate in a batch environment allowing for consistent hypochlorite concentrations and greatest efficiencies.

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2.10 Storage Tanks

- .1 Sodium Hypochlorite Storage Tanks:
 - .1 The output of the hypochlorite generator, a mix 0.8% sodium hypochlorite solution shall be piped directly to a storage tank, where hydrogen gas will be separated from the liquid phase, diluted to less than 1% in air (v/v) and vented to the atmosphere.
 - .2 Provide two (2) 235,000 litre sodium hypochlorite storage tanks per Section 13205, Fiberglass Reinforced Storage Tanks.
 - .3 Install ultrasonic level transmitters on each tank for operation of the generation equipment and alarm initiation. Level controls for each tank shall be brought to the touch screen operator interface for selection of the active tank. The level transmitters shall provide 4-20 mA signals linearly proportional to tank level. Signals shall be connected to the hypochlorite system control panels to monitor the following four specific level conditions within the hypochlorite system panel. These four values shall also be made available to the WTP SCADA system:
 - .1 One (1) high for generator shut-off.
 - .2 One (1) low for generator start.
 - .3 One (1) high-high for high level alarm.
 - .4 One (1) low-low for low level alarm.

2.11 Sodium Hypochlorite Dosing System

- .1 Functional Requirements
 - .1 The sodium hypochlorite solution shall be pumped to each injection point by positive displacement, peristaltic hose-type, metering pumps.
 - .2 For each injection point, a set of two (2) pumps, one duty and one standby, shall be furnished as a pump skid.
 - .3 Each pump shall have a minimum capacity of 10,500 L/h at 50 psig.
 - .4 Each pump shall be furnished with an inverter duty motor. The motor horsepower shall be equal to or less than 7.5 kW.
 - .5 The solution metering pumps shall be suitable to operate 24-hour per day.
 - .6 Each pump skid will consist of one (1) floor mounted duty and one (1) floor mounted standby pump, two (2) mag flow meters to monitor flow and detect loss of flow, one per two pumps, two (2) VFD, one per pump, as well as pressure relief valve, pulsation damper and backpressure valve. These components will be panel mounted on a freestanding epoxy coated stand, located between the duty and standby pumps. Each

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system will have one chemical outlet.. Each pump will have a calibration column mounted on the suction line. Pump skids to be supplied as a complete system by the Contractor.

.7 The metering pumps shall be able to operate with a 10:1 turn down ratio in conjunction with the VFD's.

.8 All pumps to be supplied with motor starters.

.2 Control

.1 Each pump shall be supplied with a variable frequency drive. The VFD's for all pumps shall be located in a separate NEMA 4X Metering Pump Control Cabinet.

.3 Materials

.1 The pump housing shall be of a material that is compatible with sodium hypochlorite with a removable plastic cover.

.2 Pump head housing shall be capable of rotation in 90-degree increments.

.3 Pump connections shall be 150# ANSI standard flange connections in PVC.

.4 The hose shall have a minimum of two layers of nylon reinforcement.

.5 The hose material shall be Buna N or EPDM.

.6 Pump rotor shall be hastelloy or equivalent. Rollers shall be cast iron on heavy-duty ball-bearings.

.4 Features

.1 Pump operation shall not require any lubricating fluid in the pump housing. Maintenance and hose replacement shall be accomplished without the need to drain and dispose any lubricating fluid.

.2 The pump shall be capable of operation in either direction without flow variation.

.3 The pump shall be capable of running dry without damage to pump or hose.

.4 The pump shall be valveless/glandless with no dynamic seals in contact with the pump product.

.5 Pump shall be provided with a leak detector as standard to provide early indication of a leak into the pump housing.

.6 Provide inductive type sensor to detect rotor revolutions. Mount sensor in between the suction and discharge ports. Contractor is responsible for any additional equipment, which may be required to integrate this into their control system.

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.5 Accessories

- .1 Each pump shall be furnished with inlet and outlet pulsation dampeners.
- .2 Dampeners shall be chargeable appendage type and consist of a two part housing, bell shaped bladder, one-way air inlet valve, pressure gauge, and air fill valve.

.6 Acceptable Manufacturers

- .1 ProMinent Verderflex
- .2 USFilter/Wallace & Tiernan

2.12 Hydrogen Dilution Blower and Accessories

- .1 An air dilution blower shall be furnished to provide forced ventilation to the hypochlorite storage tank and reduce the concentration of Hydrogen gas in the tank to below 1% in air (v/v), which is equivalent to 25% of hydrogen's low explosivity limit (LEL = 4% v/v).
- .2 A set of two (2) blowers, one duty and one standby, shall be furnished for each hypochlorite storage tank. A total of four (4) blowers shall be provided. The standby blower shall be provided to automatically start if the duty blower fails.
- .3 The blowers shall be centrifugal, single-stage type.
- .4 Blowers shall be controlled by the system control panel.
- .5 On system shut down, the blower must remain active for a period of 15 minutes.
- .6 Equipped with safety interlocks and powered, controlled and monitored by the generator control panel.
- .7 Blower construction shall be FRP

2.13 Hydrogen Gas Monitor

- .1 Monitor ambient room conditions for hydrogen gas in high areas.
- .2 Output: 4-20 mA analog signal to generator control panel for continuous monitoring.
- .3 Alarms shall be sent to WTP SCADA

2.14 Control System

- .1 Provide a fully functional PLC system as specified in Division 17.

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- .2 The control panel shall provide for complete system control in automatic and manual modes and shall display all relevant operating parameters, modes, status, and/or alarm conditions on a color graphic touch screen HMI.
- .3 The Type 304 stainless steel NEMA 4X control cabinet shall be UL 508 approved house the PLC, hydrogen blower controls, and terminal strips to fully support the functions of generator operation, tank levels.
- .4 The WTP PLC shall control the dose rate of the onsite hypochlorite feed system based on totalized flow rates through the chlorine contact tank.
- .5 The control cabinet logic shall function at the PLC level where operating parameters shall be measured, corrected, scaled, reported and controlled.
- .6 The PLC shall come shipped with fully debugged and annotated application software, for both the PLCs and the OIT panels. Control system functionality shall include making available through the Ethernet communication network, all key process parameters, status and alarm conditions. Remote control of the generator systems from the SCADA is required.
- .7 The software shall include security measures to prevent unauthorized modification of PLC code or parameters. All passwords, etc. shall be provided to the owner upon completion of system performance testing. Refer to Section 17500 – PLC and Operator Interface Requirements.
- .8 The generator PLC and display shall control and monitor all functions and operational parameters including, but not limited to, the following:
 - .1 Cell safety devices.
 - .2 Rectifier control.
 - .3 DC amperage and voltage.
 - .4 Hypochlorite tank levels.
 - .5 Brine tank levels Both Salt & Brine.
 - .6 Blower controls.
 - .7 Generator operating mode, including FAIL/ON/REMOTE/RUN/LOW-LOW controls and status indications.
 - .8 Generator selection
 - .9 Alarm history.
 - .10 Security protection.

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- .9 Generator Operation:
 - .1 The generator shall automatically start and stop based on the high and low levels in the storage tanks.
 - .2 The water softener resin shall automatically be regenerated with salt solution from the brine tank.
 - .3 The generator shall shut down and alarm for the following conditions:
 - .1 Cell is not full.
 - .2 Hypochlorite temperature exceeds 50 degrees C.
 - .3 Inlet flow falls below a preset value.
 - .4 Rectifier high voltage.
 - .5 Rectifier high temperature.
 - .6 Hydrogen dilution blower failure.
 - .4 The following additional alarms shall be provided on the control panel:
 - .1 Low-low level for storage tank.
 - .2 High-high level for storage tank.
 - .10 The SHG Contractor shall be responsible for programming the Sodium Hypochlorite System package control software.
 - .11 The SHG Contractor shall perform functional, performance and start-up testing of the Sodium Hypochlorite System.
 - .12 Provide conduit and wire in accordance with Division 16, Electrical.

2.15 Emergency Operation

- .1 Provide a Sodium Hypochlorite blending station as shown on PID and drawings to allow for the dilution of a 12.5 percent hypochlorite solution to a 0.8 percent solution.

2.16 Fabrication

- .1 In general, workmanship and finish of all metalwork shall be of the highest grade and equal to the best practice of modern shops. Exposed surfaces shall have smooth finish and sharp, well defined lines. Methods of fabrication not specified herein shall be adequate for the service encountered, and as reviewed by the Engineer.

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2.17 Factory Finishing

- .1 Exposed metal surfaces (except stainless steel) of equipment and accessories specified herein shall be shop primed and finished coated. Preparation of metal surface and application of coating shall be as specified and in accordance with Section 11901, Factory Applied Maintenance And Corrosion Protection Coatings.

2.18 Source Quality Control

- .1 Factory Tests and Adjustments: Test all equipment actually furnished.
- .2 Factory Test Report: Include test data sheets.
- .3 Functional Test: Perform manufacturer's standard test on equipment.
- .4 Manufacturer's standard inspections.

3. EXECUTION

3.1 Manufacturer's Representative Field Services

- .1 Verify satisfactory delivery of the equipment by completing Form 100, illustrated in Section 01650 – Equipment Installation.
- .2 Instruct Installer in the methods and precautions to be followed in the installation of the equipment. Certify the Installation Contractor's understanding by completing Form 101, illustrated in Section 01650 – Equipment Installation.
- .3 Arrange for a technically qualified Manufacturer's Representative to attend the installation work, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.
- .4 The total number of trips will depend on the Contractor's schedule. The cost of additional trips, to be determined by the Contract Administrator, will be borne by the Contractor. Arrange for a technically qualified Manufacturer's Representative to attend the installation work, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.

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Item	Description	Total number of business days	Form
1	Equipment Delivery	1	100
2	Installation Assistance	1	101
3	Witnessing of Equipment Installation	2	102
4	Assistance in Equipment Performance Testing	8	103
5	Operator and Maintenance Training	8	T1

3.2 Installation Witnessing

- .1 The Installation Contractor shall ensure that equipment is installed plumb, square and true within tolerances specified by the Manufacturer's Representative and as indicated in the Contract Documents.
- .2 The Manufacturer's Representative shall ensure the equipment is installed in accordance with the Manufacturer's instructions.
- .3 The Manufacturer's Representative and the Installation Contractor are to cooperate to fulfill the requirements for a successful installation as documented by Form 102, illustrated in Section 01650 – Equipment Installation.

3.3 Process Performance Guarantee and Testing

- .1 General
 - .1 The Manufacturer's Representative shall ensure that each piece of equipment, including all component parts, operates as intended.
 - .2 The Manufacturer's Representative shall demonstrate satisfaction of requirements specified herein.
 - .3 The Manufacturer's Representative and the Installation Contractor are to cooperate to fulfill the requirements for successful testing of the equipment as specified herein and as documented by Form 103, illustrated in Section 01650 – Equipment Installation.
- .2 Performance Verification
 - .1 Overall System Performance Testing
 - .1 The overall system performance test shall be conducted by competent, authorized representatives of the SHG equipment Manufacturer who are familiar with operation of the equipment supplied and who have previous satisfactory experience in conducting tests of the type specified. The Installation Contractor and the City's operating personnel will assist the SHG equipment Manufacturer's Representative in the performance test. Qualified personnel shall perform the tests, record the data, make calculations, and prepare a report on the results. At a minimum, the SHG Equipment Manufacturer's field representatives shall be made

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available. Representatives of the Contract Administrator will observe the tests and collect a copy of the recorded data. The information collected will be used as a basis for determining acceptability of the SHG Equipment Manufacturer's results. In case of conflict, interpretations and calculations made by the Contract Administrator will govern.

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

.3 Test Procedures

- .1 One (1) field performance test shall be conducted using the SHG systems under the service and design conditions specified to demonstrate the SHG systems' ability to consistently perform as specified herein and as guaranteed on Form N: Salient Features. The performance tests shall be conducted for at least fifteen (15) consecutive days during the specified test periods defined herein and shall commence after the installation is complete and all system components are operating properly as determined by the SHG Equipment Manufacturer's Representative.
- .2 The performance test will last twenty four (24) hours a day for at least fifteen (15) consecutive days and shall be conducted during the following periods:
 - .1 During the coldest weather months as advised by the Contract Administrator.
- .3 The Manufacturer's Representative will conduct all necessary checks to equipment and if necessary, advise the Installation Contractor of any further checking, flushing, cleaning, or other work needed prior to confirming the equipment is ready to run.
- .4 Demonstration of the process equipment shall be in accordance with Section 1650 – Equipment Installation.
- .5 The equipment will be restarted and run continuously for fifteen (15) days. During the fifteen day performance test period, the SHG equipment being tested shall be operated under the following testing conditions:
 - .1 Operation of Hypochlorite Generator No. 1 for five (5) consecutive days at 100% of its design capacity, with generator required WTP service water heated from its winter ambient temperature to the Contractor specified minimum operating temperature.

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- .2 Operation of Hypochlorite Generator No. 2 for five (5) consecutive days at 100% of its design capacity, with generator required WTP service water heated from its winter ambient temperature to the Contractor specified minimum operating temperature.
- .3 Operation of Hypochlorite Generator No. 3 for five (5) consecutive days at 100% of its design capacity, with generator required WTP service water heated from its winter ambient temperature to the Contractor specified minimum operating temperature.
- .6 Testing of the hypochlorite generators shall be completed consecutively. Concurrent testing of hypochlorite generators shall not be permitted. The performance requirements of Hypochlorite Generator No. 1, 2 and 3 shall be considered to be fully met when they each produce 0.8% sodium hypochlorite within the specified limits with the generation equipment operating at 100% of its design capacity 100% of the time for a five (5) consecutive calendar day period. Testing of Hypochlorite Generator No. 2 shall commence immediately upon Hypochlorite Generator No. 1 successfully meeting its performance criteria. Testing of Hypochlorite Generator No. 3 shall commence immediately upon Hypochlorite Generator No. 2 successfully meeting its performance criteria. If more than a fifteen day test period is required to achieve this objective, then the test will be extended beyond the fifteen day period until the limit is achieved.
- .7 During performance testing, the SHG equipment Manufacturer's Representative shall be allowed to adjust the rectifier/generator operation and salt usage within the ranges specified in order to optimize the performance of the SHG equipment.
- .8 The data to be determined in each test shall include, but not be limited to:
 - .1 Ambient WTP Service Water Temperature before heating
 - .2 WTP Service Water Temperature after heating
 - .3 Salt consumption
 - .4 Total rectifier/generator system power consumption
 - .5 Sodium hypochlorite concentration
 - .6 Volume of 0.8% Sodium Hypochlorite produced
- .9 Should the City be unable to meet the SHG system performance criteria previously set forth during a test period due to any malfunction of the SHG system, equipment, or WTP process, the seven (7) day test period shall begin again. The procedures shall be continued until such time as seven (7) consecutive calendar days have been accumulated.
- .10 Costs associated with repeated performance testing due to items outside the Installer's and Contractor's control shall be borne by the City.

SODIUM HYPOCHLORITE GENERATION SYSTEM

- .11 Costs associated with the use, removal and disposal of 0.8% sodium hypochlorite produced during the test shall be borne by others.

.4 Modifications

- .1 If, after operating under the specified service conditions, design loading conditions, and in accordance with the SHG equipment Manufacturer's Representative's instructions, the results of the field performance test indicate that the system performance is not in compliance with the performance and design requirements stipulated herein, the SHG equipment Manufacturer shall undertake all engineering Work and analysis necessary at the Contractor's expense to determine the cause of such non-compliance. If the SHG equipment Manufacturer finds, and the Installer, City, and Contract Administrator concur, that the cause of such non-compliance is the failure of the Installer or City to meet the conditions of the warranties, the Contractor shall be reimbursed the cost and expenses incurred in identifying the problem. However, if the cause of such non-compliance is faulty equipment or negligence on the part of the SHG equipment Manufacturer, the Contractor will be required to make the necessary modifications at no additional cost to the City.
- .2 If modifications to the SHG system supplied by the SHG equipment Manufacturer are necessary to achieve compliance with the process guarantee, the SHG equipment Manufacturer shall make whatever modifications it deems necessary, as agreed upon by the City and Contract Administrator, and shall repeat the performance test. The SHG equipment Manufacturer may require repeated tests and modifications as agreed upon by the City and Contract Administrator until the performance requirements are achieved. The Contractor shall be responsible for the cost of all such modifications, engineering and construction of such modifications, retesting, laboratory analysis, and other related costs.

3.4 Training

- .1 The Manufacturer's Representative shall provide the services of factory trained instructors for the purpose of training the Owner's personnel in the proper operation and maintenance of the equipment as documented by Form T1. Conform to the requirements of Section 01650 – Equipment Installation.

3.5 Supply of Chemicals

- .1 The City will be responsible for supplying all chemical required for the onsite hypochlorite generation system. Coordinate requirement for chemicals with the Contract Administrator.

END OF SECTION

PROCESS PUMP GENERAL REQUIREMENTS

1. GENERAL

1.1 Description

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

1.2 Definitions

- .1 The terms in the Specification generally comply with the definitions of the Hydraulic Institute.
- .2 Definitions:
 - .1 Efficiency: Pump efficiency shall be calculated as the delivered hydraulic power divided by the electrical power at the inlet box of the pump. It shall take full account of mechanical and electrical losses.
 - .2 Performance curve: The performance curve is a graph of the flow delivered (L/s; x-axis) in relation to the discharge head (metres; y-axis). It generally denotes efficiencies as isopleths and may include NPSH requirements as a function of the flow.
 - .3 BEP: The BEP is the point in the pump performance curve where the pump operates at its highest efficiency.
 - .4 Rating Point: The pump rating point is the combination of discharge head and flow which the pump must satisfy. It typically is determined on the basis of all duty pumps (one or more, depending on the service) operating simultaneously against the worst system conditions (typically maximum headloss, minimum suction head, maximum discharge head, etc.). This condition is listed in the detailed pump Specification and must be satisfied by the pump supplied.
 - .5 Low Head Point: The low head point is the combination of head and flow which corresponds to the least head the pump might operate against. It is determined on the basis of only one (1) duty pump operating against the system conditions which would produce the least discharge pressure (typically minimum headloss, maximum suction head, minimum discharge head, etc.). The minimum system head is shown or described for each pump. The Manufacturer must ensure that the pump can operate satisfactorily, without cavitation in the pump casing or over-stressing of the motor, at the intersection of the pump curve and the minimum head curve, or low head point.
 - .6 Low Speed Point: The minimum flow and head conditions against which a variable speed pump is expected to operate.
 - .7 NPSH: The total pressure (atmospheric) at the pump suction. The available NPSH is the pressure available at the pump suction and is a function of Site atmospheric pressure

PROCESS PUMP GENERAL REQUIREMENTS

and suction piping losses. Required NPSH is the pressure required at the pump suction to ensure cavitation due to water column separation does not occur.

1.3 Submissions

- .1 Shop Drawings: Submit in accordance with Section 01300 - Submittals and 11000 - Equipment General Provisions. For all pump Shop Drawings in addition to the requirements of Section 11000 - Equipment General Provisions, include the following specific details:
 - .1 Performance curve for the pumping unit(s) superimposed on the system curve for the particular pumping application. With the performance curve, include efficiency isopleths and NPSH required NPSHR variation with flow. Where required in the specific pump Sections, the performance curve should be certified in accordance with Hydraulic Institute Standards.
 - .2 Motor operating data, including motor and insulation ratings, start-up and operating current ratings, operating voltage and amperage tolerances, description of construction complete with illustrative Drawings, and any other pertinent information.
 - .3 List of materials of construction, detailing the component parts of the pump(s), their materials of construction, and reference Specifications for those materials. Chemical compatibility of all wetted and non-wetted parts for specific service.
 - .4 Required ancillary services including but not limited to electrical, seal water, and drains. The sizes, ratings, and any other pertinent information related to these services.
 - .5 Installation instructions indicating assembly and mounting requirements, alignment and assembly tolerances, and points of connection for ancillary services (electrical, seal water, drains, etc.).
 - .6 Start-up instructions including lubricant requirements, electrical requirements, etc.
- .2 O&M Data: Provide for incorporation in O&M Manual as specified in Section 01730 - Operation Maintenance Manuals.

1.4 Delivery and Storage

- .1 Prior to delivery, ensure that the Certificate of Readiness to Install (Form 101) is completed to ensure that the Installer is ready to receive the specified equipment.
- .2 Ship pre-assembled to the degree that is possible. Inform Installer of any Site assembly requirements.
- .3 Securely fasten heavy wood blanks to the pump flanges. Use blanks that are larger diameter than the flange. Protect machined surfaces against rusting. Protect threaded connections with threaded plugs or caps. Protect open, plain pipe ends with caps.

PROCESS PUMP GENERAL REQUIREMENTS

- .4 Where pumps are to be stored on-site for any period of time exceeding one (1) week, instruct Installer of specific requirements to ensure there is no uneven wear or distortion of pump component parts.
- .5 Identify any special storage requirements.

1.5 Coordination

- .1 Coordinate with other Divisions to ensure there are no conflicts in the Work.

2. PRODUCTS

2.1 Pump Performance Requirements

- .1 Supply pumps that are suitable for continuous duty.
- .2 Select impellers for fixed speed pumps that permit operation at an efficiency of within 5% of the efficiency at the BEP.
- .3 For variable speed pumps, select pump speed and impeller diameter which allow operation from the Rating Point to the Low Speed Point at efficiencies within 10% of efficiency at the BEP.
- .4 Ensure that motors are sufficiently sized to drive pumps at a maximum speed when the head is as defined for the low head point.
- .5 Supply pumps capable of operating at 30% of the flow at the rated capacity with good efficiency without exceeding the motor horsepower and capable of operating at any point on its characteristic curve, to where that curve intersects the low head point, without exceeding motor power rating.
- .6 All wetted materials are compatible with specified liquid service.

2.2 Pressure Sensing

- .1 Supply a means of measuring inlet and outlet pressure with each pump, except as noted.
- .2 For centrifugal pumps handling clean water, supply gauges for the inlet and outlet of each pump.
- .3 For submersible pumps, supply only one (1) gauge for mounting on the discharge of the pump on a weldolet installed outside, but within 2 m of the wet well.
- .4 For centrifugal pumps handling effluent water, supply one (1) pressure sensor and one (1) gauge for each pump. Mount on valved pipe that extends from inlet to outlet of pump, with a connection for flushing water.
- .5 Gauges

PROCESS PUMP GENERAL REQUIREMENTS

- .1 Supply gauges that are 100 mm diameter, 13 mm bottom connection, complete with shut off cock with stainless steel movement and Bourdon tube.
- .2 Use metric units of measurement (kPa or Pa), clearly indicated on the face of the gauge.
- .3 Calibrate the gauges to read pressure ranges approximately as follows:

	Actual Pressure	Gauge Pressure Range
Suction	-50 to +50 kPa	-50 to 350 kPa
	50 to 200 kPa	0 to 350 kPa
	200 to 700 kPa	0 to 1000 kPa
Discharge	50 to 350 kPa	0 to 700 kPa
	350 to 700 kPa	0 to 1000 kPa
	700 to 1500 kPa	0 to 2000 kPa

- .4 Acceptable Manufacturers: Ashcroft, H.O. Trerice.
- .6 Pressure Sensors
 - .1 Supply annular ring, flow through type pressure sensors, with stainless steel body, a sensing element compatible with the corrosive and abrasive nature of the fluid being measured, 25 mm diameter.
 - .2 Acceptable Products: Red Valve Series 42 or Robbins and Myers RKL Series W.
 - .3 Provide stainless steel nipples extending to a tee from the pressure sensor. Mount the gauge on one leg of the tee. If a pressure indicator/transmitter/switch is shown on the Drawings, mount on the other side of the tee. Otherwise, plug the tee.
 - .4 Supply annular type pressure sensors with their initial fill of fluid.

2.3 Pump Seals

- .1 Provide double mechanical seals, unless otherwise noted in the Specifications of the particular pump.
- .2 Single mechanical seals can be used only where noted in the Specifications of the particular pump.
- .3 Double mechanical seals are located adjacent to one another, with a cooling/flushing water filled space between. They are supplied as a single package.
- .4 Provide non-destructive, self aligning seals of the stationary design which require no wearing sleeve for the shaft.

PROCESS PUMP GENERAL REQUIREMENTS

.5 Materials of construction:

Type of Service	Metal Parts	Spring(s)	O-Rings	Faces
Potable water.	316 or 316L Stainless Steel	Hastelloy C	Buna-N or Viton	Silicon Carbide on Carbon

.6 Provide connections for cooling/flushing water.

.7 Acceptable Manufacturers are:

- .1 Durametallic.
- .2 John Crane.
- .3 Chesterton.

2.4 Stuffing Boxes

- .1 Integrally cast the stuffing box with the motor mounting bracket, providing adequate area for the internal recirculation of the flushing/cooling fluid around the sealing medium.
- .2 Provide a tapped and plugged hole for external flushing/cooling water.

2.5 Bearings

- .1 Refer to Section 11000 - Equipment General Provisions.

2.6 Protective Guards

- .1 Provide a protective guard for all couplings and keys, drive belts, or other exposed rotating devices. As a minimum, conform to the requirements of Section 11000 – Equipment General Provisions.

2.7 Couplings

- .1 Design couplings so that the pump unit can be disassembled without disturbing face piping.

2.8 Tagging Instructions

- .1 Tag loose items associated with a particular unit with the equipment number. Use aluminum or stainless steel (no plastic) tags securely attached to each item.
- .2 Identification used shall be the same as the symbol indicated in the Specifications or on the Drawings and shall be located in a conspicuous place as acceptable to the Contract Administrator.

PROCESS PUMP GENERAL REQUIREMENTS

2.9 Spare Parts

- .1 For each pump, provide for one spare mechanical seal or packing kit (as applicable) and one (1) set of pump bearings.
- .2 For each centrifugal pump type and size, provide a single impeller, wear plate, suction ring (if replaceable), one pump shaft and nut.
- .3 For spare parts for positive displacement pumps, provide as a minimum, one (1) wearing element. Refer to related pump Specifications for the specific spare part requirements.

2.10 Factory Performance Testing

- .1 Where required for specific pumps, as noted in the Sections related to those pumps, factory performance test all pumps.
- .2 Conduct factory performance testing in compliance with the Hydraulic Institute Standards.
- .3 Inform Contract Administrator at least three (3) weeks prior to the factory testing to allow for his attendance.
- .4 Certify test results and summarize findings in a short report. Submit report to the Contract Administrator within three (3) weeks of completing factory tests.
- .5 Where the pump(s) does not satisfy the specified performance requirements within the tolerances specified by the Hydraulics Institute, redesign, modify, and re-test the pump(s), all at no additional cost.
- .6 Do not ship the pump(s) until the test result report has been submitted to the Contract Administrator.

2.11 Finishes

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

3. EXECUTION

3.1 General

- .1 Comply with the requirements of the specific Sections for the pumps to be provided.

3.2 Installation

- .1 Comply with the requirements of Section 01650 – Equipment Installation, and any special requirements listed in the specific Sections related to each pump.

PROCESS PUMP GENERAL REQUIREMENTS

3.3 Testing

- .1 The Installation Contractor will field test all pumps greater than or equal to 3.7 kW, and smaller units where noted, to verify performance. The Contractor will record the results of the testing and provide as required, clarification of testing procedures, or any additional information necessary to complete testing in an appropriate manner.
- .2 The Installation Contractor will provide temporary connections, flow monitoring, pressure monitoring, ammeters, and temporary tankage required for the performance of the tests.
- .3 Flow Metering
 - .1 Where possible, use fill and draw techniques to determine the amount of flow conveyed during the test period. Ensure that the volumes are sufficient for at least five (5) minutes of pump operation at the flows that are to be tested, other than runoff.
 - .2 Where permanent flow meters are installed on the downstream piping, they may be used to measure the flow during testing when accepted by the Contract Administrator. Ensure that the permanent flow meters are calibrated to within 5% of the rated flow of the pump to be tested prior to testing.
 - .3 Temporary metering may be used if accepted by the Contract Administrator. Temporary meters must have an accuracy of plus or minus 5%, at the rated flow of the pump, to be acceptable.
 - .4 Where other methods are not possible or where directed, use dye testing to determine the flow during the test periods. Dye testing is to be conducted by an agency acceptable to the Contract Administrator. Measured flows during the testing will be certified by a qualified Representative of the Contract Administrator to be within 5% of the actual flows.
- .4 Pressure Monitoring
 - .1 Do not use permanent gauges for pressure monitoring during tests. Temporary test gauges can be connected to the permanent gauge taps.
 - .2 Use gauges with sufficient accuracy to measure anticipated pressures on pump discharges within 2.5%. Where pump suction draws from an open tank or wet well, test gauge must be capable of measuring pressure at pump suction within 1.0 kPa.
 - .3 Provide evidence of pressure gauge calibration within three (3) months of conducting tests.
- .5 Test pump(s) at a minimum of three (3) flow conditions, typically corresponding to the rating point flow, 75% of that flow, and 120% of that flow. At each test point, measure flow, pressure, and amperage. In addition, verify run-out conditions.

PROCESS PUMP GENERAL REQUIREMENTS

- .6 For variable speed pumps, conduct the tests at two (2) speeds, typically 100% of the design speed and 30% of the design speed.
- .7 Field Test Report
 - .1 Compile field test results into a report for submittal to the Contract Administrator.
 - .2 Describe test set-up and measurement devices used to conduct the tests.
 - .3 For each pump, list the specified performance requirements and field test results. Show field test results (flow, pressure, power draw) superimposed on the performance curve provided with the submissions.
- .8 Where field tests do not verify compliance with specified performance requirements; investigate cause for noncompliance, undertake remedial Work as required to bring pump into compliance or replace the pump and all necessary ancillaries, and retest to prove compliance. All Work required to bring the pump into compliance is the responsibility of the Contractor and will be performed at no extra cost to the City.

END OF SECTION

FACTORY APPLIED MAINTENANCE AND CORROSION PROTECTION COATINGS

1. GENERAL

1.1 Work Included

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

1.2 Submissions

- .1 With the equipment Shop Drawings, submit details of the coating systems to be applied.

1.3 Quality Assurance

- .1 This Specification is intended to be a minimum reference standard.

2. PRODUCTS

2.1 Surface Preparation

- .1 Immersion Service: After degreasing, dry blast all ferrous components to a white metal finish in accordance with SSPC-SP5 to a degree of cleanliness in accordance with NACE No. 1 and obtain a 50 micron blast profile.
- .2 Non-immersion Service: After degreasing, dry blast all ferrous components to a near white finish in accordance with SSPC-SP10 to a degree of cleanliness in accordance with NACE No. 3 and obtain a 50 micron blast profile.

2.2 Prime Coating

- .1 Prime coat all ferrous surfaces before the blasted surfaces deteriorate.
- .2 Coat ferrous surfaces with inorganic zinc primer, containing a minimum of 50% solids by volume, applied to a minimum dry film thickness of 75 microns.

2.3 Assembly

- .1 For items which are to be bolted together before shipment, clean surfaces and coat before the parts are assembled.
- .2 Continuous weld all welded connections, sealing the mating surface completely. On completion of the welding and fettling, treat all weld seams with phosphoric acid solution. Rinse and thoroughly dry before the prime is applied.
- .3 Where dissimilar metals are mated insulate the mating surfaces from one another to provide protection against corrosion. Insulate bolts, nuts, washers, and rivets in a similar manner.
- .4 Use 304 stainless steel or better for all nuts, bolts, washers and similar fittings for immersion service. For non-immersion service, use 304 stainless or zinc or cadmium plated nuts, bolts,

FACTORY APPLIED MAINTENANCE AND CORROSION PROTECTION COATINGS

washers, and similar fittings. Clean and coat the inner face of non-threaded bolt holes as required for other surfaces.

3. EXECUTION

3.1 Inspection

- .1 Notify the Contract Administrator two (2) weeks before commencing the protective coating to permit the inspection by the Contract Administrator of the surface preparation and protective coating application.

3.2 Protection

- .1 Equipment Manufacturer shall supply to the Installation Contractor touch up paint to repair any equipment is damaged or scratched during shipment, off-loading, storage on-site and installation. The paint shall be provided to the Installation Contractor at the Contractor's own expense
- .2 Make good damage to coatings occurring at any time prior to the application of any further coatings.

3.3 Application Conditions

- .1 Apply all factory applied coatings under controlled conditions, in a dust-free atmosphere at a temperature of between 10 and 20 °C, and a relative humidity should not exceed 80%.

END OF SECTION

FIBERGLASS REINFORCED STORAGE TANKS

1. GENERAL

1.1 References

.1 The following is a list of standards that may be referenced in this Section:

- .1 CAN/CGSB-41.22-93
- .2 ASTM D3299
- .3 ASTM D2563

1.2 Submittals

.1 Shop Drawings

.1 Materials used for tanks including:

- .1 Type of resin, percent ratio of resin and fibreglass.
- .2 Wall thicknesses.
- .3 Sequence of layers of glass reinforcement showing thicknesses of cure stages.

.2 Method of fabrication, including industry standards governing fabrication, quality control.

.3 Layout, overall dimensions, required clearances and description of equipment.

.4 Location of any electrical equipment, control panels and auxiliary equipment.

.5 Attachment of equipment, services, auxiliary equipment, accessories.

.6 Electrical control schematics, wiring diagrams, panel layout and general description including list of materials.

.7 Tank bottom.

.8 Load conditions, design criteria, critical strain values, design factors and similar items used in manufacturing specified tank.

.9 Accessories: Manways, nozzles, liquid level indicator and similar items.

.10 Materials, methods of fabrication, quality control, catalyst-curing system, type and minimum thickness of chemically-resistant veil (barrier) on tank interior, and other pertinent data on materials, fabrication and similar items.

FIBERGLASS REINFORCED STORAGE TANKS

1.3 Quality Assurance

- .1 Provide equipment and materials of highest quality and best suited to requirements. Provide materials and finishes in contact with chemicals that are resistant to chemicals or chemical vapours.
- .2 Supply, without additional cost, appurtenances not shown on drawings or specified which are found necessary to complete every portion of equipment specified so that equipment functions as intended by specifications.

2. PRODUCTS

2.1 Design Requirements

- .1 Sodium Hypochlorite storage tanks design criteria:

	<u>Unit</u>	<u>Quantity</u>
.1 Number of tanks	-	2
.2 Volume (each tank)	L	235,000
.3 Minimum inside diameter	m	5.5
.4 Maximum inside length	m	10.0
.5 Maximum tank height (from bottom of tanks supports to top of tank)	m	9.0
.6 Sodium Hypochlorite – NaOCl properties		
% Strength	%	0.8
Specific gravity	-	Approx 1.0

- .2 Brine Tank design criteria:

	<u>Unit</u>	<u>Quantity</u>
.1 Number of tanks	-	2
.2 Maximum outside diameter	m	3.65
.3 Maximum tank height	m	6.5
.4 Food grade salt (NaCl) and brine solution		
% Strength	%	30

FIBERGLASS REINFORCED STORAGE TANKS

2.2 Brine Tank

.1 Fabrication

- .1 Fabricate tanks by filament wound method to ensure high quality and uniformity of structures.
- .2 The brine tank shall be constructed of filament wound reinforced thermoset plastic, manufactured in accordance with Specification ASTM D-3299-00 with the inner surface and the interior layer included in the structural wall calculation. Inner corrosion liner shall be fabricated with Isophthalic polyester resin, reinforced with 0.25-0.5 mm "C" glass surface veil and backed with 2 mm chop strand fiberglass laminate. Balance of laminate shall be fabricated to full wall thickness with the same resin as above. Exterior surface shall be finished with translucent protective coating with ultraviolet inhibitors.
- .3 All materials in contact with water, brine solution, or salt should be NSF approved.
- .4 Design fibreglass reinforced plastic material, type and percent ratio of resin and fibreglass to suit handling under design conditions.
- .5 Contractor is responsible for design, selection of suitable materials, fabrication, quality control, handling, inspection and delivery of tanks.
- .6 Fabricate tanks with inner wall with chemically-resistant liner, layer of insulation and outer wall.
- .7 Contractor to supply heating element(s) in lower part of tank between inner wall and insulation.
- .8 Fabricate structural portion of inner wall by filament-wound method to thickness calculated by Contractor to meet design load conditions.
- .9 Fabricate internal protective liner with several layers of chemically-resistant materials to minimum total thickness of 5 mm. Do not include internal protective liner in calculations for tank wall thickness.
- .10 Fabricate FRP laminate outer walls (minimum 3 mm thick) with:
 - .1 One layer of resin rich mat.
 - .2 One layer of woven roving glass.
 - .3 One layer of resin rich mat.
 - .4 One layer of C glass veil.
- .11 Incorporate fire retardant additive into construction materials of outer wall of tank.
- .12 Fabricate tanks with ultraviolet inhibitor to prevent chalking.

FIBERGLASS REINFORCED STORAGE TANKS

- .13 Allowable laminate defects: Level II as defined in ASTM D2563 Standard.
 - .14 Maximum strain of tank wall: 0.001 mm/mm as specified in ASTM D3299.
 - .15 Laminate: Unpigmented and translucent.
 - .16 Minimum knuckle radius: 40 mm.
 - .17 Verify resin cure by Barcol hardness and acetone tests.
 - .18 Barcol hardness of laminate: Minimum 90% of resin manufacturer's minimum tacky. Process side of laminate: hard, smooth and glossy, with no resin-starved areas.
- .2 Features
- .1 Fabricate fully gusseted nozzles with unpigmented, flat-faced ANSI Class 150 flanges with 1050 kPag rating.
 - .2 Fabricate access manholes with double reinforcement all around. Design thickness equal to shell wall thickness. Design width around manhole equal to radius of manhole.
 - .3 Bolt holes: Resin coated.
 - .4 1000 mm diameter flanged tank access side manhole and cover, double reinforced with centre line 900 mm above tank bottom with flexible PVC, transparent gaskets, epoxy coated, stainless steel bolts, nuts and washers.
 - .5 1000 mm diameter flanged 316L stainless steel access manhole and cover on tank top, double reinforced, with gasket and fasteners.
 - .6 Eight (8) stainless steel, seismic zone 1 tie down lugs.
 - .7 Four (4) stainless steel lifting channels.
 - .8 Minimum 25 mm diameter stainless steel, epoxy coated anchor bolts, minimum embedment 300 mm.
 - .9 Dished top, flat bottom designed to stand on flat concrete surface.
- .3 Fittings
- .1 Each Brine Tank shall have ANSI B16.5 Class 150 flanged pipe connections for:
 - .1 50 mm diameter suction pipe.
 - .2 50 mm diameter outlet pipe.
 - .3 150 mm flanged ultrasonic level sensor connection.

FIBERGLASS REINFORCED STORAGE TANKS

- .4 150 mm flanged ultrasonic level sensor connection.
- .5 100 mm flanged temperature probe connection.
- .6 100 mm diameter overflow pipe.
- .7 100 mm diameter tank bottom drain.
- .8 100 mm diameter tank salt fill connection.
- .9 200 mm diameter vent connection

2.3 Sodium Hypochlorite Tank

.1 Materials of Construction:

- .1 Fiberglass reinforced thermoset resin shall be a commercial grade premium corrosion resistant vinyl ester that has been evaluated in a laminate by test in accordance with and complying with ASTM C581 or that has been determined by previous documented service to be acceptable for the service conditions.

.2 Resins:

- .1 The same fire-resistant premium grade resin shall be used throughout the entire wall section of each tank. Resin shall not contain pigments, dyes, colorants or fillers except as specified hereinafter.
- .2 Continuous roving shall be a commercial-grade of C-type glass fiber with a sizing that is chemically compatible with the resin system used. Continuous roving for chopping in spray-up process shall be principally silane finished with as little chrome compounds as practical to achieve chopper performance while maintaining visual laminate clarity requirements.
- .3 Woven roving: Woven roving shall be in accordance with ASTM Specification 02150.
- .4 Inner corrosion barrier shall be one "C" veil in front of one synthetic fiber surface mat such as Nexus Type 1012 with a curing resin system.

.3 Laminate Construction Requirements:

- .1 General: The laminate comprising the structural tank (bottom, cylindrical shell, top head) shall consist of a corrosion-resistant barrier comprised of an inner surface, interior layer and a structural layer.
- .2 Inner Surface: The inner surface exposed to the chemical environment shall be a resin-rich 0.50 to 0.75 mm thick, reinforced with 2 plies of synthetic fiber surface mats. Each ply shall be separately gelled prior to application of the subsequent ply.

FIBERGLASS REINFORCED STORAGE TANKS

- .3 Interior Layer: The inner surface layer exposed to the corrosive environment shall be followed with a layer composed of resin, reinforced only with noncontinuous glass-fiber strands applied to a minimum thickness of 2.5mm. The combined thickness of the inner surface and interior layer shall be 2.9 to 3.3 mm and in no case less than 2.85 mm. Glass content of the inner surface and interior layer combined shall be plus or minus 27 percent by weight. Resin used in these layers shall be as specified hereinabove and shall incorporate a cure system as recommended by the resin manufacturer. The degree of cure, after post cure shall be such as to exhibit a Barcol Hardness on the inner surface of at least 90 percent of the resin manufacturer's minimum specified hardness for the cured laminate with a synthetic surface mat.
- .4 Structural Layer: Subsequent reinforcement shall be comprised of 460g/m² chopped strand mat or equivalent weight of chopped roving, or shall be comprised of chopped strand mat or chopped roving and such additional number of alternating plies of 815/m² woven roving to a thickness as required to meet the physical properties that are used for the design. Each successive ply or pass or reinforcement shall be well-rolled prior to the application of additional reinforcement. Where woven rovings are used, chopped strand glass reinforcement shall be used as alternating and final layers. All woven roving and chopped strand shall be overlapped. Laps in subsequent layers shall be staggered at least 60 mm from laps in the preceding layer. Resin used in the structural layer shall be the same as used in the inner surface and interior layers. A cure system shall be applied to the structural layer.
- .5 The storage tank shall each be given a post-cure cure system to increase service life.
- .6 Laminates shall have a primary corrosion barrier consisting of resin rich layer on the side exposed followed by two layers of glass mat with approximately 70 percent resin content as specified hereinabove.
- .7 Linings or structures shall contain the minimum amount of thixotropic agent as possible for viscosity control in resins with no thixotropic agents used in the inner corrosion barrier, interior layer, interior secondary layers and interior topcoats which will be exposed to the environment. No thixotropics shall be used in the outer final paraffinated pigmented gel coat.
- .8 Resin pastes used to fill crevices may contain thixotropic agents provided that all such areas are subsequently covered with a full corrosion-resistant barrier laminate.
- .9 Secondary lay-up around joints and flanges shall be well curved and contain the minimum amount of thixotropy (Cab-0-Sill).
- .10 Total corrosion barrier for tank shall be a minimum of 100 mils and shall be contact molded. Only an automated process chopper gun may be used, the manual use of a chopper gun shall not be permitted in the construction of the tank.

FIBERGLASS REINFORCED STORAGE TANKS

- .11 Ultraviolet absorbers shall be added to the exterior surface for improved weather resistance for the tank. Tank shall have a white pigmented exterior gelcoat layer.
 - .12 The storage tank shall be post-cured with dry heat in accordance with the resin manufacturer's recommendation. Post-cure shall consist of a temperature of at least 85 C for a minimum of 4 hours. Barcol reading taken after the post-cure shall not be greater than four points less than the resin manufacturer's published Barcol readings and in no case less than 35. Where steam is used in the post-cure, no steam shall impinge on the interior surface of the tank or the inside of any nozzle. A steam sparge pipe protecting at least 300 mm beyond the interior surface of any nozzle and 300 mm away from any wall shall be used. During steam post-curing, the tank shall be maintained at atmospheric pressure. Cobalt compounds shall not be used in curing in any way.
- .2 Fabrication:
- .1 Provide FRP ladder and cage with handrail.
 - .2 The tank shall meet or exceed Visual Acceptance Level II in accordance with ASTM D2563.
 - .3 Tank shall be of the types and sizes shown on the Drawings and specified herein.
 - .4 Flanged Nozzles: All pipe connections shall be flanged and made by hand lay-up method. Pipe connections shall be of the same material as tank. Flanges shall be flush type, conical gusseted, reinforced with strength requirements of 2,050 Newton-Meters of bending and 2,700 Newton-Meters of torque, flat face, conforming to ANSI B16.5 150-pound drilling. Flanges shall be flat and true to a tolerance of plus or minus 1.5 mm. Flanges shall be either parallel or perpendicular to tank straight shell, as shown. Press molded flanges are not permitted nor are threaded fittings.
 - .5 Chemical metering pump suction nozzle for the storage tank shall be of the siphon drain type extending to within 50 mm of the tank bottom.
 - .6 Invert of overflow pipes shall be located a minimum of 150 mm below the seam line separating the dish-top from the vertical side walls.
 - .7 The tank shall be furnished with a top vent connection. Vent connection shall be located at tank top and the vents shall terminate through the roof in a gooseneck. Terminate vent 1.0 m from roof top. The Contractor shall supply sufficient vent material so that the Installer can terminate the vent 1m above the roof. Vent termination shall come with a stainless steel insect screen fitting. Roof vents shall be installed by Others.
 - .8 Each tank shall be furnished with a flanged connection for fill lines. Fill line connections shall be located at tank top. Fill lines shall extend down to within 450 mm of the tank bottom. The tank fill line shall be equipped with 1-inch diameter siphon break hole drilled above top of tank overflow pipe. Each tank shall also be furnished with a valved drain line.

FIBERGLASS REINFORCED STORAGE TANKS

- .9 Top Manway: Top manway shall provide a minimum 1000 mm tank opening, provide a port and bar type hinge, a grip handle, a drip lip and raised collar laminated into the tank top.
 - .10 The tank shall be furnished with sufficient number of pipe supports molded to the tank interior and exterior wall to restrain the fill lines. The number of supports shall be as recommended by the tank manufacturer but shall not be less than two.
 - .11 Lifting Lugs: Constructed of FRP or Type 316L stainless steel and capable of withstanding weight of empty tank. A minimum of three lugs shall be furnished per tank. Lifting lugs shall be attached to tank wall with hand-laid laminate equal to or greater than the tank wall thickness. Lifting lugs shall be so constructed to prevent tear-out of hole when in use.
 - .12 Tank bottom corners shall have a bottom 90 mm knuckle radius for maximum resistance against hydrostatic pressure. Thickness of knuckle shall be equal to the combined thickness of the shell wall and the bottom.
 - .13 The storage tanks shall be furnished with two universal mounting lugs. The lugs are to be used to fasten electrical junction boxes thereto. Lugs shall be installed at either the locations shown on the Drawings or where directed on approved Shop Drawings.
- .3 Features:
- .1 1000 mm diameter flanged tank access side manhole and cover, double reinforced with centre line 900 mm above tank bottom with flexible PVC, transparent gaskets, epoxy coated, galvanized steel bolts, nuts and washers.
 - .2 1000 mm diameter flanged access manhole and cover on tank top, double reinforced, with gasket and fasteners. All galvanized steel bolts, nuts and washers shall be epoxy coated
 - .3 Supports designed for horizontal placement of tank on flat concrete surface
 - .4 FRP supports for electrical conduits for ultrasonic level transmitter and temperature probe.
 - .5 Tank shall include stainless steel, seismic zone 1 tie down lugs and shall have stainless steel lifting channels. Furnish all necessary Teflon coated Type 316L stainless steel anchor bolts. Tie-down lugs shall be placed on tanks so they do not protrude below bottom surface of each tank. The design, number and attachment of such lugs is the responsibility of the tank fabricator.
 - .6 Tank shall have a clear 25 mm diameter PVC liquid level sight glass calibrated in litres c/w shutoff valve and vent
- .4 Fittings

FIBERGLASS REINFORCED STORAGE TANKS

- .1 Each Sodium Hypochlorite Tank will have ANSI B16.5 Class 150 flanged pipe connections for:
 - .1 50 mm diameter suction pipe.
 - .2 100 mm diameter outlet pipe.
 - .3 150 mm flanged ultrasonic level sensor connection.
 - .4 150 mm diameter overflow pipe.
 - .5 150 mm diameter tank bottom drain.
 - .6 25 mm diameter lower level indicator connection.
 - .7 25 mm diameter upper level indicator connection.
 - .8 300 mm diameter blower pipe connection
 - .9 300 mm diameter vent connection

2.4 Source Quality Control

- .1 Three inspections of fabrication facility will be made by Contract Administrator to check and assess resin formulation and control, fabrication methods and procedures, quality-control procedures.
- .2 Inform Contract Administrator of following inspections:
 - .1 Arrange first visit before fabrication begins to review materials, quality control procedures and to discuss testing procedures.
 - .2 Arrange second visit when first shell is complete to verify laminate quality and thickness and to test nozzle cut-outs.
 - .3 Arrange final inspection for finished tanks to check critical dimensions, nozzle elevations and orientations, areas with high stress concentrations (lower knuckle radius) and testing of resin cure.
- .3 Hydrostatically test tanks in factory by filling with water for minimum period of two hours to allow testing of nozzles, manholes and to ensure tanks are sound before shipping. Test pressure to reflect design specific gravity of liquid contents specified under design conditions.

FIBERGLASS REINFORCED STORAGE TANKS

3. EXECUTION

3.1 Painting and Finishes

- .1 Manufacturer's standard finish is acceptable, compatible with actual conditions of service for indoor operation. Contract Administrator reserves right to modify proposed finishes and protective coatings to ensure parts are protected against corrosion.
- .2 Apply protective coatings in shop under suitable conditions of moisture and temperature, with no delay between preparation and application.

3.2 Contractor's Representative

- .1 A Contractor's Representative is to attend the Site prior to the arrival of the equipment to train the Installation Contractor and ensure a seamless custody transfer.
- .2 A Contractor's Representative shall attend the Site to witness installation and testing to ensure the equipment is installed and operated as intended.
- .3 The Contractor's Representative shall verify the Installation Contractor's understanding by completing Form 101 as shown in Section 01650 – Equipment Installation.

3.3 Installation Training

- .1 Instruct the Installer in the methods and precautions to be followed in the installation of the pump(s).
- .2 The Contractor's Representative shall verify the Installation Contractor's understanding by completing Form 101 as shown in Section 01650 – Equipment Installation.

3.4 Testing

- .1 Ensure that each piece of equipment, including all component parts, operates as intended.
- .2 Cooperate with the Installation Contractor to fulfill the requirements for successful testing of the equipment, as documented by Form 103, illustrated in Section 01650 – Equipment Installation.

3.5 Performance Testing

- .1 Attend performance testing of the process system which includes the equipment specified in this Section to ensure that each piece of equipment functions as intended in the process system.

END OF SECTION

ELECTRICAL GENERAL REQUIREMENTS

1. GENERAL

1.1 Work Included

- .1 Complete an operational electrical package for each Process Unit as required.
- .2 Identify and submit to the Contract Administrator power requirements for each Process Unit. The Contractor shall identify the size of an over current protection device and feeder size for each Process Unit supplied, within 14 days of award of Contract.

1.2 Quality Assurances

- .1 Codes, Rules, Permits, and Fees:
 - .1 Comply with all laws, ordinances, rules, regulations, codes, and orders of all authorities having jurisdiction relating to this Work.
 - .2 Comply with all rules of CEC Part I C22.1-98.
 - .3 Comply with all rules of local Electrical Code and the applicable building codes.
 - .4 Quality of Work specified shall not be reduced by the foregoing requirements.
 - .5 All components shall be CSA approved.
- .2 Standard of Workmanship:
 - .1 Execute all Work in a competent manner and to present an acceptable appearance when completed.

1.3 Submittals

- .1 Submit samples as required where specified in Division 16 and 17.
- .2 Refer to Section 01300 - Submittals for general requirements for submittals.
- .3 Indicate materials, methods of construction and attachment of support wiring, diagrams, connections, recommended installation details, explanatory notes and other information necessary for completion of Work. Where equipment is connected to other equipment, indicate that such items have been coordinated, regardless of the Section under which the adjacent items will be supplied and installed.

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

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

ELECTRICAL GENERAL REQUIREMENTS

1.4 Operation and Maintenance Manuals

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

1.5 Product Handling

- .1 Use all means necessary to protect the products of this Division until Form 100 is completed.
- .2 Immediately make good any damage by repair or replacement at no additional cost to the City and to the approval of the Contract Administrator.
- .3 Remove advertising labels from all electrical equipment. Do not remove identification or certification labels.

2. PRODUCTS

2.1 Selected Products and Equivalents

- .1 Products and materials provided shall be new and free from all defects. Defective products or materials will be rejected regardless of previous inspections. The Contractor shall be responsible to remove and replace Defective products at their expense, and shall be responsible for any resulting delays and associated expenses, which result from defective products being rejected. Related materials shall be of the same Manufacturer.

2.2 Quality of Products

- .1 All products provided shall be CSA approved.
- .2 If products specified are not approved as specified above, obtain special approval from the local regulatory authority. Pay all applicable charges levied and make all modifications required for approval.
- .3 Products provided, if not specified, shall be new, of a quality best suited to the purpose required and their use subject to approval by the Contract Administrator.

2.3 Uniformity of Manufacture

- .1 Unless otherwise specifically called for in the Specifications, maintain uniformity of manufacture for similar products throughout the Work.

ELECTRICAL GENERAL REQUIREMENTS

3. EXECUTION

3.1 Equipment Identification

- .1 3 mm thick plastic lamacoid name plates, white background, mechanically attached with self tapping screws, 6 mm high black lettering, to be attached to the front face of the following equipment:
 - .1 Starters, contactors, and disconnects (designation, voltage, load controlled).
 - .2 Terminal cabinets and pull boxes (system, voltage).

END OF SECTION

SCOPE OF SUPPLY

1. GENERAL

- .1 Refer to Sections 11000 through 11901.
- .2 This Section describes the Electrical Division scope of supply for the Onsite Hypochlorite Generation Equipment electrical package.
- .3 The Contractor shall furnish all necessary components to provide a complete and fully functioning Hypochlorite Generation Equipment electrical package.
- .4 Contractor to provided recommendations for the supply of starters for large motors (over 22 kW).

1.2 Process Area Environment

- .1 This paragraph describes process area environment for various components of the Onsite Hypochlorite Generation Equipment.
 - .1 The Hypochlorite Generation Equipment electrical components will be installed in the WTP hypochlorite generation building, which is considered a corrosive wet and corrosive (NEMA 4X) location.
 - .2 Local Control Panel for the Onsite Hypochlorite Generation Equipment installed in the WTP hypochlorite generation building, which is considered a corrosive wet and corrosive (NEMA 4X) location.
 - .3 Electrical distribution panels will be installed in the WTP hypochlorite generation building electrical room, which is considered a clean, dry clean (NEMA 1) location.

1.3 Scope of Supply

- .1 For all supplied equipment, and equipment skid the Contractor shall supply the following:
 - .1 All motor starters and control devices as required to supply a complete electrical system (for motors less than or equal to 22 kW).
 - .2 All VFD and control devices as required to supply a complete electrical system.
 - .3 All wires and cables as required for a complete electrical system.
 - .4 All junction boxes and pull boxes as required for a complete electrical system.
 - .5 All wire and box connectors as required to supply a complete electrical system.
 - .6 All other components as required to supply a complete electrical system.
- .2 External conduit and wiring between separate equipment/skid packages is to be provided by Installation Contractor.

SCOPE OF SUPPLY

- .3 Termination of external wiring between separate equipment/skid packages is to be provided by the Contractor.

2. PRODUCTS - NOT USED

3. EXECUTION - NOT USED

END OF SECTION

WIRES AND CABLES 0 - 1000 V

1. GENERAL

1.1 Work Included

- .1 Provide a complete system of wiring, making all connections necessary for the installation of each Process Unit as required.
- .2 External conduit and wiring between separate equipment/skid packages is to be provided by others.

1.2 References, Codes, and Standards

- .1 CSA C22.2 No. 0.3, Test Methods for Electrical Wires and Cables.
- .2 CSA Standard C22.2 No. 131 for Teck cables.
- .3 Install and rate power cables in accordance with the local Electrical Code requirements.

2. PRODUCTS

2.1 Wires

- .1 Conductors: stranded for ten (10) AWG and larger.
- .2 Copper conductors: size as required by the applicable codes, with 600 V insulation of chemically cross-linked thermosetting polyethylene (XLPE) material rated RW90.

2.2 Teck Cable

- .1 Conductors:
 - .1 Grounding conductor: copper.
 - .2 Circuit conductors: copper, size as required by the applicable codes.
- .2 Insulation:
 - .1 Type: ethylene propylene (EP).
 - .2 Chemically XLPE rated type RW90, 600 V.
- .3 Inner jacket: polyvinyl chloride (PVC) material.
- .4 Armour: interlocking aluminum.
- .5 Overall covering: PVC material.

WIRES AND CABLES 0 - 1000 V

.6 Fastenings:

- .1 One (1) hole aluminum straps to secure surface cables 50 mm and smaller. Two (2) hole steel straps for cables larger than 50 mm.
- .2 Channel type supports for two (2) or more cables.
- .3 6 mm diameter threaded rods to support suspended channels.

.7 Connectors:

- .1 Watertight in non classified areas, explosion-proof in classified areas, as approved for TECK cable.

2.3 Control Cables

- .1 Type low voltage thermoplastic (LVT): Two (2) soft annealed copper conductors, sized as required by the applicable codes, with thermoplastic insulation, outer covering of thermoplastic jacket.
- .2 Low energy 300 V control cable: Stranded annealed copper conductors sized as required by the applicable codes, with PVC insulation type over each conductor and overall covering of PVC jackets and interlocked aluminum armour.
- .3 600 V type: Stranded annealed copper conductors, sizes as required by the applicable codes with PVC insulation type, XLPE type R90 (x-link) over each conductor and overall covering with sheath of aluminum interlocked armour and jacket over sheath of PVC.

3. EXECUTION

3.1 Installation of Teck Cable 0 - 1000 V

- .1 Install cables.
- .2 Group cables wherever possible on channels.
- .3 Terminate cables in accordance with Section 16151 - Wire and Box Connectors - 0 -1000 V.

3.2 Installation of Control Cables

- .1 Install control cables in conduit or use Teck cables.
- .2 Ground control cable shield at one end only.

WIRES AND CABLES 0 - 1000 V

3.3 Workmanship

- .1 Before pulling wire, ensure conduit is dry and clean. If moisture is present, thoroughly dry out conduits; vacuum if necessary. To facilitate pulling, recognized specially manufactured wire pulling lubricants may be used. Do not use grease. Employ suitable techniques to prevent damage to wire when ambient temperature is below the minimum permitted for each insulation type. Pull wires only into complete runs.
- .2 Installation to be free of opens and grounds. Before energization, measure insulation resistance and comply with the local Electrical Code. Submit data sheet with values measured.
- .3 Provide sizes of conductors as required by the applicable codes.
- .4 Exercise care in stripping insulation from wire. Do not nick conductors.

3.4 Identification, Coding and Balancing

- .1 Colour code all feeders at all terminations, at all points where taps are made, and at all panelboards, switchboards, motor control centres, etc. Use two (2) wraps of 3M No. 471 plastic film tape 48 mm wide.
- .2 For direct current wiring use red for positive and black for negative.

3.5 Testing

- .1 All power and control wiring shall be tested for insulation resistance value with a 1000 V megger. Resistance values shall be as recommended by the cable Manufacturer.
- .2 All wire test results shall be properly tabulated, signed, dated, and submitted to the Contract Administrator.

END OF SECTION

JUNCTION BOXES AND PULL BOXES

1. GENERAL

1.1 Work Included

- .1 Provide a complete system of splitters boxes and cabinets for the installation of wiring and equipment that is part of the equipment scope of supply.

2. PRODUCTS

2.1 Junction Boxes and Pull Boxes, Weatherproof

- .1 Materials:
 - .1 NEMA 4X suitable for outdoor locations.

2.2 Junction Boxes and Pull Boxes for corrosive process areas

- .1 Materials:
 - .1 NEMA 4X suitable for outdoor locations.

3. EXECUTION

3.1 Installation

- .1 Junction Boxes and Pull Boxes:
 - .1 Supply all pull boxes and junction boxes required for the installation.
 - .2 Identify with system name and circuit designation as applicable.
 - .3 Size in accordance with the local Electrical Code, as a minimum.

END OF SECTION

WIRE AND BOX CONNECTORS 0-1000 V

1. GENERAL

1.1 Work Included

- .1 Provide a complete system of wiring, making all connections necessary for the wiring installation on each Process Unit as required.

1.2 Special Codes

- .1 Install and rate power cables in accordance with the applicable Electrical Code requirements, or in accordance with IPCEA requirements where permissible.

1.3 References

- .1 CSA C22.2 No. 65 Wire Connectors.
- .2 EEMAC 1Y-2, Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).

2. PRODUCTS

2.1 Materials

- .1 Pressure type wire connectors: with current carrying parts same material as conductors sized to fit the conductors as required.
- .2 Bushing stud connectors: to EEMAC 1Y-2 to consist of:
 - .1 Connector body and stud clamp for stranded copper conductors.
 - .2 Clamp for stranded copper conductors.
 - .3 Stud clamp bolts.
 - .4 Bolts for copper conductors.
- .3 Clamps or connectors for armoured cable, aluminum sheathed cable, flexible conduit, as required.

2.2 Wire Connectors

- .1 Use 3M "Scotchlock", self-insulated connectors for hand twist wire joints for lighting, small power, and control wiring.
- .2 Use T & B non-insulated ring type compression lugs for terminating No. 10 AWG and smaller motor connections. Tape with rubber and scotch tape. Lugs to accept ten (10) - 32 x 3/8" machine bolts.

WIRE AND BOX CONNECTORS 0-1000 V

- .3 Terminate conductors No. 8 AWG and larger with Thomas & Betts Colour-Keyed compression connectors Series 54000, or on lugs provided with equipment.
- .4 Thomas & Betts "KOPR-SHIELD" compound Series CP8 on all terminations for compression connectors.

3. EXECUTION

3.1 Installation

- .1 Remove insulation carefully from ends of conductors and:
 - .1 Apply coat of zinc joint compound on aluminum conductors prior to installation of connectors.
 - .2 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by the Manufacturer. Installation shall meet secureness tests in accordance with CSA C22.2 No. 65.
 - .3 Install fixture type connectors and tighten. Replace insulating cap.
 - .4 Install bushing stud connectors in accordance with EEMAC 1Y-2.

3.2 Wire Connectors

- .1 Select hand twist connectors for wire size and Install tightly on conductors.
- .2 Brush "KOPR-SHIELD" compound on terminations for compression connectors as recommended by the Manufacturer.
- .3 Install compression connectors using methods and tools recommended by the Manufacturer.
- .4 Do not Install stranded conductors under screw terminals unless compression lugs are installed.

END OF SECTION

MOTOR STARTERS TO 600 V

1. GENERAL

1.1 Scope of Work

- .1 This Specification describes the requirements for the supply of motor starters for three (3) phase, squirrel cage induction motors as required by various process equipment specified in this Specification.

1.2 References

- .1 NEMA Contactors and Motor-starters.

1.3 Starter Requirements

- .1 Provide motor starters for all single-phase and three (3) phase motors up to 22kW as required.
- .2 Provide interlocking between starters where required.
- .3 All starter accessories such as pilot lights, COH, Start-Stop, etc. whether integrally or remote mounted shall be heavy duty oil tight, unless otherwise specified. Each COH switch shall have a voltage free contact terminated in terminals indicating Computer and NON-Computer position of the switch. Computer status for each COH switch shall be wired to a digital input on the PLC.

1.4 Shop Drawings and Product Data

- .1 Submit Shop Drawings in accordance with Section 16010 - Electrical General Requirements and Section 01300 - Submittals.
- .2 Indicate:
 - .1 Mounting method and dimensions.
 - .2 Starter size and type.
 - .3 Layout of identified internal and front panel components.
 - .4 Enclosure types.
 - .5 Wiring diagram for each type of starter.
 - .6 Interconnection diagrams.

MOTOR STARTERS TO 600 V

1.5 Operation and Maintenance Data

- .1 Provide O&M data for motor starters for incorporation into manual specified in Section 16010 - Electrical General Requirements and Section 01730 – Operation and Maintenance Manuals.
- .2 Include operation and maintenance data for each type and style of starter.

1.6 Maintenance Materials

- .1 Provide maintenance materials in accordance with Manufacturer recommendation. Include maintenance materials, special tools, and spare parts.
- .2 Provide listed spare parts for each different size and type of starter:
 - .1 Three (3) contacts, stationary.
 - .2 Three (3) contacts, movable.
 - .3 One (1) contact, auxiliary.
 - .4 One (1) control transformer(s).
 - .5 One (1) operating coil.
 - .6 Two (2) fuses.
 - .7 10% indicating lamp bulbs used.

2. PRODUCTS

2.1 Materials

- .1 Starters to NEMA Standards.

2.2 Enclosure

- .1 All individually mounted motor starters shall be enclosed in a general purpose sheet steel enclosure unless in wet areas where they shall be watertight EEMAC 4X.

2.3 Manual Motor Starters

- .1 Manual motor starters shall be of size, type, rating, and enclosure type as required by local applicable codes, with components as follows:
 - .1 Switching mechanism, quick make and break.
 - .2 Overload heaters, manual reset, and trip indicating handle.

MOTOR STARTERS TO 600 V

- .3 Rated volts and poles to suit application.
- .2 Accessories:
 - .1 Indicating lights: Heavy duty L.E.D. type and colour as indicated.
 - .2 Locking tab to permit padlocking in "ON" or "OFF" position.

2.4 Full Voltage Non Reversing (FVNR) Magnetic Starters

- .1 Combination magnetic starters shall be of size, type, rating, and enclosure type as required by local applicable codes with components as follows:
 - .1 Contactor solenoid operated rapid action type.
 - .2 Motor overload protective device in each phase, manually reset from outside enclosure.
 - .3 Wiring and schematic diagram inside starter enclosure in visible location.
 - .4 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.
- .2 Combination type starters shall include motor circuit interrupter, or circuit breaker with operating lever on outside of enclosure to control the disconnect switch, or the motor circuit interrupter or the circuit breaker, and provision for:
 - .1 Locking in "OFF" position with up to three (3) padlocks.
 - .2 Independent locking of enclosure door.
 - .3 Provision for preventing switching to "ON" position while enclosure door open.
- .3 Accessories:
 - .1 Pushbuttons, selector switches: heavy duty labelled to identify control function.
 - .2 Indicating lights: Heavy duty L.E.D. type red pilot light to indicate energized motor circuit and where called for, green pilot light to indicate de-energized motor circuit. Pilot lights to be push-to-test transformer type.
 - .3 In addition to standard, one (1)-N/O and one (1)-N/C spare auxiliary contacts unless otherwise specified.

2.5 Full Voltage Reversing (FVR) Magnetic Starters

- .1 FVR magnetic starters shall be of size, type, rating, and enclosure type as required by local applicable codes with components as follows:
 - .1 Two (2) to three (3) pole magnetic contactors mounted on common base.

MOTOR STARTERS TO 600 V

- .2 Mechanical and electrical interlocks to prevent both contactors from operating at same time.
- .3 Three (3) overload relays with heater elements, manual reset.
- .2 Accessories:
 - .1 Pushbuttons selector switches: Heavy duty labelled to identify control function.
 - .2 Indicating lights: Heavy duty L.E.D. type, red pilot light to indicate energized motor circuit and where called for, green pilot light to indicate de-energized motor circuit. Pilot lights to be push-to-test transformer type.
 - .3 In addition to standard, one (1)-N/O and one (1)-N/C spare auxiliary contacts per contactor unless otherwise specified.

2.6 Equipment Identification

- .1 Provide equipment identification in accordance with Section 16010 - Electrical General Requirements.
- .2 Manual starter designation label, white plate, black letters, size one (1).
- .3 Magnetic starter designation label, white plate, black letters.

2.7 Acceptable Manufacturers

- .1 Acceptable motor starter Manufacturers are: Schneider Electric, Cutler-Hammer, Square D, and Allen Bradley.
- .2 Multilin motor protector relays are preferred for large motor protection (> 37 kW).

3. EXECUTION

3.1 Installation

- .1 Make connections to starters on skid mounted equipment.
- .2 Ensure correct overload devices elements installed.

3.2 Starter Verification

- .1 Field check motor starters supplied by Contractor prior to completing Form 102. As a minimum, verify the following:
 - .1 Check of control circuits.
 - .2 Verify that overload relay installed is correctly sized for motor used.

MOTOR STARTERS TO 600 V

- .3 Record overload relay size and motor nameplate amperage.
- .4 Visual inspection of fuses and contactors.
- .5 Ensure all connections are tight.
- .2 Measure and record motor amps under load conditions and compare with full load amps and motor service factor. Report any excessive readings and unbalance. Measure voltage as close to motor terminals as possible while motor is running.
- .3 Set all motor circuit protectors to the minimum level which will consistently allow the motor to start under normal starting conditions.

3.3 Overload Relays

- .1 For starters provided, select overload relays in accordance with relay and motor Manufacturers' recommendations, considering motor service factors, ambient temperature, temperature differences between motor and starter locations. Monitor motor operation during start-up to ensure motor operation is satisfactory and relays provide proper protection. For side inlet fans and other long acceleration time loads, provide special overload relays to suit the start-up condition. Provide Manufacturers' curves and data sheets for the driven equipment where necessary to provide supporting data for motor protection.

3.4 Field Quality Control

- .1 Operate switches, contactors to verify correct function.
- .2 Perform starting and stopping sequences of contactors and relays.
- .3 Check that sequence controls, interlocking with other separate related starters, equipment, and control devices operate as specified.

END OF SECTION

VARIABLE FREQUENCY DRIVES

1. GENERAL

1.1 Standards

- .1 All VFD's supplied under this Contract shall meet or exceeds the following Specifications.
- .2 Provide a complete inventory of spare cooling fans, and fuses, for each VFD supplied.
- .3 The adjustable frequency controller shall be designed to operate standard squirrel cage induction motor with a 1.15 S.F. or definite purpose motors meeting NEMA MG1 Part 31.
- .4 Harmonic loading shall not exceed a motor service factor of 1.0.
- .5 Products shall comply with IEEE Standard 519.
- .6 VFD unit shall be UL listed and CSA certified.
- .7 VFD unit shall comply with applicable requirements of the latest standards of CSA, ANSI, IEEE and the CEC.

1.2 Tests

- .1 Factory testing
 - .1 Initial setup and programming will be provided by Installation Contractor in accordance with Section 01650.
 - .2 Provide certified copies of production test results required by CSA and EEMAC to the Contract Administrator, prior to acceptance of the equipment.
- .2 Field testing
 - .1 Initial setup and programming will be provided by the Installation Contractor in accordance with Section 01650.
 - .2 The VFD Manufacturer's Representative shall provide Site functionality test reports indicating loading/current levels during testing as well as control point proving results.
 - .3 The VFD Manufacturer's Representative shall ensure shaft to ground voltages do not exceed 1.5 V at any speed or load requirement.
 - .4 Allow for all costs and labour for as many trips as necessary to complete requirements.
 - .5 It is the intent of this Specification to provide a VFD installation that does not adversely affect the electrical system.

The VFD Manufacturer's Representative shall evaluate the predicted effect of the VFD installation on electrical system and advise the Contract Administrator of these effects.

VARIABLE FREQUENCY DRIVES

Further information about the electrical distribution on-site will be provided upon request.

- .3 Provide certified copies of all production test results required by CSA and NEMA.

1.3 Warranty

- .1 The VFD supplier to provide warranty coverage for a period of two (2) years upon Total Performance when the warranty period has commenced.
- .2 Review specifications of motors for application compatibility. Obtain and submit written approval from both the motor and VFD suppliers confirming that both pieces of equipment are compatible when used together to maintain the required warranty.
- .3 Indicate the level of local support detailing response time if a piece of equipment should fail or malfunction. Include estimated replacement part delivery times, as well as nearest parts depot location and a contact name and phone number.

2. PRODUCTS

2.1 Variable Frequency Drives

- .1 VFD as supplied by one of the following acceptable Manufacturers:
 - .1 ABB, Series ACS-80.
- .2 The drive shall be rated for continuous duty while operating a NEMA design induction motor of the sizes and operating voltages as shown in the following schedules and indicated on the Drawings. Drive output shall be sized for a 1.0 motor service factor. The VFD shall have a current rating at least 10% in excess of the motor full load amp rating. Overload service factors of 110% for thirty (30) minutes and 135% for one (1) minute must be provided to ensure adequate safety margins. VFD selection shall be based on load current at constant torque ratings. Do not size VFD's based on variable torque maximums.
- .3 Input voltage shall be as indicated on motor schedules and Drawings (line voltage variation $\pm 10\%$). Based on 347/600 volt systems (Not 575 V). Line frequency variation $\pm 5\%$. Output voltage shall vary with motor speed to nominal motor voltage. Speed stability shall be $\pm 1\%$. Drive shall match torque characteristic of load.
- .4 Input frequency setting signal will be 4 to 20 mA. Output speed monitoring signal shall be 4 to 20 mA.
- .5 Enclosure:
 - .1 Drive shall be installed in the electrical room or with individual CSA one (1) enclosure, drip proof. Filters to be provided for any forced air cooled enclosures as required by the Manufacturer. VFD(s) shall be suitable for mounting in a typical building electrical room and shall be able to operate under these conditions with no special cleaning

VARIABLE FREQUENCY DRIVES

requirements. VFD cabinets shall be mounted in such a way that there is adequate room for ventilation and no build up of heat. The minimum clearance in front of VFD's is 1 m.

- .6 Protective devices to be incorporated are:
 - .1 Fast acting electronic circuit board protective devices for protection of electronic components.
 - .2 Line reactor, DC link or filter in the drive input to protect electronic components from transient voltage conditions.
 - .3 Integral electronic motor overload protection adjustable up to 150% of motor rating for 60 seconds.
 - .4 Overcurrent instantaneous trip 250%.
 - .5 Programmable short-circuit protection.
 - .6 Programmable ground fault protection.
 - .7 Overvoltage/overcurrent DC bus monitor/protection.
 - .8 Undervoltage protection.
 - .9 Loss of phase and phase unbalance protection.
 - .10 Inverter over-temperature protection.
 - .11 Capable of running without motor for start-up.
 - .12 Output filter package (as required) to limit motor voltage to 1200 volts maximum at motor terminals. A reflective wave trap mounted at the motor may be used to accomplish this.
 - .13 Longlead (motor feeder) filter package, as required for these installations. Contractor is responsible to determine where this will be required, and must indicate as to the requirement or non-requirement of longlead filter package components in their submittals.
 - .14 Maximum acceptable noise level is 80dBA at 1m.
- .7 Operation features:
 - .1 Integral flush mounted display in VFD cover with keypad for programming, monitoring and operating of drive, accessible through password or other acceptable security measure only. Remote keypads, completely duplicating functions of integral keypads, shall also be provided for all VFD(s) located inside a fan plenum. The remote keypads in these cases shall be located adjacent to the door entering the plenum.

VARIABLE FREQUENCY DRIVES

- .2 Fault shutdown and indication.
- .3 Automatic restart following power outage.
- .4 Ability to disconnect motor load for setup or trouble.
- .5 Manual speed control (potentiometer or keypad).
- .6 Adjustable maximum and minimum speed.
- .7 Acceleration and deceleration time adjustment.
- .8 Controller “stop” interlock from a NC dry contact.
- .9 Drive fault contact.
- .10 Stop/start push buttons on key pad.
- .11 Transient voltage protection.
- .12 Provide three (3) dry “C” type contacts programmable for any combination of the following:
 - .1 Running (output frequency being generated).
 - .2 Fault lockout.
 - .3 Stopped.
 - .4 At speed.
 - .5 Under speed.
 - .6 Forward/Reverse.
 - .7 Low reference.
 - .8 Manual/Auto Mode.
 - .9 Local/Remote Mode.
- .13 Soft start sequence.
- .14 Minimum of three (3) skip frequencies.
- .15 Provide Computer/Off/Hand selector switch. Keypad C/O/H is not an acceptable replacement.

VARIABLE FREQUENCY DRIVES

- .16 Password protection of parameter programming or some method to prevent unauthorized changes.
- .17 Output speed monitoring signal to be 4-20 mA.
- .18 Ethernet data communication gateway.
 - .1 A data communication gateway shall be provided for the connection to the Ethernet Plant Control and Monitoring System. The data communication protocol shall be Modbus/TCP.
- .8 Environmental Capabilities: The drive shall operate without mechanical or electrical damage under any combination of conditions as follows:
 - .1 Ambient temperature 10° to 40°C.
 - .2 Humidity 0 to 90% (non condensing).
 - .3 Vibration up to 0.5 g.
 - .4 Altitude: Plant elevation is 232 ± 50 m above MSL.
- .9 Diagnostic and indicating features:
 - .1 Power On indication.
 - .2 Percentage speed indicator.
 - .3 Overload indication.
 - .4 Short circuit indication.
 - .5 Ground fault indication.
 - .6 Overvoltage indication.
 - .7 Undervoltage indication.
 - .8 High temperature (controller).
 - .9 AC voltmeter (output).
 - .10 AC ammeter (output).
 - .11 Inverter ready.
 - .12 Inverter fault.
 - .13 External fault.

VARIABLE FREQUENCY DRIVES

.10 Cooling System:

- .1 Contractor to provide adequate proven cooling devices for VFD equipment.
- .2 Contractor to ensure any enclosure utilized will not allow a build up of heat. This can be accomplished by use of fans and/or sufficient guarded, filtered openings.

.11 Normal Distribution

- .1 Normal power distribution is subject to voltage surges and sags as a normal condition of operation. Design and supply with each VFD the required inverter protection such that the VFD will not be stressed or damaged, in the following conditions:
 - .1 Line transients of up to 3,000 volts with energy levels of 50 joules.
 - .2 Line surges of up to 115% of rated voltage for up to ten (10) cycles. Based on 347/600 volt systems.
 - .3 Line voltage sags down to 85% of rated voltage of up to one (1) second duration.
- .2 Control wiring shall be TEW 105°C rise.
- .3 Terminal blocks in separate control enclosures for remote interface shall be Weidmueller SAK6N or approved equivalent.
- .4 Provide wire markers at both ends of all control wires, Electrovert Type Z or approved equivalent.

3. EXECUTION

3.1 Operations Manual Information

- .1 The Contractor shall provide the VFD Manufacturer as built of each motor application. Motor application data will include at a minimum, the following:
 - .1 Motor Manufacturer.
 - .2 Class.
 - .3 Motor model number.
 - .4 Motor serial number.
 - .5 Motor frame.
 - .6 Motor hp.
 - .7 Motor full load amps.

VARIABLE FREQUENCY DRIVES

- .8 Motor conductor size.
- .9 Ground conductor.
- .10 Length of conductors from VFD to Motor.
- .11 Motor MCP or fuse and overload.
- .2 Installation
 - .1 Identify mounting requirements including concrete pads for all floor mounted equipment.
 - .2 Contractor shall make provisions for the wiring of all interlocks including (but not limited to) vibration switch, freeze stats, and fire alarms to the VFD. These interlocks will be active in both the Hand (local) or Auto (remote) configurations.
 - .3 Contractor shall ensure that all safety interlocks, control and stop commands shut down the drive as per Manufactures recommended procedure (example, ramp to stop, ramp and hold, or coast to stop). Contactors on the line or load side of the drive are not an approved method of control.
 - .4 VFD and motor isolation switch shall be labelled with proper shutdown procedures as follows:
 - “Caution”**
 - “* Ensure VFD is stopped before operating this switch”.
 - “* Record all faults before resetting”.
 - .5 Motor supply cables/conductors shall be run in conduits separate from supply feeders to line side of VFD. No conductors (supply or motor feeders) are to be taped or otherwise bundled within the conduits.
- .3 Field Quality Control
 - .1 Contractor shall be responsible for complete performance testing of each variable speed drive to satisfaction of the Contract Administrator and the City. Contractor shall allow for Factory Representative to completely calibrate all drive circuits after installation on-site.
- .4 Software
 - .1 Provide VFD programming/troubleshooting software to City.
- .5 VFD Shop Drawings.

VARIABLE FREQUENCY DRIVES

- .1 The Contractor shall indicate the level of local support detailing response time if a piece of equipment should happen to fail or malfunction. Details are to include estimated replacement part delivery times, as well as nearest parts depot location and a contact name and phone number.
- .2 The Shop Drawings for each type/size of VFD must be specific to that unit. A generic Shop Drawing is not acceptable. The Shop Drawings are to include dimensions and physical details of the cabinets, a wiring diagram and a ladder diagram showing both internal connections and terminals for field wiring.
- .3 Provide labels/lamacoids on each VFD, isolation switch as follows:

“Caution”

“* Ensure VFD is stopped before operating this switch”.

“* Record all faults before re-setting”.
- .4 All Drawings, manuals, parameter settings, and test reports are to be included with the O&M Manual, Electrical Section. This manual shall be issued in both Hard Copy and Electronic format.

END OF SECTION

CONTROL DEVICES

1. GENERAL

1.1 Work Included

- .1 Control equipment such as:
 - .1 Pushbutton stations, indicating lights, control and relay panels, are supplied under this Specification to form complete control system for a Process Unit in conjunction with:
 - .2 Motor control centre (by Others), starters, and items provided under Division 17 for example, pressure, flow, float, solenoid valves, panels, pneumatic electric switches, transducers, etc. Some or all of the preceding items are interconnected under this Specification.

2. PRODUCTS

2.1 AC Control Relays

- .1 Convertible contact type: contacts field convertible from normally-open (NO) to normally-closed (NC), electrically held with sliding barrier to permit access to contacts only or coil only, three (3) to four (4) poles. Coil rating: 120 V. Contact rating: 120 V, minimum 3 A.
- .2 Sealed contact type: electrically held with three (3) to four (4) poles and front mounted contact block. Coil rating: 120 V. Contact rating: 120 V, min 3 A.
- .3 Universal pole type: electrically held with three (3) to four (4) poles, convertible from NO to NC by changing wiring connections. Coil rating: 120 V. Contact rating: 120 V, minimum 3 A.
- .4 Fixed contact type: heavy duty with three (3) to four (4) poles. Coil rating: 120 V. Contact rating: 120 V, minimum 3 A.

2.2 Relay Accessories

- .1 Standard contact cartridges: NO - convertible to NC in field.

2.3 Sealed Contact Oil tight Limit Switches

- .1 Lever type switches: roller operated, double pole, double throw. Contact rating: EEMAC B-600.
- .2 Push type switches: actuated by rod located on tip or side of operating head, spring return double pole, double throw. Contact rating: EEMAC B-600.
- .3 Wobble stick cat whisker type switches: actuated by rod or stick extending from tip of operating head. Moving rod in any direction operates contacts. Double pole, double throw. Contact rating: EEMAC B-600.

CONTROL DEVICES

- .4 Lever operated: time delay switch: adjustable time delay from $\frac{1}{2}$ s to 15 s plus 25%.
Contact rating: EEMAC B-600.
- .5 Plug-in construction switches: CSA Type four (4), lever or push type, contact rating:
EEMAC A-600.

2.4 Solid State Timing Relays

- .1 Construction: ac operated electronic timing relay with solid-state timing circuit to operate output contact. Timing circuit and output contact completely encapsulated to protect against vibration, humidity and atmospheric contaminants.
- .2 Operation: on-delay or off-delay.
- .3 Potentiometer: self contained to provide time interval adjustment.
- .4 Supply voltage: 120 V, ac, 60 Hz.
- .5 Temperature range: minus 20°C to plus 60°C.
- .6 Output contact rating: maximum voltage 300 V ac or dc. Current: EEMAC B300.
- .7 Timing ranges: As required.

2.5 Instantaneous Trip Current Relays

- .1 Enclosure: CSA Type to match the location in which they are to installed.
- .2 Contacts: NO, NC automatic reset with adjustable tripping point.
- .3 Control: Three (3) wire, with provision for shorting contacts during accelerating period of motor.
- .4 Contact rating: EEMAC B600.

2.6 Operator Control Stations

- .1 Enclosure: CSA Type to match the location in which they are to installed

2.7 Pushbuttons

- .1 Heavy duty, Operator recessed, flush, or mushroom type, as required. Black, with one (1)-NO and one (1)-NC contacts rated as required. Stop pushbuttons coloured red, provision for padlocking in depressed position. Design standard Allen Bradley 800 H series.

2.8 Selector Switches

- .1 Maintained or Spring return to center position, as required, heavy duty, operators standard wing lever, contact arrangement as required, rated 120 V, minimum 3 A, ac. Design standard

CONTROL DEVICES

Allen Bradley 800 H series.

2.9 Indicating Lights

- .1 Heavy duty, full voltage, push-to-test, lens colour: as required, L.E.D. type lamps, labels as required. Design standard Allen Bradley 800 H series.

3. EXECUTION

3.1 Installation

- .1 Install pushbutton stations, control and relay panels, control devices and interconnect.

END OF SECTION

INSTRUMENTATION AND CONTROL GENERAL REQUIREMENTS

1. GENERAL

1.1 Requirements of Work

- .1 Supply a complete and fully documented I&C system as shown on the Drawings and specified herein. The I&C system will form a subsystem of the overall WTP control system.
- .2 Component subsystems of the I&C system will include, but are not limited to, the following:
 - .1 Primary elements and transmitters.
 - .2 Final control elements.
 - .3 I&C field devices.
 - .4 I&C junction boxes, local control panels, and marshalling panels.
 - .5 Specialized Instrumentation cables.
 - .6 Instrumentation power supplies.
 - .7 Instrument cabling and associated conduit and/or fasteners where the instrument is connected to a control panel or other instrument located within the same equipment package skid.
- .3 Ensure the correct functionality of any equipment supplied under other Divisions of this Specification.
- .4 Documentation provided by the Contractor shall include as a minimum:
 - .1 Equipment descriptive data.
 - .2 Equipment installation instructions, service manuals, O&M Manuals, bills of materials, and recommended spare parts lists.
 - .3 Schematics and interconnection wiring diagrams sealed by a Professional Engineer registered in the Province of Manitoba.
 - .4 Records of conductor identification, field terminals, cable lists, and other information necessary for field installation of the equipment or system.
 - .5 I&C panel Shop Drawings, face layouts, schematics, and point-to-point wiring diagrams sealed by a Professional Engineer registered in the Province of Manitoba.
 - .6 I/O lists for digital or programmable systems.
 - .7 For the PLC based control system, the Contractor shall provide detailed documentation of the system hardware and software. Minimum software documentation shall include

INSTRUMENTATION AND CONTROL GENERAL REQUIREMENTS

a detailed operating description, flow charts that describe the functionality of the PLC program, a memory map, and the PLC program and documentation. This information shall be submitted at the Shop Drawing stage.

- .5 Documentation provided by the Contractor shall be formatted as follows:
 - .1 *Piping and Instrumentation Diagram (P&IDs)* – Depict the general intent of the control systems and are to be used as the governing document for the scope of Work.
 - .2 *Instrument Index* – A sorted index of the detailed information for the devices shown on the P&IDs. The index lists the appropriate support documentation for the devices' supply and installation. The instrument index is the controlling document for the supply of materials.
 - .3 *Input/Output Index* – A sorted index of the control system I/O points shown on the P&IDs, giving the supporting documentation as per the instrument index.
 - .4 *Instrument Specification Sheets* – Detail the relevant data for the supply of devices.
 - .5 *Instrument Loop Diagrams (ILD)* – Shows typical interconnections and hook-up of devices. The Contractor is to produce an ILD for each device and record all relevant information on each sheet. Fill in all terminal and wiring numbers etc. A set of 'B' size (11" x 17") AutoCAD drawings and associated files will be made available to the successful bidder.
 - .6 *Location Drawings* – Indicate in plan and/or elevation views where the instrument elements are physically located. These Drawings are provided to assist the Installer in estimating the amount of cable and ducting required.
 - .7 *Standard Details* – Provide a reference for installation, operation, and other instructions pertinent to a particular device.
- .6 References
 - .1 This Specification contains references to the following documents. They are a part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section prevail.

<u>Reference</u>	<u>Title</u>
API RP550-86	Manual on Installation of Refinery Instruments and Control Systems, Part I – Process Instrumentation and Control Section one (1) Through thirteen (13)
ASME Section VII-89	Rules for Construction of Pressure Vessels
ASTM B68-86	Seamless Copper Tube
ASTM D883-89	Terms Relating to Plastics

INSTRUMENTATION AND CONTROL GENERAL REQUIREMENTS

IEEE 100-88	Dictionary of Electrical and Electronic Terms
ISA RP7.1-56	Pneumatic Control circuit Pressure Test
ISA RP12.6-87	Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations
ISA S5.4-76	Instrument Loop Diagrams
ISA S18.1-79	Annunciator Sequences and Specifications
ISA S51.1-79	Process Instrumentation Terminology
NEMA 250-85	Enclosures for Industrial Controls and Systems
NEMA ICS 1-88	General Standards for Industrial Controls and Systems
NEMA ICS 2-88	Industrial Control Devices, Controllers, and Assemblies
NFPA 70-90	NEC
SAMA PMC 17-10-63	Bushings and Wells for Temperature Sensing Elements
UBC-88	Uniform Building Code
UL 1012-89	Power Supplies
UL 94-80	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
Weik, Martin H.	Communications Standard Dictionary, Van Nostrand Reinhold Co., 1983

.7 Related Work

- | | |
|----------------|-------------|
| .1 Process: | Division 11 |
| .2 Electrical: | Division 16 |

.8 Codes, Rules, Permits and Fees

- .1 Comply with all laws, ordinances, rules, regulations, codes, and orders of all authorities having jurisdiction relating to this Work.
- .2 Comply with all rules of the electrical Safety Act of the Province, CSA Standards, ULC and the applicable building codes, whether specifically shown on Drawings or not.
- .3 Give all required notices, submit drawings, obtain all permits, licenses, and certificates, and pay all fees required for this Work.

INSTRUMENTATION AND CONTROL GENERAL REQUIREMENTS

.9 Standards of Workmanship

- .1 Execute all work in a manner which will result in the completed installation presenting an acceptable appearance, to a level of quality defined in the general conditions of this Specification.
- .2 Install products in accordance with the recommendations and ratings of the product Manufacturers.
- .3 Supply and execute installation of all instrumentation control tubing in accordance with the Specifications.

.10 Contract Drawings and Specifications

- .1 Refer to Division 1.
- .2 Supply all items and accessories specified by the Drawings or the Specification in the quality and quantity required. Perform all operations as designated by the Specification according to the methods prescribed, complete with all necessary labour and incidentals.
- .3 Treat any item or subject omitted from this Division's Specifications or Drawings, but which is mentioned or reasonably specified in other Divisions' Specifications or Drawings and pertains to the I&C system, as being integral to the overall system. Provide such specified items or subjects.
- .4 Provide all minor items and work not shown or specified but which are reasonably necessary to complete the Work.
- .5 If discrepancies or omissions in the Drawings or Specifications are found, or if intent or meaning is not clear, consult the Contract Administrator for clarification before submitting tender.
- .6 The responsibility to determine which Division provides various products and work rests with the Contractor. Additional compensation will not be considered because of differences in interpretation of Specifications.

1.2 Equipment

.1 Tender Submittals.

- .1 Submit with the Tender an equipment list indicating the type and make of all equipment and materials proposed for this project.
- .2 Perform a final examination prior to delivery to Site to ensure that:
 - .1 All I&C components supplied for this project under this Section of the Specification comply with the requirements stated in the instrument specification sheets.

INSTRUMENTATION AND CONTROL GENERAL REQUIREMENTS

- .2 All I&C components supplied under other Sections of this Specification, to be connected to I&C components supplied under this Section of the Specification, comply with the requirements stated in the Contract documents.
 - .3 All I&C components conform to the specifications. Any delays in construction resulting from the delivery to Site of non-conforming I&C components shall be borne by the Contractor.
 - .4 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.
- .2 Take all necessary precautions to ensure that equipment is supplied free of damage. If deemed necessary by the Contract Administrator, damaged equipment shall be replaced with new product. The Contractor shall bear any costs due to construction delays resulting from the delay in delivery of acceptable equipment.

1.3 Documentation

- .1 Submittals
 - .1 Submit Shop Drawings for all products supplied by this Division. Submit Shop Drawings for review prior to purchase of any products or equipment and sufficiently in advance to allow ample time for checking.
 - .2 Contractor to review, modify, and approve the Shop Drawings prior to submitting Shop Drawings to the Contract Administrator for review. Contractor approval of a Drawing indicates the following:
 - .1 The Drawing has been checked by the person making the approval.
 - .2 The equipment or material complies in all respects with the requirements of the Specifications and Drawings.
 - .3 The quantities indicated are correct.
 - .4 The physical dimensions of the components are such that they can be installed without interference with the building structure or other equipment, and after installation, there are sufficient clearances on all sides for maintenance, servicing and operation of the equipment.
 - .5 The points of attachment are clearly indicated, i.e. TOP, BOTTOM, SIDE, etc.
 - .6 The arrangement and location are properly oriented.
 - .7 The product is suitable for its intended use.

INSTRUMENTATION AND CONTROL GENERAL REQUIREMENTS

- .8 The submission consists of sufficient information to adequately convey the scope of supply and the specific product to be supplied is highlighted.
- .9 The submission contains sufficient information to install the equipment or systems.
- .3 Stamp and sign the Shop Drawing to show approval, indicating the above has been complied with. If Contractor revisions are too extensive, return the submission to the Manufacturer for revision, then repeat the Shop Drawing approval process before submitting them to the Contract Administrator.
- .4 Manufacture of products shall conform to Shop Drawings marked as reviewed by the Contract Administrator and returned to the Contractor.
- .5 Refer to Division 1 for further information on Shop Drawing submittals.
- .2 O&M Manuals
 - .1 Refer to Division 1 for general O&M manual submittal information.
 - .2 In addition to the requirements specified in Division 1, provide the following information:
 - .1 Table of Contents – Arrange contents sequentially by systems under Section numbers. Label tabs of dividers between each to match Section numbers in the Table of Contents.
 - .2 Systems Descriptions – A brief synopsis of each system typed and inserted at the beginning of each Section. Include sketches and diagrams where appropriate.
 - .3 O&M instructions of all equipment and controls – These operating instructions need not be Manufacturer’s data but may be typewritten instructions in simple language to guide the City in the proper O&M of this installation.
 - .4 A copy of all wiring diagrams complete with wiring coding.
 - .5 Include type and accuracy of instruments used.
 - .6 Set of final reviewed Shop Drawings.
 - .7 Provide a tabulated list of all consumables utilized (fuses, lamps, etc.) indicating where used, type, rating and reorder details.

2. PRODUCTS

2.1 General

- .1 Refer to the requirements of Division 1.

INSTRUMENTATION AND CONTROL GENERAL REQUIREMENTS

- .2 Selected products.
 - .1 Provide products and materials that are new and free from all defects.
 - .2 The design has been based on the use of the first named product. Where applicable, equivalent products are listed.
- .3 Quality of Products
 - .1 All products provided to be CSA approved and ULC approved where applicable.
 - .2 If products specified are not CSA approved, obtain approval of the relevant provincial regulatory authority. Pay all applicable charges levied and make all modifications required for approval.
 - .3 Refer to Division 1 of this Specification for further information.
- .4 Uniformity of Manufacture
 - .1 Unless otherwise specifically called for in the Specification, uniformity of manufacture to be maintained for similar products throughout the Work.
- .5 Product Finishes
 - .1 Contractor to specify proposed finishes to be used for Contract Administrator's review.

2.2 Instrumentation

- .1 General
 - .1 Instruments to be suitable for the environmental conditions in which they are to be installed.
 - .2 Determine where injurious conditions may be expected to occur and make proper provision to protect the instruments to ensure their proper and reliable operation.
 - .3 Provide power surge protection, heating cables, and devices to protect instruments, equipment, and lines from being functionally impaired or damaged by power surges or environmental conditions such as moisture or freezing.

2.3 Identification

- .1 Refer to Division 16 for general identification requirements. Provide lamacoid nameplates with 6 mm black lettering on white background. Identify the loop tag number (where applicable) and the device name, function, and instrument range or setpoint value on the nameplate.

INSTRUMENTATION AND CONTROL GENERAL REQUIREMENTS

- .2 Where it is not possible to attach a lamaroid nameplate to a field instrument component, provide the component with a stainless steel metal tag firmly wired to the device and identified with the loop tag number.
- .3 Identify all wires where they terminate at the marshalling panels, junction boxes, control panels, and field devices with a heat shrink sleeve with machine printed labelling.
- .4 Clearly mark all panels, pull boxes, junction boxes, etc. to indicate the nature of service.
- .5 Provide neatly typed circuit directories for panel power distribution systems to indicate loops or devices powered by the circuit and the fuse size.
- .6 For direct current wiring use black for positive and white for negative.
- .7 For thermistor wiring to motors use red and blue coloured insulated wire.

3. EXECUTION

3.1 Coordination with other Divisions

- .1 Examine the Drawing and Specifications of all Divisions and become fully familiar with the Work. Before commencing Work, obtain a ruling from the Contract Administrator on any conflicting issues between Divisions. No compensation will be made for any costs arising from conflict not identified before Work has commenced.
- .2 Coordinate the work to be performed under this Section of the Specification with all Divisions installing equipment to ensure that there are no conflicts.
- .3 Layout the work and equipment with due regard to architectural, structural, and mechanical features. Architectural and structural Drawings take precedence over electrical Drawings regarding locations of walls, doors, and equipment.

3.2 Separation of Services

- .1 Maintain separation between the electrical wiring system and the instrumentation cables so that each system is isolated (except at approved connections to such systems) to prevent galvanic corrosion. In particular, contact between dissimilar metals, such as copper and aluminum, in damp or wet locations is unacceptable.
- .2 Classifications of Circuits
 - .1 The circuit categorization shall of first priority follow Canadian Electrical Code with respect to separation for electrical safety and the following shall apply with respect to electro-magnetic compatibility:

INSTRUMENTATION AND CONTROL GENERAL REQUIREMENTS

Very Noisy	High voltage circuits and their associated grounding
	High current (>200A) LV circuits.
	Harmonic-rich LV circuits.
	DC circuits: un-suppressed or above 50V.
Noisy	Low current class two (2) circuits.
	Medium power pulsed or radio frequency circuits.
Indifferent	ELV digital status circuits.
	Intrinsically safe circuits.
	Telecommunications circuits.
	Fire alarm and emergency lighting circuits (note that some fire alarm circuits may fall into the category of signal circuits).
	Any other emergency, shutdown, or high integrity circuit (e.g. toxic gas alarm).
Sensitive	Analogue signal circuits.
	Data communication circuits.
Very Sensitive	Low level voltage and current signals (e.g. from instrument sensors).

.3 Separation of Circuits

- .1 This Section relates to the running of cables carrying differing types of circuit in close proximity to one another and to other services. Sensitive circuits shall normally be run in overall shielded cable. Very sensitive circuits shall normally be run in individually twisted pair shielded cable.
- .2 For cables sharing the same support/containment system, the following shall provide guidance to minimize extraneous interference.

Segregation between circuits	Very Noisy	Noisy	Indifferent	Sensitive	Very Sensitive
Very Noisy	Thermal grouping as per CE Code.	150 mm	300 mm	300 mm	300 mm
Noisy	150 mm	Thermal grouping as per CE Code.	150 mm	150 mm	150 mm
Indifferent	300 mm	150 mm	Separation of circuit types.	100 mm	100 mm
Sensitive	300 mm	150 mm	100 mm	Touching	50 mm
Very Sensitive	300 mm	150 mm	100 mm	50 mm	Touching

3.3 Wire and Cable

- .1 Refer to Section 17124 – Instrumentation Cable.

INSTRUMENTATION AND CONTROL GENERAL REQUIREMENTS

3.4 Equipment Connections

- .1 Control circuits may vary with different Manufacturers of equipment. Verify all control circuits with the Manufacturers of the equipment and make any corrections to the control wiring diagrams that may be required.
- .2 Provide power disconnect switches for all 120 VAC powered instruments.

3.5 Access Panels

- .1 Provide access panels where I&C system junction boxes are concealed. Panels to be of adequate size for servicing of the concealed junction box and complete with necessary frames and hinged doors held closed with captive fasteners.

3.6 Tagging Standards for Devices and Wiring

- .1 Tag all devices, wires, and I/O using the assigned loop, equipment, or device tag name. Where tag naming and numbering is not defined the Contract Administrator will provide naming and numbering that is consistent with the WTP naming conventions.

3.7 Training

- .1 Provide training, described in detail in Division 1, as required by the WTP personnel to become fully competent in the proper O&M of all control devices, control valves, and ancillary instrumentation described under this Section of the Specification.
- .2 For the PLC based control system, the Contractor shall provide maintenance training that includes a review of the PLC program, system troubleshooting, and identification of programmed system variables such as setpoints, alarms, and status.

3.8 Test Forms

<u>Form No.</u>	<u>Title</u>
.1 ITR	Instrument Test Report.
.2 LCR	Loop Check Report.

INSTRUMENTATION AND CONTROL GENERAL REQUIREMENTS

INSTRUMENT TEST REPORT

SYSTEM: _____
 SERVICE: _____ TAG NO.: _____
 LOCATION: _____
 MAKE: _____ MODEL: _____
 SERIAL NO.: _____ CSA: _____
 ELEMENT: _____ RANGE: _____
 DESIGN SETTING/RANGE: _____ CONTACT TO: _____ ON: _____
 SIGNAL IN: _____ OUT: _____ ASSOCIATED INSTRUMENT: _____
 INSTRUMENT CONDITION: _____ CONFORM TO SPEC: _____
 PROJECT NO: _____ DATA SHEET: _____

	TEST 1				TEST 2			
TEST METHOD	INPUT		OUTPUT		INPUT		OUTPUT	
	INC.	DEC.	INC.	DEC.	INC.	DEC.	INC.	DEC.
TEST POINT 1								
TEST POINT 2								
TEST POINT 3								
TEST POINT 4								
TEST POINT 5								
COMMENTS								
GRAPHS								

TESTED BY: _____ CHECKED BY: _____

DATE: _____ DATE: _____

INSTRUMENTATION AND CONTROL GENERAL REQUIREMENTS

LOOP CHECK REPORT

- CHECKED OUT OK
 NOT APPLICABLE
 FURTHER ACTION REQUIRED

	INSTRUMENT TAG NO.							
LOOP NO. _____								
SHEET NO. _____								
P & I DWG. NO. _____								
INSTALLATION COMPLETE								
Primary Element.								
Impulse Lines.								
Block and Drain Valves.								
Air Supply/Filter/Reg.								
Wiring.								
Tracing/Insulation/Housing.								
Mounting and Location.								
PLC/SCADA I/O & Status.								
CALIBRATED								
Impulse Lines Press. Tested.								
LOOP CHECKED								
Element to Receiver.								
X Mtr. To Receiver.								
X Mtr./Trans. to Receiver.								
X Mtr./Trans. to Switches.								
Switches to Annunciator.								
Interlocking Circuit.								
Controller to Valve.								
Controller Action D or R.								

REMARKS:

READY FOR START-UP

Date: _____

Installed by: _____

Checked by: _____

INSTRUMENTATION AND CONTROL GENERAL REQUIREMENTS

3.9 Testing of Instrumentation Loops

- .1 After all devices within a loop have been connected, check the loop for correct functioning and interaction with other loops, where applicable. Provide written notice to the Contract Administrator when the loops are going to be tested so that the tests may be witnessed at the Contract Administrator's discretion.
- .2 Check the operation of final control elements such as solenoid valves, actuators, etc. by manual control before checking with automatic control.
- .3 Check and simulate all alarms and shutdown functions.
- .4 Verify the status of all points connected or accessible to the WTP control and monitoring system.
- .5 Where applicable, test all tubing for leaks in compliance with ISA RP7.1. Isolate all instruments when tubing is being tested to protect against over pressure.
- .6 Perform tests and record results on test data forms which are included in this Section. Develop additional and/or more detailed test forms as necessary to suit more complex instrumentation.
- .7 Sign and date all test reports. Submit the test reports to the Contract Administrator within five (5) Business days of testing.

3.10 Calibration

- .1 Instruments to be factory pre-calibrated. Provide a printed record of the factory calibration parameters for "smart" devices.
- .2 Prior to calibration, completely program all "smart" transmitters including entries of the appropriate range and tag number. Provide a printed record of smart device serial numbers against their assigned tag number.
- .3 Instruments to be set up and calibrated by an accredited instrument technician working under the approval of the instrument Manufacturer.
- .4 Calibrate all instruments to an accuracy of ½ of 1% of full range, or to the Manufacturer's state accuracy of the instrument whenever an accuracy of ½ of 1% is not achievable.
- .5 Prior to instrument installation perform the following applicable calibration for each instrument and its associated signal conditioning equipment:
 - .1 Calibrate all inline flow meters by a draw-down test.
 - .2 Calibrate all density meters by lab samples.
 - .3 Calibrate all vacuum and pressure instruments by manometer or accurate test instrument and hand test pump.

INSTRUMENTATION AND CONTROL GENERAL REQUIREMENTS

- .4 Calibrate gas detectors using standard gas sample.
- .5 Calibrate temperature instruments against a standard lab thermometer.

3.11 Installation and Performance Testing

- .1 During Performance Testing, demonstrate to the Contract Administrator proper calibration and correct operation of instruments and gauges.
- .2 Performance Testing of the I&C system to include but not be limited to the following:
 - .1 Verify installation of components, wiring connections, and piping connections.
 - .2 Verify wiring continuity and pipe leak tests.
 - .3 Verify instrument calibration and provide written report.
 - .4 Function check and adjust under operational conditions the I&C equipment.
 - .5 Coordinate I&C equipment supplier's service personnel as required for complete system testing.
 - .6 Provide WTP personnel with training in the correct method of operation of I&C equipment.
 - .7 Provide WTP personnel with training at hand-over as to final adjustment of the system for correct operation of plant.
 - .8 Verify signal levels and wiring connections to all I&C equipment.
 - .9 Coordinate and cooperate with the Contract Administrator to verify the Performance of the interface between the WTP SCADA and the packaged PLC based control system.

END OF SECTION

SCOPE OF SUPPLY

1. GENERAL

1.1 Requirements of Work

- .1 This Section describes the I&C scope of supply for the SHG control system.
- .2 The Contractor shall furnish all necessary components to provide a complete and fully functioning SHG control system.

1.2 Process Area Environment

- .1 Refer to Section 16015 – Scope of Supply for detailed information.

1.3 Scope of Supply

- .1 For the SHG control system the Contractor shall provide the following:
 - .1 A Local Control Panel to provide full control of the SHG systems.
 - .2 The data communication link between the Local Control Panels and any other Control Panel shall be Modbus/TCP via Ethernet.
 - .3 All instruments used for monitoring and control of the SHG systems.
 - .4 All instruments (temperature, vibration, and others as required) for personnel safety and equipment protection.
 - .5 ESD pushbutton for the SHG systems.
 - .6 Hydrogen Gas detection with ESD of the SHG systems in the event of a high gas alarm
 - .7 An interface to the WTP SCADA System providing the following functionality
 - .1 Provision for full remote (from the SCADA) control of the SHG systems.

END OF SECTION

ENCLOSURES

1. GENERAL

1.1 References - General

- .1 Equipment, products, and execution must meet all requirements detailed in Section 17010 – Instrumentation and Control General Requirements.

2. PRODUCTS

2.1 General

- .1 Unless otherwise specified, provide outside finishes on all enclosures in ANSI 61 Grey.
- .2 The enclosures must be suitable for carrying the weight of the equipment mounted inside the panel and on the doors without any warpage.

2.2 Enclosures

- .1 Supply EEMAC Type 12 gasketed enclosures in MCC rooms and control rooms.
- .2 All enclosures for mounting outside of MCC rooms and control rooms to be EEMAC Type 4, watertight except where otherwise specified.
- .3 Enclosures for certain equipment in corrosive atmospheres to be EEMAC 4X approved for the classification (e.g. chemical cleaning).
- .4 Enclosures for mounting field control indicator lamps and switches in unclassified areas to be Allen Bradley model 800T-xTZ die cast enclosures.
- .5 Enclosures for mounting field control indicator lamps and switches in Class 1 areas to be Allen Bradley model 800H-xHHX7 cast aluminum enclosures.

2.3 Panel Enclosures

- .1 Fabricate panel enclosures from 11 gauge steel panels complete with necessary stiffening to form a rigid free-standing line-up. The structures must be suitable for carrying the weight of the equipment mounted inside the panel and on the doors. Provide removable top and bottom cable entry plates.
- .2 Supply panels with front access only. Doors shall be key lockable and fitted with 3 point heavy duty latching assemblies. Provide a continuous piano hinge and pneumatic hold open device on each door.
- .3 Finish the interior of the enclosure with white paint. Provide a switched fluorescent light fixture and 120 VAC duplex convenience receptacle inside the enclosure.

ENCLOSURES

2.4 Marshalling and Control Panels

- .1 Supply, fabricate, checkout, layout, document, and deliver to Site fully equipped and functional panels.
- .2 Supply all components contained on or within the panels fully wired under this Section of the Specification.
- .3 The selection of all accessories, materials, and methods for fabrication not covered by this Specification, but which are necessary to complete the fabrication of the control panels, is the responsibility of the panel fabricator.
- .4 Fans and filters shall be installed to pressurize all control panels thus discouraging dust accumulation and providing air purging for temperature and corrosion control.

2.5 Wiring and Accessories

- .1 Provide wiring inside the panels according to the following Specifications:
 - .1 Control wiring to be a minimum of No. 16 AWG tinned stranded copper; insulation rated at 300 V.
 - .2 Wiring for power distribution shall be a minimum of No. 14 AWG tinned stranded copper; insulation rated at 600 V.
- .2 Tag each wire at both ends with a heat shrink sleeve that is machine printed. Allow approximately 20 mm of wire insulation between the tag and the bare wire.
- .3 Wiring systems with different voltage levels or types shall be suitably segregated within the panel, according to relevant electrical codes.
- .4 Run all wiring in enclosed plastic wireways such as Panduit. Size all wireways so that the total cross sectional area of the insulated wire and cable does not exceed 40% of the cross sectional area of the wireway.
- .5 Provide a minimum clearance of 50 mm between wireways and any point of wire termination.
- .6 Terminate all wiring, incoming and outgoing, at terminal strips mounted inside the panels. Identify each terminal strip with a terminal strip number, defined as follows:
 - .1 Wire identification to use the connected field device tag name with the wire's corresponding terminal number appended to it.
 - .2 Identify every joint and/or terminal of the above wire run with the same identifier until the wire meets another tagged device, at which point the wire identifier will change to use the new device name and terminal number.

ENCLOSURES

- .3 For example, pressure transmitter PPT-100A located in the field has a 2PR-TPSH cable connected to it. The cable runs through a junction box to a marshalling panel. The wire identifiers for the pair of wires would start with PPT-100A all the way to the marshalling panel.
- .4 Identify spare wires by using the cable tag, terminal number and an “-SP” suffix.
- .5 Arrange wiring on terminal blocks such that all internal panel wiring terminates on the inboard side of the terminal blocks and all external wire connections are made on the outboard side.
- .7 Two (2) sources of 120 VAC power will be supplied by others to each control panel: UPS power for critical loads and non-UPS power for non-critical loads. Provide separate critical and non-critical 120 VAC power distribution systems and a 24 VDC power distribution system in each panel. Provide a thermal magnetic circuit breaker on each main power circuit and a fused terminal block for each branched circuit off the main.
- .8 Provide disconnect type terminal blocks Weidmuller WTR 4 series to isolate field wiring that is powered sourced from the panel. Provide fused disconnect type terminal blocks for each PLC input and output.
- .9 Provide sufficient terminals so that not more than two (2) wires are connected under the same terminal. Provide 20% spare terminal capacity at each terminal block assembly.
- .10 Terminals shall be Weidmuller W Series colour coded as follows:

Red	=	positive 24 VDC.
Black	=	analog signal plus.
White	=	analog signal common and VAC neutral.
Grey	=	120 VAC.
Green	=	ground.
- .11 Provide nameplates for each device on or within the panels and enclosures. Nameplates shall be white lamacoid with black lettering, a minimum of 25 x 75 mm in size with up to three (3) lines of 3 mm lettering. Securely fasten nameplates in and situate them in a visible location.

2.6 Panel Grounding

- .1 Provide a ground system for the instrumentation circuits, isolated from the main power system ground to each marshalling panel.
- .2 Provide grounding lugs for each panel, suitable for termination of up to No. 2 AWG copper grounding conductor.

ENCLOSURES

- .3 Provide in each marshalling panel an isolated grounding bus bar 6 x 25 x 600 mm, equipped with necessary lugs for accepting two (2) No. 2 AWG grounding conductors.
- .4 Firmly bond all panel-mounted devices on or within the panels to ground. Provide supplementary bonding conductors for backpanels and doors. Attach a separate bonding conductor to all devices that are not firmly fastened to the panels with screws for such devices as case mounted instruments, meters, etc.

3. EXECUTION

3.1 References – General

- .1 Refer to Section 17010 – Instrumentation and Control General Requirements, Part 3.

END OF SECTION

INSTRUMENTATION CABLE

1. GENERAL

1.1 Product Data

- .1 Submit Product data in accordance with Division 1 and Division 16.
- .2 Instrument cables shall be supplied and installed for all instruments that are connected to the local control panels and equipment located on the same skid. For example, if a metering pump is supplied on a skid with a local control panel, instruments located on that pump shall come pre-wired to the local control panel.

1.2 Standards

- .1 All wire and cable shall be CSA approved.

2. PRODUCTS

2.1 Twisted Pair Shielded Cables

- .1 TPSH shall be constructed as follows:
 - .1 Two (2) copper conductors, stranded, minimum No. 18 AWG, PVC insulated, twisted in nominal intervals of 50 mm.
 - .2 Insulated for 600 V, 90°C.
 - .3 100% coverage aluminum foil or tape shield.
 - .4 Separate bare stranded copper drain wire, minimum No. 18 AWG.
 - .5 Overall flame retardant PVC jacket to CSA-C22.2.
 - .6 The entire cable assembly to be suitable for pulling in conduit or laying in cable tray.
 - .7 Shaw approved type or Beldon equivalent.
- .2 Where multiconductor TPSH cables are called for, each pair shall be individually shielded, continuous number coded, and the cable assembly shall have an overall shield and overall flame retardant PVC jacket.

2.2 Resistance Temperature Detector and Multi Conductor Shielded Cable

- .1 RTD cables shall be CSA approved and shall be constructed as follows:
 - .1 Three (3) or more copper conductors, stranded, minimum No. 18 AWG.
 - .2 PVC insulated for 600 V.

INSTRUMENTATION CABLE

- .3 100% coverage aluminum foil or tape shield.
- .4 Separate bare stranded copper drain wire.
- .5 Overall flame retardant PVC jacket to CSA-C22.2

2.3 100 Base TX Category 5E Communication Cable

- .1 Category 5E cable shall be CSA approved and constructed as follows:
 - .1 Four (4) pairs, solid stranded, #24 AWG
 - .2 PVC inner and outer jackets
 - .3 UL verified to Category 5E
 - .4 Insulated for 300 V

2.4 Fibre Optic Cables

- .1 Provide terminations for fibre optic cables including; buffer tube fan out kits, connectors, termination/distribution panels, and wall mount enclosures.
- .2 Provide 62.5/125 μm multi-mode duplex fibre patch cords for inter-cabinet connections.

3. EXECUTION

3.1 Analog Signals

- .1 Use TPSH cable for all low level analog signals such as 4 to 20 mA, pulse type circuits 24 VDC and under, and other signals of a similar nature.
- .2 Use RTD cable for connections between RTDs and transmitters or PLC RTD inputs.

3.2 Digital Signals

- .1 Use TPSH cable for all low level input (24 V and below) and output signals.
- .2 Use Teck cable or wire and conduit for power to instruments, for 120 V signals other than those mentioned above and as otherwise indicated on the Drawings. Use stranded wire and cable to supply power to instruments.

3.3 Installation

- .1 Install instrumentation cables in conduit systems or in cable trays. Use a minimum of 300 mm and a maximum of 1000 mm length of liquid tight flexible conduit to connect the field sensors to the conduit.

INSTRUMENTATION CABLE

- .2 Where non-armoured instrumentation cables are installed in cable trays, provide barriers in the tray to separate instrumentation cables from power cables.
- .3 At each end of the run leave sufficient cable length for termination.
- .4 Do not make splices in any of the instrumentation cable runs.
- .5 Cable shields shall be terminated on insulated terminals and carried through to the extent of the cable.
- .6 Ground cable shields at one end only. Unless otherwise specified, ground the shields at the control panel.
- .7 Protect all conductors against moisture during and after installation.
- .8 Fibre Installation:
 - .1 Always follow the Manufacturer's guidelines for minimum bend radius and tension. Minimum bend radius shall be a minimum of 20 times the cable diameter.

3.4 Conductor Terminations

- .1 All equipment supplied shall be equipped with terminal blocks to accept conductor connections.
- .2 Instrumentation conductors, where terminated at equipment terminals other than clamping type terminal blocks, shall be equipped with Burndy-YAE-2 or STA-KON, self-insulated, locking type terminators, sized as required to fit conductors and screw terminals.

3.5 Testing

- .1 Test all conductors for opens, shorts, or grounds. Resistance values shall not be less than those recommended by the cable Manufacturer.

3.6 Identification

- .1 Identify all instrumentation cables.
- .2 Identify each conductor with wire numbers using a machine printed Raychem TMS heat shrink wire marker or approved equal.

END OF SECTION

POWER SUPPLIES

1. GENERAL

1.1 References - General

- .1 Refer to Section 17010 – Instrumentation and Control General Requirements.

2. PRODUCTS

2.1 Power Supply and Conditioning Equipment

.1 General

- .1 Provide all DC power supplies as required for all instrument circuits. All circuits to be powered from the local control panels. Power supplies to be equal to Hammond or G.F.C., complete with an over-voltage protection module.
- .2 Provide redundant configurations for power supply equipment serving more than one (1) instrument loop, so that failure of a single unit will not disable all or any shared part of the instrumentation and communication system. Provide diode isolation for redundant direct current supply units, and ground the negative terminal of the power supply. In accordance with 17110.2.5.7, a dedicated thermal magnetic circuit breaker shall feed each power supply.
- .3 Power supplies and transmitters feeding circuits that run in non-armoured cable in cable tray shall meet the requirements for Class 2 circuits as defined under Division 16 of the Canadian Electrical Code Part 1.
- .4 Unless otherwise required, all DC power supplies to be rated 28 VDC, adjustable plus or minus 5%, and set to provide 26.4 V on the panel direct current bus. Size the power supply for two (2) times the connected load, minimum size is 2 A.
- .5 Provide transient voltage surge protection devices as manufactured by Leviton or equal on all panel assembly power input lines. Provide power line conditioning equipment on all main power supplies to control panels; Sola or equal.

2.2 Noise Suppression

- .1 Provide power conditioners in each panel to power AC instrumentation and control loads. Power conditioners are Oneac Series CX.

2.3 Uninterruptible Power Supply

- .1 Two (2) sources of 120 VAC power will be supplied by others to each control panel: UPS power for critical loads and non-UPS power for non-critical loads. Separate UPS power will be provided from an external UPS power source.

POWER SUPPLIES

- .2 Control and operator interface system hardware including but not limited to PLC's, PLC I/O racks, PLC communication modules, HMI computers and industrial network switches shall be powered from the UPS.
- .3 Instrument power and associated DC power supplies shall be powered from the UPS.
- .4 Non-critical loads include control panel interior lights and receptacles.
- .5 Provide the total expected critical and non-critical loads fed from each control panel as a shop drawing submittal so that the external power sources and UPS can be properly sized.
- .6 Mount a lamacoid on the control panel stating that the panel has more than one power source.

3. EXECUTION

3.1 References – General

- .1 Refer to Section 17010 – Instrumentation and Control General Requirements, Part 3.

END OF SECTION

INSTRUMENT AIR SUPPLY AND TRANSMISSION

1. GENERAL

1.1 References - General

- .1 Equipment, products, and execution must meet all requirements detailed in Section 17010 – Instrumentation and Control General Requirements.

2. PRODUCTS

2.1 Pneumatic and Process Connections

- .1 Pipe, fittings, valves, tubing, tube fittings, etc. required under this Section of the Contract to be Swagelok and rated for the service in which they are to be employed. Tubing and fittings to be made of stainless steel.
- .2 Dimensions:
 - .1 Process connections - 12 mm (nominal) O.D. tubing.
 - .2 Output/signal - 10 mm (nominal) O.D. tubing.
 - .3 Air supply - 12 mm pipe (nominal) to isolation valves and 10 mm O.D. tubing (nominal) from isolation valves to end devices (e.g., valves).
- .3 Provide a continuous support channel or raceway for all tubing.

2.2 Air Sets

- .1 Provide all pneumatic actuator assemblies with an air set.
- .2 Provide Fisher approved air sets or approved equal.
- .3 Air set to be complete with filter regulator and output gauge.

2.3 Solenoid Valves

- .1 Provide Asco Redhat type solenoid valves unless specified otherwise in Division 11.
- .2 Solenoid enclosures to be minimum EEMAC 4; corrosive areas require EEMAC 4X and hazardous areas require EEMAC Type 9.
- .3 Provide manual overrides on coils when solenoid is used to actuate a valve.
- .4 Standard coil voltage: 120 VAC.
- .5 Pipe size: 3 way valve – 6 mm; 4 way valve – 10 mm.

INSTRUMENT AIR SUPPLY AND TRANSMISSION

- .6 Maximum operating pressure: 850 kPa instrument air.
- .7 Minimum operating pressure: 20 kPa instrument air.

3. EXECUTION

3.1 References - General

- .1 Refer to Section 17010 – Instrumentation and Control General Requirements, Part 3.

END OF SECTION

PROCESS TAPS AND PRIMARY ELEMENTS

1. GENERAL

1.1 References - General

- .1 Equipment, products, and execution must meet all requirements detailed in Section 17010 – Instrumentation and Control General Requirements.

2. PRODUCTS

2.1 Process taps

- .1 Provide pressure gauge and thermowell tapping requirements as shown on the relevant P&IDs. The selection of materials for pressure gauge and thermowell process taps shall be such that the material is inert to the effects of the process fluid.

2.2 Primary Elements

- .1 Provide written assurance that the instrument Manufacturer approves the selection of materials of primary elements, which are in contact with the specified process fluid, to be inert to the effects of the process fluid.
- .2 Provide drip pots installed below sensing elements measuring gas. Provide seamless stainless steel drip pots consisting of a 50 x 300 mm pipe with an isolating valve and a drain valve. Provide a separate drip pot for each sensing line. Locate the drain valve within 500 mm of the floor.
- .3 Provide diaphragm seals on any fluid other than clean water or glycol.
- .4 When diaphragm seals are specified with a pressure gauge or a pressure switch provide the assembly filled with ethylene glycol and calibrated by the Manufacturer.
- .5 Provide ethylene glycol filled assembly calibrated by the Manufacturer when in-line pressure sensors are specified with a pressure gauge or a pressure switch or in combination.

3. EXECUTION (NOT USED)

END OF SECTION

TRANSMITTERS AND INDICATORS

1. GENERAL

1.1 References - General

- .1 Equipment, products, and execution must meet all requirements detailed in Section 17010 – Instrumentation and Control General Requirements.

2. PRODUCTS

2.1 Transmitters and Indicators

- .1 Transmitters shall have adequate power output to drive all devices associated with that signal loop. Provide signal boosters as required to achieve adequate signal strength or to isolate the signal.
- .2 All transmitters to have local indication scaled in engineering units as specified in the engineering Specifications. Provide a lamacoid label indicating the calibrated range and engineering units and mount adjacent to the transmitter. Mount the transmitter so the indicator is visible by the operator.
- .3 Remote indicators provided by Crompton Instruments, Simpson or Newport are acceptable for use.
- .4 Where the loop Specification calls for a transmitter and an indicator to be mounted in the same panel, an indicating transmitter may be considered acceptable provided the indicator is normally visible from outside the enclosure.
- .5 Where available as an option, the transmitter shall be supplied with an isolated fault contact.
- .6 The following tables provide listings of equipment which is of acceptable standard. Other equipment besides transmitters and indicators is shown and these other items shall be deemed acceptable where applicable in other Specification Sections included in this document:

TRANSMITTERS AND INDICATORS

DESCRIPTION OF EQUIPMENT	ACCEPTABLE MANUFACTURER NO.1	ACCEPTABLE MANUFACTURER NO.2	ACCEPTABLE MANUFACTURER NO.3	ACCEPTABLE MANUFACTURER NO.4
Power Supplies, Conditioning, Suppression etc.				
DC Power supplies for instrumentation power	Wiedmuller	Sola Hevi Duty		
Transient Voltage Surge Suppression	Sola Hevi Duty STV100K	Leviton	Square D	Cutler Hammer
Power conditioning	Oneac			
UPS	Powerware	APC		
Flow Measuring and Monitoring				
Magnetic Flow Meters	Rosemount 8700	ABB Magmaster	Krohne	Fischer and Porter
Coreolis Flow meter				
Thermal Flowswitch	Ifm	Weber		
Thermal Mass Flowmeter	ABB	Brooks		
Variable Area Flowmeter	Omega	Kobold		

TRANSMITTERS AND INDICATORS

DESCRIPTION OF EQUIPMENT	ACCEPTABLE MANUFACTURER NO.1	ACCEPTABLE MANUFACTURER NO.2	ACCEPTABLE MANUFACTURER NO.3	ACCEPTABLE MANUFACTURER NO.4
Pressure Measurement and Monitoring				
Absolute Pressure Indicator Transmitter	Rosemount model 3051	ABB	Foxboro	
Differential Pressure Indicator Transmitter with integral manifold	Rosemount model 3051	ABB	Foxboro	
Pressure Switches (electronic type)	Ifm	United Electric		
Pressure Switches (conventional type)	Ashcroft	United Electric	Barksdale	
Pressure Gauges	Ashcroft	H.O. Trerice	Budenberg	
3 Valve Manifolds	Anderson Greenwood			
Level Measurement and Monitoring				
Ultrasonic Level Indicator Transmitter	Siemens Multiranger 100/200	Magnetrol	Endress & Hauser	
Radar Type Level Indicator Transmitter	Endress & Hauser	Siemens	Magnetrol	
Conductivity Level Switch	Endress & Hauser			

TRANSMITTERS AND INDICATORS

DESCRIPTION OF EQUIPMENT	ACCEPTABLE MANUFACTURER NO.1	ACCEPTABLE MANUFACTURER NO.2	ACCEPTABLE MANUFACTURER NO.3	ACCEPTABLE MANUFACTURER NO.4
Vibration type level switch	Endress & Hauser			
Bypass Level Indicator	Krohne	Magnetrol		
Magnetic Level Indication	Magnetrol (Orion)	K-Tek KM26		
Float Switch	Flygt	Consolidated Electric	Warwick	Magnetrol
Sludge Blanket Level	Partech	Siemens		
Capacitance Level Switch	Siemens	Endress & Hauser		
Admittance Level Switch	Magnetrol	Bestobell		
Temperature Measurement and Monitoring				
RTD	Rosemount	ABB	Foxboro	
Temperature Switch	Ifm			
Analytical Instrumentation				
Ph/ Temp	Rosemount	Endress & Hauser	ABB	Foxboro 870
Turbidity	Hach	Rosemount	Endress & Hauser	GLI
Residual Chlorine Analyzer	Wallace & Tiernan	Rosemount	Endress & Hauser	

TRANSMITTERS AND INDICATORS

DESCRIPTION OF EQUIPMENT	ACCEPTABLE MANUFACTURER NO.1	ACCEPTABLE MANUFACTURER NO.2	ACCEPTABLE MANUFACTURER NO.3	ACCEPTABLE MANUFACTURER NO.4
Ozone Analyzer	Crowcon			
Dew/Moisture Measurement	Veronics			
Particle Counter Analyzer	Hach			
Suspended Solids Analyzer	Hach			
Monochloramine Analyzer	Hach			
Water Hardness Monitor	Hach			
Valve Control				
Electric Actuators	Limitorque	Rotork		
Solenoid Valves	Asco Redhat			
I/P Converters	Omega	Moore		
Relays, Barriers etc				
Plug in Relays	Omron	Idec	Potter& Brumfield	
Plug in Timers	Omron	Idec	Potter& Brumfield	
Analog I/S Barriers	MTL	Stahl	Peperl & Fuchs	
Digital Barriers	MTL	Stahl	Peperl & Fuchs	

TRANSMITTERS AND INDICATORS

3. EXECUTION

3.1 References - General

- .1 Refer to Section 17010 - Instrumentation and Control General Requirements, Part 3.

END OF SECTION

POWERED ACTUATORS

1. GENERAL

1.1 Work Included

- .1 Supply, installation, and testing of electric actuators and accessories for controlled devices such as valves, gates, dampers etc.
- .2 Sizing and selection of modulating control valve components.
- .3 Size and match powered actuators to controlled devices.

1.2 Submittals for Review

- .1 Submittals in accordance with Division 1 and Section 17010 – Instrumentation and Control General Requirements.
- .2 Furnish Shop Drawings for complete actuator assemblies and accessories prior to delivery.
- .3 Provide calculations for sizing, noise, cavitation, and actuator torque calculations, etc., in addition to the requirements of Division 11.
- .4 Submit a completed ISA S20.50 Instrument Specification Sheet for each device.

1.3 Submittals For Information Only

- .1 Submit the following in addition to the requirements of Division 1 and Section 17010 - Instrumentation and Control General Requirements.
 - .1 Factory calibration and testing reports. Handwritten reports not to be accepted.
 - .2 Operations and maintenance manuals in accordance with Division 11.

1.4 Service Conditions

- .1 Enclosures for equipment to be EEMAC 4X.
- .2 Refer to Section 17010 - Instrumentation and Control General Requirements for additional details.

1.5 Shipment, Protection, and Storage

- .1 Ship and store equipment in accordance with Division 1 and Section 17010 – Instrumentation and Control General Requirements.

1.6 Delivery

- .1 Deliver valves and actuators to Site use loading methods which do not damage casings or coatings.

POWERED ACTUATORS

- .2 Clearly tag all control valves and actuators, stating size, type, coatings, and mating parts.

2. PRODUCTS

2.1 General

- .1 Provide new material only.
- .2 Acceptable manufacturers of electric actuators shall be Limitorque or Rotork.
- .3 Provide all actuator mounting hardware and accessories mounted on the device prior to shipment.
- .4 Provide device and actuator as a matched set from the same Manufacturer wherever possible.
- .5 Tag the control devices, accessories and actuators to indicate operating characteristics. Tag the actuator inlet and outlet ports for electric or pneumatic services. Electric actuators must be CSA approved.
- .6 Refer to Section 17140 – Instrument Air Supply and Transmission for solenoid valves.

2.2 Actuator Types

- .1 Electro-Mechanical Actuators, General
 - .1 Unless otherwise specified, electric actuators to be 120 V/-1 ph/60 Hz for service where required torque is less than 115 N.m and 3 ph/60 Hz for service with torque above 115 N.m. Provide each actuator with a high torque, reversible motor which is capable of continuous duty over the full operating range.
- .2 Electric Quarter Turn Actuators, Open/Close Type (EMQO) and Modulating Type (EMQM)
 - .1 Provide electric operators suitable for mounting on quarter turn valves or dampers intended for on/off and modulating service.
 - .2 Provide each actuator with built-in motor overload protection.
 - .3 Fit each actuator with a hand wheel which will enable manual override control of the valve.
 - .4 Each actuator to be capable of operating in any horizontal or vertical orientation.
 - .5 Provide external mechanical indication of valve position. Provide an external visual position indicator for each positioner.
 - .6 House internal components in an EEMAC 4X enclosure, moisture-resistant and corrosion-resistant. Internal components to be permanently lubricated.

POWERED ACTUATORS

- .7 Motors will be rated at 20% intermittent duty cycle.
 - .8 For remote indication provide the actuator with two (2) SPDT travel limit switches, 10A, 125 VAC, CSA listed. The travel limit switches to be adjustable.
 - .9 Provide the actuator with two SPDT torque limit switches, 10A, 125 VAC. The torque limit switches to be factory preset and field adjustable.
 - .10 Provide adjustable mechanical limit stops to ensure over-turning of the valve does not occur.
 - .11 Protect exterior mounted actuators against low temperature and condensation.
 - .12 The actuator speed will be field adjustable.
 - .13 Provide a terminal board for field wiring. Include contacts to indicate the open/closed status of the valve.
 - .14 Modulating actuators to accept a 4 to 20 mA control signal for remote proportional control.
- .3 Electric Linear Actuators, Open/Close Type (EMLO) and Modulating Type (EMLM)
- .1 Electric actuators for gates to be comprised of an electric motor and one (1) or two (2) gear boxes, depending on the gate design.
 - .2 Provide a sufficiently sized motor to seat and unseat gates and, if necessary, for control to traverse from full open to full closed position in small increments, in response to control signals.
 - .3 The actuator will impart a travel speed of 2.5 m/hr to modulating gates and 18.0 m/h to open/close gates unless otherwise specified on the ISS. The actuator speed to be field adjustable.
 - .4 The actuator shall be fully compatible with the gate. Mount at operating height on the frame.
 - .5 Actuators to accept 3 phase/60 Hz power. Protect motors against reversed phase rotation.
 - .6 Modulating actuators to accept a 4 to 20 mA control signal for remote proportional control of gate opening.
 - .7 The drive train to be rated for heavy duty, continuous service. Connect the actuator drive shaft to gear box shaft(s) through a removable flexible mechanical coupling. Where the actuator is fitted to two stems, ensure that the gearing in each gearbox allows both stems to move identically.

POWERED ACTUATORS

- .8 House the internal components of actuators and related gear boxes in weather proof, corrosion proof metal enclosures. Electrical components to be contained in EEMAC six (6) enclosures. All electrical and mechanical components shall be capable of continuous operation in an ambient temperature range of -40°C to + 40°C.
- .9 Provide a space heater for each actuator.
- .10 Fit actuators with a capstan hand wheel operator. Fit hand wheel assemblies with a clutching mechanism which prevents hand wheel operation during normal motor operation. Provide a one (1) to one (1) gearing ratio with respect to the main drive shaft for the hand wheel.
- .11 Fit removable safety guards over all moving drive train components between the actuator and each gear box.
- .12 Provide adjustable limit switches on each actuator to define the upper and low limit of the stroke.
- .13 High torque switches will protect the equipment and the structure against excessive gate travel. Provide high torque protection at the lower and upper ends of the stroke.
- .14 Provide a controller enclosure to contain a motor contactor complete with overload protection. Provide line, load, and external control terminal strips.
- .15 Provide a local operating station with a Local-Off-Remote switch and an Open-Close switch

2.3 Minimum monitoring and control signal requirements

- .1 Open Close actuators:
 - .1 Momentary Open Command (Remote dry contact).
 - .2 Momentary Close Command (Remote dry contact).
 - .3 Open Status (Dry contact for remote indication).
 - .4 Closed Status (Dry contact for remote indication).
 - .5 Computer (Remote) Mode (Dry contact for remote indication).
 - .6 Remote dry contacts will be rated 2 Amps at 120 VAC minimum.
- .2 Modulating actuators:
 - .1 Input signal: 4 to 20 mA from programmable logic controller (PLC).
 - .2 Output signal: 4 to 20 mA to PLC for position monitoring.

POWERED ACTUATORS

- .3 Computer (Remote) Mode (Dry contact for remote indication).

3. EXECUTION

3.1 Field Testing and Performance Verification

- .1 Provide testing and Performance Verification assistance in accordance with Division 1 and Section 17010 – Instrumentation and Control General Requirements, Part 3.
- .2 Factory test each actuator assembly prior to shipment.
- .3 The Manufacturer's Representative will be required to verify the installation of the electric and/or pneumatic actuators is correct and make final travel limits and torque adjustments.

3.2 Training

- .1 Provide training in accordance with Division 1.

END OF SECTION

SWITCHES AND RELAYS

1. GENERAL

1.1 References - General

- .1 Refer to Section 17010 – Instrumentation and Control General Requirements.

2. PRODUCTS

2.1 General

- .1 Use normally closed contacts for alarm actuation. The contacts open to initiate the alarm.
- .2 Use normally open contacts to control equipment. The contacts close to start the equipment.
- .3 Contacts monitored by solid state equipment to be hermetically sealed and adequately rated for the connected load.
- .4 Contacts monitored by electro-magnetic devices such as mechanical relays to be rated NEMA ICS 2, designation B300.
- .5 Provide double barriers between switch elements and process fluids such that failure of one (1) barrier will not permit process fluids into electrical enclosures.
- .6 Electrical enclosures to be rated EEMAC 4X, minimum.
- .7 120 VAC switches to have a 4A rating.

2.2 Indicators, Pushbuttons, and Selector Switches

- .1 All control indicator lamps, pushbutton switches and selector switches in unclassified or non-corrosive areas to be Allen Bradley 800T or 800E series items or Cutler Hammer 10250T series.
- .2 All control indicator lamps, pushbutton switches, and selector switches in classified or corrosive (includes outdoors) areas to be Allen Bradley 800H series items or Cutler Hammer E34 series.
- .3 All control indicator lamps shall be push-to-test type.

2.3 Relays

- .1 Acceptable manufacturers of relays shall be Omron.
- .2 120 VAC relays to be Model LY 4PDT, plug-in, complete with test button and operation indicator, and surge suppressor.

SWITCHES AND RELAYS

- .3 24 VDC relays to be Model MY 2PDT plug-in, complete with test button and operation indicator, and surge suppressor diode.
- .4 Time delay relays for behind panel mounting to be Omron Model H3BA, 2PDT, plug-in, and programmable for sixteen (16) time ranges and four (4) operation modes.
- .5 Time delay relays for flush panel mounting and operator accessible timing range modifications to be Omron Model H5BR, SPDT, screw terminals, programmable for five (5) timing ranges and eight (8) operation modes, complete with digital display, module for time settings and flexible protective cover.
- .6 Where the contact ratings of the relays listed are insufficient for the application, select an appropriate type from an approved Manufacturer with the same quantity of contacts as was originally specified.
- .7 Provide relay plug-in sockets for DIN mounting complete with stacked screw clamp terminals.

3. EXECUTION

3.1 References – General

- .1 Refer to Section 17010 – Instrumentation and Control General Requirements.

END OF SECTION

PANEL INSTRUMENTS

1. GENERAL

1.1 References - General

- .1 Equipment, products, and execution must meet all requirements detailed in Section 17010 – Instrumentation and Control General Requirements.

2. PRODUCTS

2.1 Electronic Panel Instruments

- .1 Provide panel instruments with the following requirements, unless otherwise specified:
 - .1 Analog instruments to be miniature case, drawout type, nominally 150 mm high x 75 mm wide x not more than 350 mm deep.
 - .2 Make the operator, tuning, and configuration adjustments accessible without disconnecting the instrument from the process.
 - .3 Analog signal indicators to be solid state, LED. or gas-discharge type, including bar-graph displays with not less than two hundred (200) segments. Backlit LCD indication is also acceptable.
 - .4 Analog signal inputs to be 4 to 20 mA DC.
 - .5 Analog signal outputs to be 4 to 20 mA DC into 500 ohms.
 - .6 Galvanically isolate the signal and power supply from the instrument case.
 - .7 Panel instruments specified in this Section are to be the product of a single Manufacturer, and to match and line up to form an integrated appearance and operator interface strategy. Approved Manufacturers are Crompton Instruments and Simpson.

3. EXECUTION

3.1 References - General

- .1 Refer to Section 17010 – Instrumentation and Control General Requirements, Part 3.

END OF SECTION

MISCELLANEOUS PANEL DEVICES

1. GENERAL

1.1 References - General

- .1 Equipment, products, and execution must meet all requirements detailed in Section 17010 – Instrumentation and Control General Requirements.

2. PRODUCTS

2.1 Miscellaneous Panel Devices

- .1 Pilot Lights
 - .1 Provide pilot lights of the transformer type for extended lamp life, oil tight, push to test, complete with appropriate colour lenses. Normal colours used are run = red, stop = green. Refer to Division 16 for additional information.
- .2 Terminals
 - .1 Provide strap screw type terminal blocks rated for 600 V.
 - .2 Identify each terminal block within an enclosure with a unique machine printed terminal block number. Cabinet chassis grounding terminal blocks are to be identified by the electrical ground symbol.
 - .3 Connections to screw terminals to be locking fork tongue insulated crimp type wire connectors.
 - .4 Terminals to be Weidmuller or approved equal.
 - .5 Provide a group of terminals for each of 120 VAC hot and neutral, 120 VAC UPS hot and neutral and 24 VDC positive and negative power. Distribution wiring to have a thermal magnetic circuit breaker upstream of all major blocks of loads, adequately sized to protect the connected load while not causing nuisance tripping.
 - .6 Provide Weidmuller disconnect type terminal blocks for each load or loop powered from the marshalling panels.
- .3 Nameplates
 - .1 Refer to Section 17010 – Instrumentation and Control General Requirements for nameplate Specification.

MISCELLANEOUS PANEL DEVICES

2.2 Intrinsic Safety Barriers and Relays

- .1 Provide intrinsic safety barriers where required for two-wire transmitters of the active, isolating, loop powered type; MTL Type MT3042, Stahl 9005/01-252/100/00, Pepperl & Fuchs ZG series, or approved equal.
- .2 Provide dual type intrinsic safety barriers for process switches; MTL 787, Panalarm 201-BR2.
- .3 Intrinsic safety relays to be Gems or Warrick.

2.3 Industrial Ethernet Switches

- .1 Install Ethernet Switches in all control panels housing PLCs that interface to the WTP control and operator interface network. Connect to PLCs, meters and all other Ethernet capable equipment resident within the control panel using cable rated for 100 Base-TX communication.
- .2 Switches shall comply with IEEE 802.3, 802.3u, 802.3x, 802.1D.
- .3 Switches that are part of the WTP control system communication ring or plant monitoring system communication ring shall include a minimum of 5 10/100 Base T(x) RJ45 Ports and two (2) multimode 100 Base FX Fibre ports. Switches that only provide an interface between a PLC and local VFDs and motor protection relays shall include a minimum of 8 10/100 Base T(x) RJ45 Ports.
- .4 Switches shall include one relay output alarm contact rated for 1A@24 VDC.
- .5 Input power shall be capable of ranging from 9 to 32 VDC with redundant inputs.
- .6 Switches shall be fast spanning for a sub-second recovery in a ring configuration.
- .7 Switches shall be Eagle Technology ED6008 Series, Schneider ConneXium Series or approved equal.

2.4 Fibre Termination Panel

- .1 Install a fibre termination panel suitable for the termination of two (2) 12-strand multimode fibre optic cables in each panel that houses a fibre Ethernet switch and next to all control panels housing PLCs, PLC remote I/O racks, or HMI that interface to the WTP control and operator interface networks.

MISCELLANEOUS PANEL DEVICES

3. EXECUTION

3.1 References - General

- .1 Refer to Section 17010 – Instrumentation and Control General Requirements, Part 3.

END OF SECTION

GAS DETECTION SYSTEMS

1. GENERAL

1.1 Description

- .1 This Section specifies the supply, installation, testing and Performance Verification of gas detection systems.
- .2 Use this Specification in conjunction with Section 17010 – Instrumentation and Control General Requirements.

1.2 Reference Standards

- .1 Conform to the following reference standards in accordance with Division 1:
 - .1 CSA C22.2 No. 152, Combustible Gas Detection Instruments.
 - .2 CSA - C22.1 Canadian Electrical Code

1.3 Shipping and Storage

- .1 Ship and store equipment in accordance with the requirements of Division 1.
- .2 Store gas detection instruments in their original shipping containers in a dry location that is free of fumes and vapors. Never store an instrument in an area where desensitizing agents (such as paint or silicone) may be present.

2. PRODUCTS

2.1 Function

- .1 General
 - .1 Refer to Section 17010 – Instrumentation and Control General Requirements, Part 2.
 - .2 Provide gas detection systems which include:
 - .1 Field mounted sensors/transmitters.
 - .2 Alarm beacons.
 - .3 Room entrance alarm panels.
 - .3 Provide field elements that are certified Class I, Division I.

GAS DETECTION SYSTEMS

2.2 Details

- .1 The gas detection system will monitor for concentrations of Hydrogen.
- .2 Provide sensors and calibrators as specified on the Instrumentation Specification Sheets in Section 17701 – Instrument Specification Sheets.
- .3 Alarm beacons will operate on 120 V, 60 Hz. Beacons mounted in the process area will be classified Class I, Division I. Beacons mounted outdoors will be EEMAC 4X.
- .4 Power gas monitors from separate breakers located in a UPS powered panel board in the electrical room or the local control panel.
- .5 Refer to the requirements of Section 17010 – Instrumentation and Control General Requirements for instrument and wiring identification.

2.3 Spare Parts/Tools

- .1 Provide a calibration kit including a one year supply of all gases to calibrate all sensors and sensor types. The calibration kit must include, but not be limited to, all regulators and equipment required to perform regular on-site calibrations.

3. EXECUTION

3.1 General

- .1 Refer to the requirements of Section 17010 – Instrumentation and Control General Requirements, Part 3 for additional execution details.

3.2 Wiring

- .1 Wire devices as shown on the installation details and the cabling diagrams.
- .2 Wiring methods must comply with the area classification, CSA C22.2 No. 152 and the requirements of Division 16.

3.3 Field Testing and Inspection

- .1 Refer to the requirements of Section 17010 – Instrumentation and Control General Requirements, Part 3 for additional details.
- .2 Provide an inspection of the gas detection system and all related components. The inspection will comprise of the following:
 - .1 That the system functions as intended including equipment shutdowns and start-ups, alarms, reset, calibration, etc.

GAS DETECTION SYSTEMS

- .2 That all CSA requirements were adhered to when making wiring connections to all equipment components.
- .3 That equipment has been installed in accordance with Manufacturer's recommendations and that all signal devices have been operated or tested to verify their operation.

3.4 Performance Verification and Start-Up

- .1 Performance Verification and start-up will be performed in accordance with CSA Standard C22.2 No. 152 and the requirements of Section 17010 – Instrumentation and Control General Requirements, Part 3.

3.5 Certification

- .1 Inspection certification: on completion of the inspection and when all of the above conditions have been complied with, the Contract Administrator will be issued:
 - .1 A copy of the inspecting technician's report showing location of each device and certifying the test results of each device.
 - .2 A certificate of verification confirming that the inspection has been completed and showing the conditions upon which such inspection and certification have been rendered.

3.6 Training

- .1 Provide On-Site training in accordance with Division 1 and Section 17010 – Instrumentation and Control General Requirements.

END OF SECTION

PLC AND OPERATOR INTERFACE REQUIREMENTS

1. GENERAL

1.1 References - General

- .1 Equipment, products, and execution must meet all requirements detailed in Section 17010.

1.2 Requirements - General

- .1 Design, supply, and installation of a PLC based control system for the SHG Equipment that will control and monitor the system in accordance with the requirements defined by the Contract Documents.
- .2 PLC's and I/O shall be housed in a central control panel.
- .3 PLCs shall be programmed using the latest version of Schneider Electric's Unity Programming Software. The program shall be fully documented and programmed according to standards that will be provided by the Contract Administrator.
- .4 The final PLC configuration program shall be provided to the City on compact disk.
- .5 Installation and Performance Verification support as required for the control system.

2. PRODUCTS

2.1 PLC's

- .1 General
 - .1 All new PLC equipment to be based on the Modicon Unity Processor family as applicable (no substitutions allowed).
 - .2 All PLC's shall be Unity hot standby processors complete with redundant processors.
 - .3 Communication protocol for the new PLC network to be Modbus/TCP. Ethernet communication modules shall be provided in each PLC processor rack to interface to the plant control network.
 - .4 Provide all necessary racks, power supplies, cables, communication cards, and accessories.
 - .5 Provide spares of all PLC system components (minimum of one of each exact type) supplied including: power supply, processor, communication modules, and input/output modules.
 - .6 Provide 10% spare slot capacity for each PLC panel assembly.
 - .7 Provide 25% spare power supply capacity for each PLC panel assembly.
 - .8 PLC racks shall be powered from the external UPS system. Each new PLC panel assembly shall include Sola Hevi-Duty STV100K series incoming power transient

PLC AND OPERATOR INTERFACE REQUIREMENTS

surge suppression or approved equal. Connect the surge suppressor dry contact to a PLC input and configure as an alarm on the control system at each panel.

.2 PLC

- .1 Modicon Unity main processor and hot standby CPU: Model Number 140 CPU 671 60.
- .2 Modicon NOE (Modbus/TCP) modules for each processor rack.
- .3 Redundant cable remote I/O modules in each rack: Model Numbers 140 CRP 932 00 and 140 CRA 932 00.
- .4 I/O modules to meet the Specifications defined above and the I/O requirements of Division 11.

.3 I/O.

- .1 120 VAC Digital Inputs: Model Number 140 DAI 540 00.
- .2 24 VDC Digital Inputs: Model Number 140 DAI 340 00.
- .3 Digital Outputs: Model Number 140 DAO 840 00.
- .4 Analog Inputs: Model Number 140 ACI 030 00.
- .5 Analog Outputs: Model Number 140 ACO 020 00.
- .6 Provide at least 20% spare I/O of each type in each panel assembly.

2.2 System Integration Requirements

- .1 Cooperate with other Contractors, City staff, and consultants to facilitate installation, testing, validation, and Performance Verification of the control system.
- .2 Supply, Install, test, and verify performance of the PLC Control Panel as specified in this Section and as shown on the Drawings.
- .3 Assist the SCADA System Integrator to establish communication with the PLC. Test data exchange with the PLC as defined in this Section and the process description.

3. EXECUTION

3.1 References – General

- .1 Refer to Section 17010 – Instrumentation and Control General Requirements, Part 3.

END OF SECTION

OPERATOR INTERFACE REQUIREMENTS

1. GENERAL

1.1 References – General

- .1 Equipment, products, and execution must meet all requirements detailed in Section 17010 – Instrumentation and Control General Requirements.

1.2 General Requirements

- .1 Local Control and Operator Interface Requirements
 - .1 Provide all necessary local controls to allow local operation that compliments the operation of the plant control system and facilitates satisfactory system control consistent with the intent of this Specification. The extent of local controls to be provided shall be fully described as part of the submittals defined in Division 11.
 - .2 Provide a local operator interface consisting of an industrial grade PC complete with graphical interface software that has been configured for the application.
 - .3 The graphical interface software shall be fully documented and programmed according to standards that will be provided by the Contract Administrator.
 - .4 The final graphical interface configuration shall be fully documented and shall be provided to the City on compact disk prior to substantial performance.
 - .5 Configuration software and all associated licenses and tools required to maintain and re-configure the software shall be provided to the City prior to substantial performance.
 - .6 Detailed local control and operator interface requirements are defined in Division 11.
- .2 Interface to the Water Treatment Plant Control System
 - .1 The Operator Interface to the plant control system will be supplied, installed, programmed, and commissioned by others. The contractor shall provide all information necessary for the systems integrator to create a complete and comprehensive remote monitoring and control system consistent with the requirements of this document.
 - .2 This Contractor is to support the design, installation, programming, and start-up of the plant control system as follows:
 - .1 Supply all field instrumentation necessary to facilitate both local and remote monitoring and control of the system.
 - .2 Provide all hardware interfaces required to facilitate the interconnection of the contractor supplied PLC control system to the plant control system.
 - .3 Provide all written descriptions and associated Drawings necessary to fully describe the detailed operation of the entire system supply and to allow the control

OPERATOR INTERFACE REQUIREMENTS

system integrator to develop application software on the plant operator interface network. This includes the PLC control logic software, recommended operator interface points, alarm lists, recommended historical trend and long-term data storage points, PLC tag lists and sample graphics screens as developed for the local operator interface, either as print-out or in electronic bitmap format.

- .4 Update all system documentation at the completion of commissioning and start-up to reflect the final installation.
- .3 For the purpose of this project, the tag name convention shown on the P&IDs will be used. Coordinate the implementation of tags for any instrumentation not listed with the Contract Administrator.

2. PRODUCTS

2.1 Local Human Machine Interface

- .1 Provide a local operator interface consisting of an industrial grade PC complete with an application specific graphical interface configured using InTouch Version 9.0 HMI software by ISS Wonderware, OASyS DNA by Telvent, or approved equal. The industrial grade PC shall be provided with the HMI software provider's recommended system hardware and operating system.
- .2 Minimum requirements of the industrial PC are as follows:
 - .1 15 inch color flat screen display
 - .2 Membrane keypad and mouse
 - .3 Dual Ethernet ports.

3. EXECUTION

3.1 Performance – General

- .1 Refer to Section 17010 – Instrumentation and Control General Requirements, Part 3.

3.2 Installation

- .1 Provide hardware in accordance with the foregoing requirements in sufficient quantity to satisfy the performance requirements defined in this and other Divisions of this Specification.
- .2 Provide all necessary documentation to complete the configuration of the control system including I/O lists, alarm lists, critical process variables, instrumentation lists, loop wiring requirements for I/O, local control equipment details, and detailed system operation descriptions.

OPERATOR INTERFACE REQUIREMENTS

- .3 Assist with commissioning and system start-up as defined herein.
- .4 Provide all documentation and training as defined herein.

END OF SECTION