

# THE CITY OF WINNIPEG

# **BID OPPORTUNITY**

**BID OPPORTUNITY NO. 428-2005** 

WINNIPEG WATER TREATMENT PROGRAM - SUPPLY OF OZONE EQUIPMENT

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#### **PART B - BIDDING PROCEDURES**

#### **B1.** PROJECT TITLE

B1.1 WINNIPEG WATER TREATMENT PROGRAM – SUPPLY OF OZONE EQUIPMENT

# **B2. SUBMISSION DEADLINE**

- B2.1 The Submission Deadline is 4:00 p.m. Winnipeg time, September 14, 2005.
- B2.2 Bid Submissions determined by the Manager of Materials to have been received later than the Submission Deadline will not be accepted and will be returned upon request.
- B2.3 The Contract Administrator or the Manager of Materials may extend the Submission Deadline by issuing an addendum at any time prior to the time and date specified in B2.1.

#### **B3. ENQUIRIES**

- B3.1 All enquiries shall be directed to the Contract Administrator identified in D4.1.
- B3.2 If the Bidder finds errors, discrepancies or omissions in the Bid Opportunity, or is unsure of the meaning or intent of any provision therein, the Bidder shall notify the Contract Administrator of the error, discrepancy or omission, or request a clarification as to the meaning or intent of the provision at least five (5) Business Days prior to the Submission Deadline.
- B3.3 Responses to enquiries which, in the sole judgment of the Contract Administrator, require a correction to or a clarification of the Bid Opportunity will be provided by the Contract Administrator to all Bidders by issuing an addendum.
- B3.4 Responses to enquiries which, in the sole judgment of the Contract Administrator, do not require a correction to or a clarification of the Bid Opportunity will be provided by the Contract Administrator only to the Bidder who made the enquiry.
- B3.5 The Bidder shall not be entitled to rely on any response or interpretation received pursuant to B3 unless that response or interpretation is provided by the Contract Administrator in writing.

#### B4. ADDENDA

- B4.1 The Contract Administrator may, at any time prior to the Submission deadline, issue addenda correcting errors, discrepancies or omissions in the Bid Opportunity, or clarifying the meaning or intent of any provision therein.
- B4.2 The Contract Administrator will issue each addendum at least two (2) Business Days prior to the Submission Deadline, or provide at least two (2) Business Days by extending the Submission Deadline.
- B4.2.1 Addenda will be available on the Bid Opportunities page at The City of Winnipeg, Corporate Finance, Materials Management Branch internet site at http://www.winnipeg.ca/matmgt.
- B4.2.2 The Bidder is responsible for ensuring that he has received all addenda and is advised to check the Materials Management Branch internet site for addenda shortly before submitting his Bid.
- B4.3 The Bidder shall acknowledge receipt of each addendum in Paragraph 10 of Form A: Bid. Failure to acknowledge receipt of an addendum may render a Bid non-responsive.

#### **B5.** SUBSTITUTES

- B5.1 The Work is based on the materials, equipment, methods and products specified in the Bid Opportunity.
- B5.2 Substitutions shall not be allowed unless application has been made to and prior approval has been granted by the Contract Administrator in writing.
- B5.3 Requests for approval of a substitute will not be considered unless received in writing by the Contract Administrator at least seven (7) Business Days prior to the Submission Deadline.
- B5.4 The Bidder shall ensure that any and all requests for approval of a substitute:
  - (a) provide sufficient information and details to enable the Contract Administrator to determine the acceptability of the material, equipment, method or product as either an approved equal or alternative;
  - (b) identify any and all changes required in the applicable Work, and all changes to any other Work, which would become necessary to accommodate the substitute;
  - (c) identify any anticipated cost or time savings that may be associated with the substitute;
  - (d) certify that, in the case of a request for approval as an approved equal, the substitute will fully perform the functions called for by the general design, be of equal or superior substance to that specified, is suited to the same use and capable of performing the same function as that specified and can be incorporated into the Work, strictly in accordance with the Contract;
  - (e) certify that, in the case of a request for approval as an approved alternative, the substitute will adequately perform the functions called for by the general design, be similar in substance to that specified, is suited to the same use and capable of performing the same function as that specified and can be incorporated into the Work, strictly in accordance with the Contract.
- B5.5 The Contract Administrator, after assessing the request for approval of a substitute, may in his sole discretion grant approval for the use of a substitute as an "approved equal" or as an "approved alternative", or may refuse to grant approval of the substitute.
- B5.6 The Contract Administrator will provide a response in writing, at least two (2) Business Days prior to the Submission Deadline, only to the Bidder who requested approval of the substitute.
- B5.6.1 The Bidder requesting and obtaining the approval of a substitute shall be entirely responsible for disseminating information regarding the approval to any person or persons he wishes to inform.
- B5.7 If the Contract Administrator approves a substitute as an "approved equal", any Bidder may use the approved equal in place of the specified item.
- B5.8 If the Contract Administrator approves a substitute as an "approved alternative", any Bidder bidding that approved alternative shall base his Total Bid Price upon the specified item but may also indicate an alternative price based upon the approved alternative. Such alternatives will be evaluated in accordance with B14.
- B5.9 No later claim by the Contractor for an addition to the price(s) because of any other changes in the Work necessitated by the use of an approved equal or an approved alternative will be considered.

# **B6. BID SUBMISSION**

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

- (a) Form A: Bid;
- (b) Form B: Prices;;
- (c) Form G1: Bid Bond and Agreement to Bond, or Form G2: Irrevocable Standby Letter of Credit and Undertaking, or a certified cheque or draft.
- B6.2 All components of the Bid Submission shall be fully completed or provided, and submitted by the Bidder no later than the Submission Deadline, with all required entries made clearly and completely in ink, to constitute a responsive Bid.
- B6.3 The Bid Submission shall be submitted enclosed and sealed in an envelope clearly marked with the Bid Opportunity number and the Bidder's name and address.
- B6.3.1 Samples or other components of the Bid Submission which cannot reasonably be enclosed in the envelope may be packaged separately, but shall be clearly marked with the Bid Opportunity number, the Bidder's name and address, and an indication that the contents are part of the Bidder's Bid Submission.
- B6.4 Bid Submissions submitted by facsimile transmission (fax) or internet electronic mail (e-mail) will not be accepted.
- B6.5 Bid Submissions shall be submitted to:

The City of Winnipeg Corporate Finance Department Materials Management Branch 185 King Street, Main Floor Winnipeg MB R3B 1J1

# B7. BID

- B7.1 The Bidder shall complete Form A: Bid, making all required entries.
- B7.2 Paragraph 2 of Form A: Bid shall be completed in accordance with the following requirements:
  - (a) if the Bidder is a sole proprietor carrying on business in his own name, his name shall be inserted;
  - (b) if the Bidder is a partnership, the full name of the partnership shall be inserted;
  - (c) if the Bidder is a corporation, the full name of the corporation shall be inserted;
  - (d) if the Bidder is carrying on business under a name other than his own, the business name and the name of every partner or corporation who is the owner of such business name shall be inserted.
- B7.2.1 If a Bid is submitted jointly by two or more persons, each and all such persons shall identify themselves in accordance with B7.2.
- B7.3 In Paragraph 3 of Form A: Bid, the Bidder shall identify a contact person who is authorized to represent the Bidder for purposes of the Bid.
- B7.4 Paragraph 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.
- B7.4.1 The name and official capacity of all individuals signing Form A: Bid shall be printed below such signatures.
- B7.4.2 All signatures shall be original and shall be witnessed except where a corporate seal has been affixed.
- B7.5 If a Bid is submitted jointly by two or more persons, the word "Bidder" shall mean each and all such persons, and the undertakings, covenants and obligations of such joint Bidders in the Bid Submission and the Contract, when awarded, shall be both joint and several.

#### B8. PRICES

- B8.1 The Bidder shall state the lump sum price in Canadian funds for the Work on Form B: Prices.
- B8.1.1 The price on Form B: Prices shall include:
  - (a) duty;
  - (b) freight and cartage, FOB Site;
  - (c) Provincial and Federal taxes [except the Goods and Services Tax (GST) and Manitoba Retail Sales Tax (MRST, also known as PST), which shall be extra where applicable] and all charges governmental or otherwise paid;
  - (d) profit and all compensation which shall be due to the Contractor for the Work and all risks and contingencies connected therewith.
  - (b) Payment of the lump sum price will be made to the Contractor in accordance with the payment schedule set out in D21.

#### **B9. QUALIFICATION**

- B9.1 The Bidder shall:
  - (a) undertake to be in good standing under The Corporations Act (Manitoba), or properly registered under The Business Names Registration Act (Manitoba), or otherwise properly registered, licensed or permitted by law to carry on business in Manitoba, or if the Bidder does not carry on business in Manitoba, in the jurisdiction where the Bidder does carry on business;
  - (b) be responsible and not be suspended, debarred or in default of any obligation to the City:
  - (c) be financially capable of carrying out the terms of the Contract;
  - (d) have all the necessary experience, capital, organization, and equipment to perform the Work in strict accordance with the terms and provisions of the Contract;
  - (e) have successfully carried out work, similar in nature, scope and value to the Work;
  - (f) have a written workplace safety and health program in accordance with The Workplace Safety and Health Act (Manitoba).
- B9.2 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.
- B9.3 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.

#### **B10.** BID SECURITY

- B10.1 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.
- B10.1.1 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.
- B10.2 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.
- B10.2.1 Where the bid security provided by the successful Bidder is in the form of a certified cheque or draft pursuant to B10.1(c), it will be deposited and retained by the City as the performance security and no further submission is required.
- B10.2.2 The City will not pay any interest on certified cheques or drafts furnished as bid security or subsequently retained as performance security.
- B10.3 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.

#### B11. OPENING OF BIDS AND RELEASE OF INFORMATION

- B11.1 Bid Submissions will not be opened publicly.
- B11.2 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.
- B11.3 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.
- B11.4 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.

#### **B12. IRREVOCABLE BID**

- B12.1 The Bid(s) submitted by the Bidder shall be irrevocable for the time period specified in Paragraph 11 of Form A: Bid.
- B12.2 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.

#### **B13. WITHDRAWAL OF BIDS**

- B13.1 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.
- B13.1.1 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.
- B13.1.2 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.
- B13.1.3 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 B13.1.3(b), declare the Bid withdrawn.
- B13.2 A Bidder who withdraws his Bid after the Submission Deadline but before his Bid has been released or has lapsed as provided for in B12.2 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.

#### **B14. EVALUATION OF BIDS**

- B14.1 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 B9 (pass/fail);
  - (c) Total Bid Price; and
  - (d) economic analysis of any approved alternative pursuant to B5.
- B14.2 Further to B14.1(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.
- B14.3 Further to B14.1(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.
- B14.4 Further to B14.1(c), the Total Bid Price shall be the lump sum price shown on Form B: Prices.

- B14.4.1 If there is any discrepancy between the lump sum price written in figures and the lump sum price written in words, the price written in words shall take precedence.
- B14.5 This Contract will be awarded as a whole.

#### **B15.** AWARD OF CONTRACT

- B15.1 The City will give notice of the award of the Contract or will give notice that no award will be made.
- B15.2 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.
- B15.2.1 Without limiting the generality of B15.2, 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.
- B15.3 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 ozone equipment.
- D2.2 The major components of the Work are as follows:
  - (a) To supply a complete ozone equipment system including (but not limited to) delivery to Site, training, performance verification support, operation and maintenance manuals, accessories and spare parts.
  - (b) Services as specified in sections 11210-07 and 01650.
  - (c) Major components of the ozone equipment system are generally as specified in clause 1.2 of Section 11210-00.
  - (d) Electrical scope as defined in Section 16015.
- D2.3 The Site is located on Provincial Road 207, 3 km north of Highway 1 in Dugald, Manitoba.
- D2.3.1 The Site address is PR207, Lot 57082, Dugald, Manitoba.
- D2.3.2 Provincial Road 207 is a class B1 road and is subject to seasonal load restrictions which will affect the maximum weight of individual deliveries. The Contractor shall be responsible for the payment all fees and acquire all permits from the authority having jurisdiction as required by GC.7.01.
- D2.3.3 All truck deliveries shall approach the Site by heading north on PR207.

#### 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
- (i) DAF means Dissolved Air Flotation
- (k) IEC means International Electrotechnical Commission
- (I) 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
- (g) CEC means Canadian Electrical Code
- (r) LOX means liquid oxygen
- (s) Manufacturer means the person, partnership or corporation responsible for the manufacture and fabrication of equipment provided to the City for the completion of the work.
- (t) 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.
- (u) IEEE means Institute of Electrical and Electronics Engineers
- (v) **NEMA** means National Electrical Manufacturer's Association
- (w) Furnish means supply
- (x) **ISA** means the Instrumentation Systems and Automation Society
- (y) 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
- (z) AGMA means American Gear Manufacturer's Association.
- (aa) API means American Petroleum Institute
- (bb) **EEMAC** means Electrical and Electronic Manufacturer of Canada
- (cc) VFD means Variable Frequency Drive
- (dd) 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
- (ee) 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
- (ff) **Professional Engineer** means a professional engineer registered in the Province of Manitoba.

- (gg) **Major Equipment** means all equipment for which shop drawing submittals are required as specified in Division 11, 16 and 17.
- (hh) Process Unit means the Manufacturer's complete equipment package including individual process components, skid mounted equipment and any related appurtenances.
- (ii) Certified Shop Drawings means Shop Drawings prepared by the Contractor after all required Shop Drawings have been "reviewed" or "reviewed as modified" in accordance with Section 01300 of this Bid Opportunity and which incorporate all modifications to the Shop Drawings, comments and notations made by the Contract Administrator in the course of the review.
- (jj) 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
- (kk) **Control System Integrator** means a contractor retained by the City (under a different contract) to program and configure the water treatment plant SCADA system.
- (II) Systems Integrator means Control Systems Integrator.
- (mm) **SCADA** means supervisor control and data acquisition.
- 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 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. 1479 Buffalo Place Winnipeg, Manitoba, R3T 1L7

Telephone No. (204) 986-8392 Facsimile No. (204) 986-8393

# D5. NOTICES

- D5.1 GC.7.05 is hereby amended to delete reference to "registered mail" and to replace same with "ordinary mail".
- D5.2 GC.7.05 is further amended hereby to include delivery by facsimile transmission (fax) as an acceptable means of delivering notices, consents, approvals, statements, authorizations, documents or other communications required or permitted to be given under this Contract. Deliveries by fax will be deemed to have been received on the day of delivery, if a business day, or if not a business day, on the business day next following the day of delivery.

- D5.3 Further to GC.7.05, all notices, consents, approvals, statements, authorizations, documents or other communications to the City, except as expressly otherwise required in D5.4, D5.5 or elsewhere in the Contract, shall be sent to the attention of the Contract Administrator at the address or facsimile number identified in D4.1.
- D5.4 All notices of appeal to the Chief Administrative Officer shall be sent to the attention of the Chief Financial Officer at the following address or facsimile number:

The City of Winnipeg Chief Administrative Officer Secretariat Administration Building, 3rd Floor 510 Main Street Winnipeg MB R3B 1B9

Facsimile No.: (204) 949-1174

D5.5 All notices, requests, nominations, proposals, consents, approvals, statements, authorizations, documents or other communications required to be submitted or returned to the City Solicitor shall be sent to the following address or facsimile number:

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

Facsimile No.: (204) 947-9155

#### D6. INDEMNITY

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

#### **SUBMISSIONS**

# D7. AUTHORITY TO CARRY ON BUSINESS

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

#### D8. WORKERS COMPENSATION

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

#### D9. INSURANCE

- D9.1 The City will provide and maintain the following Project Insurance Coverages:
  - (a) Builder's Risk Insurance in the amount of one hundred percent (100%) of the total project cost.
    - 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)
    - The Contractor shall be responsible for deductibles up to \$10,000.00 maximum of any one loss.
  - (c) The City of Winnipeg will carry such insurance to cover all parties engaged in the Work in this Contract. Provision of this insurance by the City of Winnipeg is not intended in any way to relieve the Contractor from his obligations under the terms of the Contract. Specifically, losses relating to deductibles for insurance, as well as losses in excess of limits of coverage and any risk of loss that is not covered under the terms of the insurance provided by the City of Winnipeg remains with the Contractor.
- D9.2 The Contractor shall provide and maintain the following insurance coverage at all times during the performance of the Work:
  - (a) Automobile liability insurance for owned and non-owned automobiles used for or in connection with the work in the amount of at least two million dollars (\$2,000,000.00).
    - (i) Deductibles shall be borne by the Contractor;
    - (ii) The Contractor shall not cancel, materially alter, or cause the policy to lapse without providing at least fifteen (15) Calendar Days prior written notice to the Contract Administrator:
    - (iii) The Contractor shall provide the Contract Administrator with evidence of insurance of the policy at least two (2) Business Days prior to the commencement of any Work on the Site but in no event later than seven (7) Calendar Days from notification of the award of Contract.
  - (b) The Contractor shall not cancel, materially alter, or cause each policy to lapse without providing at least fifteen (15) Calendar Days prior written notice to the Contract Administrator.

#### D10. 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 B10.1(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 Substantial 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 Check Search Certificate from the Police Service having jurisdiction at his place of residence.
- D14.2 Prior to the commencement of any Work, and during the term of the Contract if additional or replacement individuals are proposed to perform Work, the Contractor shall supply the Contract Administrator with a Criminal Record Search Certificate obtained not earlier than one (1) year prior to the Submission Deadline, or a certified true copy thereof, for each individual proposed to perform Work within City facilities or on private property.
- 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:
    - 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 Contract Work Schedule specified in D13;
    - (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 Calgary, Alberta as specified in 1.4.1 of Section 11210-07 approximately 10 days after the Award. At this meeting the Contractor shall submit preliminary Shop Drawings for all Major Equipment and the list specified in D15.1.

# D17. CRITICAL STAGES

- D17.1 The Contractor shall achieve critical stages of the Work in accordance with the following requirements:
  - (a) Shop Drawings:
    - Acceptable Shop Drawings for all Major Equipment shall be completed by November 21, 2005. Shop drawing completion shall not be achieved until drawings are reviewed by the Contract Administrator.
    - (ii) The Shop Drawing information provided by the Contractor will be used by the City as information in future Bid Opportunities related to the installation of the Goods supplied under this Contract as specified in clause 1.3 of Section 11210-07.
  - (b) Delivery:
    - (i) Delivery of Goods to the site shall begin no earlier than November 1, 2006 and be completed no later than January 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. The Goods shall be supplied into the care of the Installation Contractor in accordance with this 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 included in Section 01650.
- (c) Satisfactory Installation: The Contractor shall provide support to the Installation Contractor as required to achieve satisfactory installation of All Goods by July 3, 2007.
  - (i) This support shall include (but is not limited to) providing a qualified representative on site as required to assist the Installation Contractor in achieving satisfactory installation of the 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) Satisfactory Performance and Training: Performance Verification and Training shall begin no earlier than July 3, 2007 and shall be completed on or before achieving Substantial Performance.
  - (i) The Contract Administrator will coordinate the performance verification and training to coincide with the project commissioning schedule and will provide the Contractor a minimum of sixty (60) calendar days written notification of the acceptable date for the start of performance verification and training.
  - (ii) During the performance verification and training period the Contractor shall provide qualified representation on site as required to assist the Installation Contractor in achieving and demonstrating satisfactory performance of the Goods supplied under this Contract.
  - (iii) Satisfactory performance and training shall be considered complete upon the issuance of Form 103: Certificate of Equipment Satisfactory Performance and Form T1: Certificate of Satisfactory Training.
- D17.2 The City will endeavour to award the Contract within twenty-one (21) Calendar Days of the Submission Deadline. If award is not made within that time period, Contract dates specified in D17.1(a) will be extended by an equivalent number of Calendar Days.
- D17.3 The Contract Administrator will endeavour to review Shop Drawings within ten (10) Calendar 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 Calendar Days.
- D17.4 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 December 1, 2007.
- 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 Substantial Performance cannot be achieved without completion of Forms 103 and T1 for all Major Equipment supplied under this Contract.

#### D19. TOTAL PERFORMANCE

D19.1 The Contractor shall achieve Total Performance by December 31, 2007.

- 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.

#### 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 The amounts specified for liquidated damages in D20.1 is based on a genuine pre-estimate of the City's losses in the event that the Contractor does not achieve critical stages, Substantial Performance or Total Performance by the days fixed herein for same.
- D20.3 The City may reduce any payment to the Contractor by the amount of any liquidated damages assessed.
- D20.4 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, performance verification and training.
    - (i) Two (2) percent of the Lump Sum Price will be paid upon the issuance of Certified Shop Drawings for the entire scope of this supply Contract.
    - (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 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;
  - (ii) Payment on account of the final progress estimate, including the holdback made by the City pursuant to The Builders' Liens Act, shall be paid to the Contractor when the time for filing liens or trust claims has elapsed, unless the City is in receipt of a lien or trust claim.

#### WARRANTY

#### 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.
- D22.4 Prior to Substantial Performance, the Contractor shall provide a written approval from the VFD and motor manufacturers certifying that both pieces of equipment are compatible when used together and maintain their individual warranties. One such written approval shall be provided for each different VFD and motor pair.
- D22.5 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 <a href="http://www.winnipeg.ca/matmgt/projects">http://www.winnipeg.ca/matmgt/projects</a>

# FORM H1: PERFORMANCE BOND (See D11)

KNOW ALL MEN BY THESE PRESENTS THAT

THOW MEETINESE TRESERVES TIME	
(hereinafter called the "Principal"), and	
(hereinafter called the "Surety"), are held and firmly bound unto <b>THE CITY OF WINNIPEG</b> (hereina called the "Obligee"), in the sum of	fter
dollars (\$	)
of lawful money of Canada to be paid to the Obligee, or its successors or assigns, for the payment of wh sum the Principal and the Surety bind themselves, their heirs, executors, administrators, successors 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. 428-2005	
WINNIPEG WATER TREATMENT PROGRAM – SUPPLY OF OZONE 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:	
<ul> <li>(a) carry out and perform the Contract and every part thereof in the manner and within the times forth in the Contract and in accordance with the terms and conditions specified in the Contract;</li> <li>(b) perform the Work in a good, proper, workmanlike manner;</li> <li>(c) make all the payments whether to the Obligee or to others as therein provided;</li> <li>(d) in every other respect comply with the conditions and perform the covenants contained in</li> </ul>	
Contract; and  (e) indemnify and save harmless the Obligee against and from all loss, costs, damages, claims, a demands of every description as set forth in the Contract, and from all penalties, assessment claims, actions for loss, damages or compensation whether arising under "The Work Compensation Act", or any other Act or otherwise arising out of or in any way connected with performance or non-performance of the Contract or any part thereof during the term of Contract and the warranty period provided for therein;	nts, ters the
THEN THIS OBLIGATION SHALL BE VOID, but otherwise shall remain in full force and effect. The Sur shall not, however, be liable for a greater sum than the sum specified above.	rety
AND IT IS HEREBY DECLARED AND AGREED that the Surety shall be liable as Principal, and to 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 contraction notwithstanding.	rge
IN WITNESS WHEREOF the Principal and Surety have signed and sealed this bond the	
day of , 20	

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SIGNED AND SEALED in the presence of:		
	(Name of Principal)	
	Per:	(Seal)
(Witness)	Per:	
	(Name of Surety)  By:  (Attorney-in-Fact)	(Seal)
	(Attorney-in-Fact)	

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

(Date)	
Corpo Legal 185 K	y of Winnipeg ate Services Department dervices Division g Street, 3rd Floor eg MB R3B 1J1
RE:	PERFORMANCE SECURITY - BID OPPORTUNITY NO. 428-2005
	WINNIPEG WATER TREATMENT PROGRAM – SUPPLY OF OZONE EQUIPMENT
Pursu	nt to the request of and for the account of our customer,
(Name	Contractor)
(Addres	of Contractor)
	REBY ESTABLISH in your favour our irrevocable Standby Letter of Credit for a sum not exceeding ggregate
	Canadian dollars.
demai Letter payme	andby Letter of Credit may be drawn on by you at any time and from time to time upon writter of for payment made upon us by you. It is understood that we are obligated under this Standby of Credit for the payment of monies only and we hereby agree that we shall honour your demand for the without inquiring whether you have a right as between yourself and our customer to make such and without recognizing any claim of our customer or objection by the customer to payment by us.
	ount of this Standby Letter of Credit may be reduced from time to time only by amounts drawn upor u or by formal notice in writing given to us by you if you desire such reduction or are willing that it be
Partia	drawings are permitted.
	gage with you that all demands for payment made within the terms and currency of this Standby f Credit will be duly honoured if presented to us at:
(Addres	
and w	confirm and hereby undertake to ensure that all demands for payment will be duly honoured by us.

(Date)

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

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)
er:	
	(Authorized Signing Officer)
Per:	
	(Authorized Signing Officer)

# FORM J: SUBCONTRACTOR LIST

(See D12)

# WINNIPEG WATER TREATMENT PROGRAM – SUPPLY OF OZONE EQUIPMENT

<u>Name</u>	Address
·	

# **PART E - SPECIFICATIONS**

# **GENERAL**

# E1. GENERAL

- E1.1 These Specifications shall apply to the Work.
- E1.2 The following are applicable to the Work:

#### **Sections**

Sections	
<u>Section</u>	<u>Description</u>
<u> Division 01 – 0</u>	General Requirements
01300	Ozone Submittals
01400	Ozone Quality Control
01650	Ozone Equipment Installation
01730	Ozone Operation and Maintenance Manuals
Division 11 – P	Process
11060	Process Motors Less Than 150 kW
11210-00	Ozone System General
11210-01	Ozone Generators
11210-02	Cooling Water System
11210-03	Off-Gas Destruct System
11210-04	Nitrogen Boost Skid
11210-05	Ozone Dissolution
11210-06	Ozone System Instrumentation
11210-07	Ozone System Contractor Services
11210-08	Ozone System Performance Testing
11901	Factory Applied Maintenance and Corrosion Protection Coatings
Division 16 – E	
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
	nstrumentation and Controls
17010	Instrumentation and Control General Requirements
17110	Enclosures
17124	Instrumentation Cable
17130	Power Supplies
17140	Instrument Air Supply and Transmission
17211	Process Taps and Primary Elements
17212	Transmitters and Indicators
17213	Powered Actuators
17216	Switches and Relays
17271	Signal Conditioning Modules
17274	Panel Instruments
17275	Miscellaneous Panel Devices
17300	Gas Detection Systems
17500	Programmable Logic Controllers
17501	Operator Interface Requirements

Drawings	
Drawing No.	<u>Description</u>
WM-P0001	Construction Standards – Instrumentation and Process - Identification
WM-P0002	Construction Standards – Process And Instrumentation - Symbols
WO-M0121	General Area Layout – Ozone Contactors – Second Floor Plan
WO-M0122	General Area Layout – Ozone Contactors – Second Floor Plan
WO-M0131	General Area Layout – Ozone Contactors – Second Floor Plan
WO-M0132	General Area Layout – Ozone Contactors – Second Floor Plan
WO-M0201 WO-P0001	General Area Layout – Ozone Contactors – Section Ozonation Area – Liquid Oxygen Storage System #1 - Piping &
VVO-F0001	Instrumentation Diagram
WO-P0002	Ozonation Area – Liquid Oxygen Storage System #2 - Piping &
	Instrumentation Diagram
WO-P0003	Ozonation Area – GOX Preparation System - Piping & Instrumentation
	Diagram
WO-P0004	Ozonation Area – Nitrogen Boost Unit – Process & Instrumentation
WO D0005	Diagram
WO-P0005	Ozonation Area – Ozone Generator #1 - Process & Instrumentation
WO-P0006	Diagram Ozonation Area – Ozone Generator #2 - Process & Instrumentation
VVO-F 0000	Diagram
WO-P0007	Ozonation Area – Ozone Generator #3 - Process & Instrumentation
	Diagram
WO-P0008	Ozonation Area – Ozone Flow Control #1 - Process & Instrumentation
	Diagram
WO-P0009	Ozonation Area – Ozone Flow Control #2 - Process & Instrumentation
1440 50040	Diagram
WO-P0010	Ozonation Area – Ozone Contactor #1 - Process & Instrumentation
WO-P0011	Diagram Ozonation Area – Ozone Contactor #2 - Process & Instrumentation
VVO-F 0011	Diagram
WO-P0012	Ozonation Area – Ozone Destruct Unit #1 - Process & Instrumentation
	Diagram
WO-P0013	Ozonation Area – Ozone Destruct Unit #2 - Process & Instrumentation
	Diagram
WO-P0014	Ozonation Area – Ozone Destruct Unit #3 - Process & Instrumentation
WO D0045	Diagram  Operation Associated Continue Metal Continue Con
WO-P0015	Ozonation Area – Open Loop Cooling Water Supply - Process &
WO-P0016	Instrumentation Diagram Ozonation Area – Cooling Water Skid #1 - Process & Instrumentation
VVO-F 00 10	Diagram
WO-P0017	Ozonation Area – Cooling Water Skid #2 - Process & Instrumentation
	Diagram
WO-P0018	Ozonation Area – Cooling Water Skid #3 - Process & Instrumentation
	Diagram
WO-P0019	Ozonation Area – Power Supply Unit #1 - Process & Instrumentation
WO DOOG	Diagram
WO-P0020	Ozonation Area – Power Supply Unit #2 - Process & Instrumentation
WO-P0021	Diagram Ozonation Area – Power Supply Unit #3 - Process & Instrumentation
VVO-FUUZ I	Diagram
WO-P0022	Ozonation Area – Dissolved Ozone Sampling System #1 - Process &
	Instrumentation Diagram
WO-P0023	Ozonation Area – Dissolved Ozone Sampling System #2 - Process &
	Instrumentation Diagram

# E2. GOODS

E2.1 The Contractor shall supply Ozone Equipment in accordance with the requirements hereinafter specified.

#### 1. SHOP DRAWINGS

#### 1.1 General

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

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

# 1.4 Drawings

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

- .4 Cross-reference Shop Drawing information to applicable portions of the Contract Documents.
- .5 Include reviewed Shop Drawings in all Operation and Maintenance (O&M) Manuals.

# 1.5 Product Data

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

#### 1.6 Electronic Submittals

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

# 1.7 Shop Drawing Review

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

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

# 1.8 Operating and Maintenance Manuals

.1 Refer to Section 01730.

# **END OF SECTION**

# **OZONE QUALITY CONTROL**

# 1. CODES AND STANDARDS

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

# 2. TESTING AND QUALITY CONTROL

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

# **OZONE QUALITY CONTROL**

- .3 Compliance and performance testing of equipment, pipe, conduit, wiring, and other items covered in other Divisions of this Specification are the responsibility of the Contractor, unless specified otherwise. The City may replicate any series of tests to provide random checks on the compliance and performance tests at the City's cost.
- .4 Remove and replace Products indicated in inspection and test reports as failing to comply with the Contract Documents.
- .5 Correct improper installation procedures reported in the inspection and test reports.
- .6 Pay the costs for the re-inspection and re-testing of replaced Work.
- .7 It is not the responsibility of the inspection and testing agents to supervise, instruct in current methods or accept or reject a part of the Work, but only to inspect, test, and to report conditions.
- 8 Notify the Contract Administrator and the appropriate inspection and testing agent not less than forty-eight (48) hours prior to the commencement of the part of the Work to be inspected and tested.
- 9 Ensure the presence of the authorized inspection and testing agent at the commencement of the part of the Work specified to be inspected or tested.
- .10 Ensure the inspection and testing reports are issued 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.

# **OZONE QUALITY CONTROL**

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

# **END OF SECTION**

# 1. INTENT

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

#### 2. EXPERTISE AND RESPONSIBILITY

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

# 3. EQUIPMENT DELIVERY

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

# 4. INSTALLATION ASSISTANCE

- .1 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.

# 5. INSTALLATION

- .1 If necessary, or if so directed by the Contract Administrator during the course of installation, the Installer shall contact the Manufacturer to receive clarification of installation procedures, direction, or any other additional information necessary to continue or complete the installation in an appropriate manner.
- .2 If it is found necessary, or if so directed by the Contract Administrator, the Installer shall contact the Contractor who shall arrange for the Manufacturer's Representative to visit the Site to provide assistance during installation, all at the Contractor's cost.
- .3 Prior to completing installation, the Installer shall inform the Contractor who shall arrange for the attendance at the Site of the Manufacturer's Representative to verify successful installation.
- 4 The Manufacturer's Representative shall conduct a detailed inspection of the installation including alignment, electrical connections, belt tensions, rotation direction, running clearances, lubrication, workmanship and all other items as required to ensure successful operation of the equipment.
- .5 The Manufacturer's Representative shall identify any outstanding deficiencies in the installation.
- .6 The deficiencies shall be rectified by the Installer and the Manufacturer's Representative shall re-inspect the installation, at the 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.
- .10 Provide a copy of Form 102 for the entire system supplied under this contract.

#### 6. OPERATION AND PERFORMANCE VERIFICATION

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

- .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 shall attend, as expeditiously as possible.
- .7 With the assistance of the Manufacturer's Representative, the Contractor shall demonstrate that the equipment is properly installed. Alignment, piping connections, electrical connections, etc. shall be checked and if appropriate, code certifications provided.
- 8 The equipment shall then be run for one (1) hour. Local controls shall be satisfactorily verified by cycling the equipment through several start-stop operations, modulating its output, or some combination. Operating parameters such as temperature, pressure, voltage, vibration, etc., shall be checked to ensure that they are within the specified or Manufacturer's recommended limits, whichever is more stringent.
- .9 On satisfactory completion of the one (1) hour demonstration, the equipment shall be stopped and critical parameters, such as alignment, shall be rechecked.
- .10 The equipment shall be restarted and run continuously for five (5) days. During this period, as practicable, conditions shall be simulated which represent the full range of operating conditions. These conditions shall be mutually agreed by the Manufacturer's Representative, the Contractor, and the Contract Administrator on the basis of the information contained in the Technical Specifications, as well as the methods utilized to create the simulated conditions and the time periods allotted to each.
- .11 Performance tests shall be conducted either concurrent with or subsequent to the running test, as practicable and agreed between the Contract Administrator and the Contractor. Performance tests of equipment shall be carried out jointly with the City's Supervisory Control and Data Acquisition (SCADA) programming team. Instrumentation and Controls (I&C) connected to the marshalling panel shall include, but not to be limited to, simulation through SCADA. Performance tests shall also be attended by the City's operations staff as part of the acceptance procedure. Testing procedures and conditions shall be agreed to among the Contractor, Contract Administrator, and the City based on information in the Specification. The Contract Administrator is the final arbiter. However, the Contractor is solely responsible for conducting the tests.

- .12 Performance tests shall be as dictated in the technical Specifications for each item of equipment or as reasonably required by the Contract Administrator to prove adherence to the requirements listed in the Specification.
- .13 The Contractor shall submit the results of the performance tests to the Contract Administrator, documented and summarized in a format acceptable to the Contract Administrator. The Contract Administrator reserves the right to request additional testing. No equipment shall be accepted and handed over to the City prior to the satisfactory completion of the performance test(s) and receipt of the test reports.
- .14 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 including liquid oxygen are to be provided by the City.
- .15 Should the initial demonstration, running test, or performance tests reveal any defects, then those defects shall be promptly rectified and the demonstration, running tests, and/or performance tests shall be repeated to the satisfaction of the Contract Administrator. If the defects are attributed to the Contractor, additional costs incurred by the Installer, the Contract Administrator, or the City, due to repeat demonstration, running tests, and/or performance tests shall be the responsibility of the Contractor.
- .16 On successful completion of the demonstration, running test, and performance tests, Form 103 attached to this Specification shall be signed by the Manufacturer's Representative, the Installer, and the Contract Administrator.
- .17 When the Contract Administrator confirms all unit processes in the plant are tested as per Form 103, and training provided as per Form T1, the twenty-eight (28) day commissioning period shall commence. The equipment shall operate continuously over the twenty-eight (28) day period without experiencing a critical failure. A critical failure is defined as one that prevents the equipment from operating for an eight (8) hour period or that presents a safety hazard. For equipment that is designed not to operate on a daily basis, the commissioning period shall be defined as twenty-eight (28) consecutive days over which the piece of equipment is operated. Upon completion of the twenty-eight (28) day commissioning period, the equipment shall be deemed to have been handed-over and accepted by the Contract Administrator, unless the Contractor or Manufacturer's Representative is notified otherwise.

#### 7. OPERATOR TRAINING

- .1 Provide training in accordance with Section 11210-07 Ozone System Contractor Services.
- .2 Upon completion of training, the Contractor shall issue form T1: Certificate of Satisfactory Training, complete with all required signatures.

# CERTIFICATE OF EQUIPMENT DELIVERY FORM 100

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

PROJECT:		
Impar of Foundation		
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	
(Authorized Signing Representative of the Contract Authinistrator)	Date	

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# OZONE 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 Represe	entative of the	Manufacturer)		Date			
I certify that I have Manufacturer/Contractor.	e received	satisfactory	installation	instructions	from	the	equipment
(Authorized Signing Represe	entative of the	Installer)		Date			

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# OZONE 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 Manufa	cturer)	Date	
		- <u></u>	
(Authorized Signing Representative of the Installer	î)	Date	

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# OZONE 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	

# 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** 

# 1. **DESCRIPTION**

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

# 2. OPERATION AND MAINTENANCE MANUAL CONTENTS AND ORGANIZATION

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

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

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

#### .4 Tab 4 - Technical Data

- .1 Insert Manufacturer's Technical Specification and data sheets.
- .2 Insert Manufacturer's certified performance and calibration curves for the equipment and instruments.

#### .5 Tab 5 - Maintenance Information

.1 Include the description and schedule for all Manufacturers' recommended routine preventative maintenance procedures including specific lubrication recommendations. Indicate whether procedure is to be done daily, weekly, monthly, quarterly, semi-annually, annually, or fill in hours of operation.

#### .6 Tab 6 - Maintenance Instructions

- .1 Provide requirements to set up and check out each system for use. Include all required and recommended step-by-step inspections, lubrications, adjustments, alignments, balancing, and calibrations. Include protective device settings, warnings, and cautions to prevent equipment damage and to insure personnel safety.
- .2 Provide Manufacturer's description of routine preventive maintenance, inspections, tests, and adjustments required to ensure proper and economical operation and to minimize corrective maintenance and repair.
- .3 Provide Manufacturer's recommendations on procedures and instructions for correcting problems and making repairs.
- .4 Provide step-by-step procedures to isolate the cause of typical malfunctions. Describe clearly why the checkout is performed and what conditions are to be sought. Identify tests or inspections and test equipment required to determine whether parts and equipment may be reused or require replacement.
- .5 Provide step-by-step procedures and list special required tools and supplies for removal, replacement, disassembly, and assembly of components, assemblies, subassemblies, accessories, and attachments. Provide tolerances, dimensions, settings, and adjustments required.

# .7 Tab 7 - Assembly Drawings

.1 Provide Drawings which completely document the equipment, assembly, subassembly, or material for which the instruction is written. Provide the following Drawings as applicable: fabrication details, wiring and connection diagrams, electrical and piping schematics, block or logic diagrams, Shop Drawings, installation Drawings, layout and dimension Drawings, and electrical component fabrication Drawings.

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

#### .8 Tab 8 - Bills of Materials

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

# .9 Tab 9 - Lubrication Data

- 1 Provide a table showing recommended lubricants for specific temperature ranges and applications.
- .2 Provide charts with a schematic diagram of the equipment showing lubrication points, recommended types and grades of lubricants, and capacities.
- 3 If the equipment or instrument is not lubricated, add a sheet under this Tab with the words "Not Applicable".

# 3. FIELD CHANGES

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

#### 4. COMMISSIONING DATA

- .1 Provide in hard cover three (3)-ring binders for 215 x 280 mm paper labelled "Commissioning Data" one copy of:
  - .1 All completed equipment testing and commissioning forms.
  - .2 All completed equipment checklists and performance reports, including noise and vibration analysis, instrumentation calibration data, and all other relevant information.
  - .3 All system performance reports

# 5. WARRANTIES

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

# **END OF SECTION**

#### 1. GENERAL

# 1.1 Description

- .1 Alternating current induction motors, 150 kW or less, National Electrical Manufacturers Association (NEMA) frame type.
- .2 Unless specified otherwise, electric motors to be provided by the Manufacturer of the driven equipment, as an integral component of the driven equipment.
- 3 Motors suitable for starting, accelerating, and running centrifugal pumps, fans, blowers, compressors, gears, progressive cavity pumps, or other loads fed via across the line starters, or variable frequency drive (VFD) as noted in the equipment data sheets.

# 1.2 Reference Standards

- .1 Conform to the following reference standards:
  - .1 Canadian Standards Association (CSA) C22.2 No. 100, Motors and Generators.
  - .2 CSA C22.2 No. 145, Motors and Generators for Use in Hazardous Locations.
  - .3 CSA C390, Energy Efficient Test Methods for Three Phase Induction Motors.
  - .4 NEMA M1-7, Motors and Generators.
  - .5 NEMA M2.1, Standard for Lead Marking and Connections for Single Phase and Polyphase Induction Motors.
  - .6 Statutes of Canada, Energy Efficiency Act (most recent revision).
  - .7 Statutes of Canada, Energy Efficiency Regulations.
  - .8 Institute of Electrical and Electronic Engineers (IEEE) 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
  - .9 IEEE 114, Standard Test Procedures for Single-Phase Induction Motors.
  - .10 IEEE 841, Standard for Petroleum and Chemical Industry Severe Duty Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors, Up to and including 500 horsepower (370 kW).
  - .11 NEMA MG1, Motors and Generators.

#### 1.3 Submittals

- .1 Shop Drawings: Submit with the related items of equipment in accordance with **Section 11210-00.** In addition, submit the following details: Provide the specified information for each typical size or type of motor driven equipment.
  - .1 Overall dimensions of motor.
  - .2 Shaft centreline to base dimension.
  - .3 Shaft extension diameter and keyway, coupling dimensions and details.
  - .4 Fixing support dimensions.
  - .5 Terminal box location and size of terminals.
  - .6 Arrangement and dimensions of accessories.
  - .7 Diagram of connections.
  - .8 Speed/torque characteristic.
  - .9 Weight of motor.
  - .10 Installation data.
  - .11 Rotation direction.
  - .12 Starting restrictions (time between starts).
  - .13 Terminal leads marking.
  - .14 Bearing data (including part numbers).
  - .15 Recommended lubricant.
  - .16 Design ambient temperature and temperature rise ratings.
  - .17 Torque characteristics including rated starting torque and breakdown torque.
  - .18 The American Bearing Manufacturers Association (ABMA) L-10 rated life for the motor bearings.
  - .19 The nominal efficiency for all motors.
  - .20 Class, zone, group and Underwriters Laboratories Inc. (UL) frame temperature limit code for explosion-proof motors.

#### 1.4 Service Conditions

- .1 Unless specified otherwise, provide motors suitable for continuous operation at an elevation of 300 m above sea level.
- 2 Provide motors suitable for continuous operation in a 40°C ambient temperature.

# 1.5 Coordination

- .1 For motors fed via VFD's, communicate motor requirements to and comply with drive requirements of the Manufacturer of the VFD.
- .2 Motors powered via VFDs shall be rated for use with VFDs.

# 1.6 Quality Assurance

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

# 1.7 Shipment, Protection and Storage

- .1 Ship, protect, and store equipment in a manner that prevents damage or premature aging.
- .2 Handle motors with suitable lifting equipment.
- .3 Store motors in heated, dry, weather-protected enclosure.

# 2. PRODUCTS

# 2.1 Approved Manufacturers

- .1 GE.
- .2 Westinghouse.

# 2.2 Materials

- 1 Motors: to Electrical and Electronic Manufacturers of Canada (EEMAC) M1-7.
- .2 Lead markings: to EEMAC M2-1.
- .3 Unless specified otherwise, provide all motors with:

.1 Frame Cast iron, steel, or cast aluminum.

.2 Endplates Cast iron or cast aluminum.

.3 Terminal boxes Cast iron, steel, or cast aluminum.

.4 Fan blades and shrouds

Non metallic, corrosion resistant.

.5 Hardware

Stainless steel.

.6 Windings

Copper, with non-hygroscopic insulation.

# 2.3 Motor Efficiency

- .1 Use high efficiency motors with minimum guaranteed full-load efficiencies listed for NEMA Design E Table 12 11 for the size and type of motor provided.
- .2 Use vertical motors with efficiency within 0.5% of minimum values stated for horizontal motors.

#### 2.4 Horizontal and Vertical Motors, 0.56 to 150 kW

#### .1 General

- .1 Unless otherwise specified, motors 0.56 to 150 kW to be three (3) phase, squirrel cage induction type, full voltage start, high efficiency, with copper windings.
- .2 Service factor of 1.15 at 40°C ambient.
- .3 Rated for 600/3/60 VAC service unless otherwise specified.
- .4 Design motors for full voltage starting, capable of running successfully when terminal voltage is from +10% to -10% of nameplate voltage and terminal frequency is from +5% to -5% of nameplate frequency.
- .5 Capacity sufficient to operate the driven load and associated devices under all conditions of operation without overloading.
- .6 Design motor so that it is able to be re-started once after an immediate trip, after coasting to rest; and subsequently at sixty (60) minute intervals. This condition might apply whether the motor was run between starts or whether it was shut down immediately after start and not run between successive starts.

# .2 Torque Requirements

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

# .3 Inertia Loading

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

#### .4 Insulation

- .1 Use Class F insulation
- .2 Design motor for temperature rise less than 90°C at 1.15 service factor loading.
- .3 Insulation to be non-hygroscopic.

# .5 Varnish

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

#### .6 Current Imbalance

- .1 Do not exceed the values tabulated below when the motor is operating at any load within its service factor rating and is supplied by a balanced voltage system:
  - .1 Under 37.5 kW: 25%.
  - .2 37.5 kW and above: 10%.
- .2 Base imbalance criteria upon the lowest value measured.

# .7 Winding Over-Temperature Protection

- .1 Provide stator winding over-temperature protection on all motors rated 37 kW and larger. Motors rated less than 45 kW to have stator winding over-temperature protection when required by the specific equipment Specification Section or if recommended by the driven equipment Manufacturer.
- Over-temperature protection for motors rated 37 kW and larger and other motors, where specified, to be NEMA MG1-12.53, Type 1, winding running and locked rotor over-temperature protection. One detector to be provided per phase. Detectors to be positive thermal protection (PTC) thermistor type, with leads brought out to a terminal strip in a NEMA 4 enclosure in Type two (2) motors and a NEMA 7C or 9 enclosure for Type three (3) motors.

# .8 Bearings

- .1 Select type of bearings on basis of torque and thrust requirements.
- .2 Provide anti-friction bearings with grease lubrication, with one (1) year continuous operation without re-greasing.
- .3 Provide sealed ball or cylindrical roller bearing type on motors less than 37.5 kW.
- .4 Bearings on 37.5 kW motors or larger to be greasable ball bearing type, rated for a minimum L-10 life of 100,000 hours at the ambient temperature specified herein.

- .5 Design bearings to have a maximum 45°C temperature rise at rated horsepower for four (4) pole and greater motors and 50°C for two (2) pole motors.
- .6 Provide features to minimize the entrance of moisture and contaminants into the bearing chamber.

# .9 Mounting

- .1 End-bell mounted bearings: Provide motor sole plates, machined top and bottom, with a minimum thickness of 50 mm depending upon motor size.
- .2 Pedestal type, independent of stator frame: Provide fabricated structural steel base, suitably braced to prevent distortion, to mount the stator frame and the bearing pedestals.
- .3 Provide vertically mounted motors with drip shield.

#### .10 Direction of Rotation

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

#### .11 Frame

- .1 Use a minimum of grade 25 cast iron, aluminum, or steel for frame, end brackets, fan cover, and conduit box. Refer to motor classifications.
- .2 Provide two (2) bronze automatic breather drains at the lowest point in the motor frame.
- .3 On frames sizes greater than 180, provide removable lifting eyes at the balance point of the motor, with a design safety factor greater than ten (10). Vertical motors require two (2) eyes, one (1) on each side of the frame.
- .4 Use stainless steel hardware.

#### .12 Motor Classifications:

- .1 Type 1 (General Duty): Unless specified otherwise, TEFC enclosures.
- .2 Type 2 (Process): TEFC, suitable for moist and corrosive environment. All internal surfaces to be coated with an epoxy paint.
- .3 Type 3 (Explosion-proof): Motors to be rated for operation in a Class 1, Zone 1, Group D hazardous location in accordance with CSA C22.1. Provide an approved breather/drain device to be provided in the motor drain hole.
- .4 Type 4 (Exterior): TEFC or weather protected. All internal surfaces to be coated with an epoxy paint.

# .13 Cooling Fans

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

#### .14 Terminal Box

- .1 Incorporate an oversize terminal box with a volume greater than NEMA requirements, rotatable in 90° increments. Provide gaskets between the terminal box and frame and between the terminal box and cover.
- .2 Provide diagonally split, gasketted, EEMAC 4 terminal boxes complete with threaded hub for conduit entry for open drip proof (ODP) and TEFC motors and adequately sized, diagonally split, gasketted EEMAC 7 terminal boxes complete with threaded hub for conduit entry for explosion-proof motors.
- .3 Provide a ground connection and lugs in the terminal box.
- .4 Provide a separate terminal box for all motors required to have internal monitoring devices c/w terminal blocks.

# .15 Vibration and Critical Speed

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

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

- .3 Ensure that axial vibration, as measured at the bearing housings, does not exceed twice the above values.
- .16 Motors are to be aligned and balanced with the related equipment in the Shop to minimize vibration and undue stresses. Maximum vibration of motor at the bearing housing is 12.5 microns peak to peak. As necessary, provide stainless steel balance washers.
- .17 Sound pressure levels at 1.0 m, free field:

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

.2 All other motors 85 dBA

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

# .19 Finishes

- .1 Factory prime and paint in accordance with **Section 11901**.
- .2 On interior of motor, apply rust inhibiting coating on all exposed machined surfaces.

# 2.5 Motors Smaller Than 0.56 kW

#### .1 General

- .1 Unless otherwise specified, motors smaller than 0.56 kW to be squirrel cage, single phase, capacitor start, induction run type with copper windings.
- .2 Construction features listed in this Section may be as normally supplied by the Manufacturer.
- .3 Single phase motors to have Class F insulation.
- .4 Small fan motors may be split-phase or shaded pole type.
- .5 Provide copper windings.

#### .2 Rating

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

#### .3 Enclosures

- .1 Unless otherwise specified, provide motors with TEFC or totally enclosed non-ventilated enclosures.
- .2 Explosion-proof motors shall be approved by CSA for hazardous locations.
- .3 Provide an over-temperature device in the enclosure to detect and automatically alarm to SCADA.

# 2.6 Motors for Variable Frequency Drives

- .1 Select high efficiency units, inverter duty rated, CSA certified to be in conformance with NEMA MG1, Part 30 and Part 31.
- .2 Design to ensure turndown of five (5): one (1) unless specified elsewhere.
- .3 Use Type two (2) or Type three (3) motors.

- .4 Insulation: Class F insulation, suitable for 90°C temperature rise, with a 1.0 safety factor, suitable for moist and corrosive environments and in accordance with NEMA MG1 Part 30 and Part 31. Provide additional treatment at winding end turns to minimize stray current failures.
- .5 Design motors for variable frequency systems so that they are not required to deliver more than 80% of the motor's power rating by any load imposed by the driven machine at any specified operating condition or any condition imposed by the driven machine's performance curve at maximum operating speed.
- .6 Ensure motors have adequate cooling capacity when operating through the entire speed range capacity of the drive.
- .7 Enclosure and other insulation requirements are the same as required for constant speed motors.

#### 2.7 Vertical Motors

- .1 Unless otherwise specified, provide full voltage vertical motors with a Type P base specifically designed for vertical installation.
- .2 Universal position motors are not acceptable.
- .3 Provide vertical motors with solid shafts unless specified otherwise.
- .4 Provide thrust bearing rating compatible with the loads imposed by the driven equipment.

# 2.8 Two Speed Motors

.1 Not used.

# 2.9 Power Factor Correction Capacitor Sizing

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

#### 2.10 Motor Mounting

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

### 2.11 Finishes

.1 In accordance with **Section 11210-00**.

# 2.12 Equipment Identification

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

# .2 Nameplates

- Provide motor nameplates on engraved or stamped stainless steel. Include information enumerated in NEMA Standard MG1, paragraph 10.37, 10.38 or 20.60, as applicable.
- .2 Additionally, indicate:
  - .1 The ABMA L-10 rated life for the motor bearings for motors 37.5 kW and larger.
  - .2 The nominal efficiency for all motors.
  - .3 Class, Zone, group and UL frame temperature limit code for explosion-proof motors.
  - .4 Permanently fasten nameplates to the motor frame and position to be easily visible for inspection.

# 2.13 Spare Parts

.1 Provide maintenance materials and spare parts in accordance with **Section 11210-00**.

# 3. EXECUTION

# 3.1 Testing

- .1 Perform tests and document results in accordance with Division 16.
- .2 Test motor efficiency in accordance with CSA C390 and NEMA MG1, accounting for stray load losses, measured indirectly based on the IEEE method. Stamp efficiency on the motor nameplate.

# **END OF SECTION**

# 1. GENERAL

# 1.1 General Requirements

- .1 All equipment furnished under this Contract shall conform to the requirements for the ozone system as set forth in this Section, and subsections 11210-01 through 11210-08.
- .2 The ozone system including, but not limited to the equipment specified hereinafter shall be the end Products of one Manufacturer to achieve standardization for appearance, operation, maintenance, spare parts, and Manufacturer's services.

# 1.2 Work Included

- .1 This Section covers the work necessary by the Contractor to furnish, complete, the ozone systems specified herein, and as further specified in Subsections 11210-01 through 11210-08.
- .2 The Contractor shall be responsible for designing and furnishing a complete system, and for coordination all major equipment components. This includes, but is not limited to, proper sizing, testing, and performance of all system components. The system shall include, but not be limited to, the following:
  - .1 Ozone generators.
  - .2 Power supply units.
  - .3 Ozone master control panel.
  - .4 Particulate filters.
  - .5 Nitrogen boost skid.
  - .6 Cooling water system(s).
  - .7 Ozone dissolution system.
  - .8 Off-gas demisters.
  - .9 Off-gas pressure and vacuum relief valves.
  - .10 Ozone destruct units.
  - .11 Off-gas blowers.
  - .12 Complete ozone control system including all instruments, control panels/cabinets, as described in these documents.
  - .13 Automatic process valves.

- .14 All piping, valving, wiring and instrumentation between components that are mounted within a common skid.
- .15 All accessories and appurtenances necessary for a complete and operational system, whether specified or not, unless specifically excluded herein or part of a separate system supplied by others.
- .3 Calibration of all instruments provided under this Equipment Contract and all control loop checks.
- .4 The Contractor shall be responsible to provide PLC data signals between the ozone master control panel PLC and main plant control system. The main plant control strategy and the main plant operator interface displays shall be developed by others. The Contractor shall coordinate with the Control System Integrator to develop and test the signal interface between the Contractor supplied PLCs and the plant control system.
- .5 The Contractor shall provide all PLC and communication hardware including communication modules and industrial grade network switches for the ozone system.
- .6 Equipment tagging shall be according to Division 17.
- .7 The Contractor shall provide 2 L of each colour of finish paint with each equipment type for field touch-up painting.
- .8 The Contractor shall include colour cards, the name of the paint manufacturer and complete descriptive specifications for the proposed paint system with submittals.
- .9 The Installer shall touch-up any shipping or installation damage to the finish, following installation.

# 1.3 Work Not Included

- .1 Unloading and installation of the furnished equipment and accessories at the job site, with the exception of items to be assembled within the scope of supplied equipment, such as installation of the dielectric tubes, transformers, and electrical power connections between the ozone generators and power supply units.
- .2 All external gas piping between the liquid oxygen LOX storage and feed system and the oxygen gas filters; the pressure regulators and the ozone generators; and downstream of the generator skids to the ozone dissolution system.
- .3 All off-skid cooling water piping and open loop cooling water pumps.
- .4 The LOX storage and feed system will be leased by the City from the LOX supplier.
- .5 All external conduit and wiring between separate equipment/skid packages, unless otherwise specified.
- .6 Concrete equipment pads and grouting.

- .7 All non-skid-mounted isolation and process valves unless otherwise specified or shown on the Specifications.
- .8 Emergency generator: the emergency power system at 600 volt, three phase, 60 Hz for the entire plant, including the equipment supplied under this Contract will be supplied by others.

# 1.4 System Supplier and Manufacturers' Services

.1 See Section 11210-07, Ozone System Contractor Services, Section 11210-08, Ozone System Performance Testing, and Section 01650, Ozone Equipment Installation, for required services including installation assistance, inspection, equipment testing, start-up, installation certification and training of City personnel.

#### 1.5 Environmental Conditions

- .1 Each component shall be designed for the environmental conditions of the space in which the component is located. All ozone system equipment will be located indoors.
- .2 Indoor areas will be mechanically ventilated and heated, not air-conditioned. Temperatures in the equipment areas will be between 10°C and 40°C, and relative humidity will be as high as 100 percent.
- .3 Plant elevation is approximately 236.5 m above mean sea level (MSL).

#### 1.6 References

- .1 Design the ozone system equipment to conform to the latest editions or revisions in effect at the time of the bid submission of the applicable, codes, standards, and regulations from the following regulating bodies:
  - .1 American National Standards Institute (ANSI)
  - .2 American Society of Mechanical Engineer's (ASME)
  - .3 American Society for Testing and Materials (ASTM):
  - .4 Compressed Gas Association (CGA): Pamphlet G-4.1, "Cleaning Equipment for Oxygen Service".
  - .5 Canadian Electrical Code (CEC).
  - .6 IEEE: 519 Guide for Harmonic Control and Reactive Compensation of Static Power Converters.
  - .7 American Water Works Association (AWWA).
  - .8 American Welding Society (AWS).
  - .9 Canadian Standards Association (CSA).

- .10 Electrical Safety Authority (ESA).
- .11 The Instrument, Systems and Automation Society (ISA).
- .12 National Fire Protection Association (NFPA).
- .13 Electrical and Electronic Manufacturers Association of Canada (EEMAC).
- .14 Local codes, by-laws, and regulations.
- .15 National Electrical Manufacturers Association (NEMA)
- .2 Specific regulations for each equipment package are listed within the individual Specifications.

#### 1.7 Submittals

- .1 Submittals shall be made as required in Section 01300, Submittals.
- .2 Operation and Maintenance manuals in accordance with Section 01730 Ozone Operation and Maintenance Manuals.
- .3 Complete all documentation in accordance with Section 01650, Ozone Equipment Installation.
- .4 Shop Drawings: The following Shop Drawings shall be submitted for all equipment:
  - .1 Itemized bill-of-materials listing for all components, including spare parts.
  - .2 Make, model, weight, and power requirements of each equipment assembly.
  - .3 Complete catalogue information, descriptive literature, Specifications, and identification of materials of construction.
  - .4 Performance data.
  - .5 Detailed structural, mechanical, and electrical Drawings showing the equipment dimensions, size, locations of connections, weights of equipment, and space required for maintenance.
  - .6 External utility requirements such as air, water, power, and drain for each component.
  - .7 For pumps, performance test data curves showing head, capacity, horsepower demand, and pump efficiency over the entire operating range of the pump, from shutoff to maximum capacity. Indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the design point.
  - .8 Manufacturer's recommended vibration limits for blowers, compressors, etc.

- .9 Complete motor nameplates data, as defined by NEMA, motor, Manufacturer, and including any motor modifications.
- .10 Instrument data sheets, conforming to ISA-20.
- .11 Functional description of all instrumentation and controls including list of parameters monitored, controlled, or alarmed.
- .12 Power and control wiring diagrams, including terminal and wire numbers.
- .13 Description of diagnostic features being provided.
- .14 Descriptive literature for all control devices such as relays, timers, etc.
- .15 Proposed factory and field test descriptions in sufficient detail to fully describe the specific tests to be conducted and quantities measured to demonstrate full conformance to these Specifications.
- .16 Factory finish system.
- .17 Rated capacity of each component under the specified operating conditions.
- .18 The heat loads generated by the supplied equipment.
- .19 Noise levels of equipment.
- .20 Material Safety Data Sheets (MSDS) where required.
- .21 Color cards, the name of the paint Manufacturer, and complete descriptive Specifications for the proposed paint system. Colors will be selected by the City.
- .22 Manufacturer's recommended equipment storage and installation procedures.
- .23 Weld procedures.
- .24 Other data as required to verify all specified requirements.
- .25 Qualifications and experience records of proposed Contractor's or Manufacturer's representatives who will assist in testing of equipment and conduct training sessions at least 21 calendar days prior to furnishing services.

#### .5 Ozone Generators

.1 Detailed structural, mechanical, and electrical Drawings showing as a minimum the equipment dimensions, sizes, locations and weights (empty and flooded);materials of construction; types of connections (gas, cooling water, power, and controls); vibration requirements; anchor bolt requirements; design and test pressures; design temperature; space required for maintenance, clearance required for dielectric replacement and

- cleaning at both ends of generator, and clearance required for servicing other equipment.
- .2 For ozone generators, performance data curves showing ozone production versus applied power at the design gas temperature and coolant water temperature for percent ozone concentrations across operating range.
- .3 Requirements for feed gas quality, including percentage oxygen purity, nitrogen, dew point, hydrocarbons, particle contamination, temperature, inlet pressure, and operational pressure.

# .6 Power Supply:

- .1 Complete written, step-by-step power supply unit system operating description.
- .2 Complete power supply unit schematic (elementary) wiring diagram.
- .3 Wiring diagrams will show complete circuits and indicate all connections. Individual Drawings are required for each loop, each motor, and each PLC I/O card.
- .4 One-line diagram of 600-volt and 120 volt/208 volt power distribution system including all component ratings
- .5 System wiring and installation Drawings for all interconnecting wiring between furnished components of the system and for all interconnecting wiring between the related ozone system equipment and the equipment furnished under this Section.
- .6 Dimensions and internal component layout of the power supply unit.
- .7 Layout of power supply unit face and other features
- .8 Complete panel fabrication Drawings and details of panel dimensions, wiring, piping, and painting. Include overall dimensions, metal thickness, door swing, mounting details and front of panel arrangement on the panel and sub-panel Drawings to show general appearance with spacing and mounting height of instruments and control devices.
- .9 Power supply data including efficiency, input current, power factor, and applied voltage at rated input voltage and 25, 50, 75, and 100 percent of rated load.
- .10 Complete system rating including all nameplate data, continuous operation load capability throughout load range.
- .11 Complete inverter (power supply unit) rating; list any special features being supplied.
- .12 If the panel terminal designations, inter-device connections, device features and options, or other features are modified as a result of the fabrication process or factory testing, re-submit revised Drawings to the Contract Administrator prior to shipment of the equipment to the Work Site. Drawings to be provided in a format that is compatible with the City's Drawing system.

- .13 Calculations of individual and total harmonic current and voltage content at the point of common coupling to the power supply (which is defined as the point where the system is connected to the 600 V distribution connection point), and their percentage of rated (fundamental) current, generated by the ozone generator for each individual harmonic up to and including the 49th harmonic. Provide specific description of provisions, such as filtering and harmonic suppression, being made to ensure proper system operation when power factor correction capacitors are included in the system.
- .14 Should separate enclosures and equipment be necessary for harmonic filter elements, provide complete dimensional information including location of space for incoming and outgoing conduit, weight, maximum heat loss, and minimum current carrying capacity and recommended wire size for required interconnecting circuits.
- .15 Electrical harmonic and radio frequency interference (RFI) analyses consisting of detailed electrical calculations demonstrating compliance with the harmonic requirements specified herein. The analysis is to be sealed by an electrical engineer registered in the Province of Manitoba. For the purposes of the harmonic and RFI analyses, assume all units are operating as required to achieve rated system capacity.
- .16 Base harmonic distortion analysis on the condition in which all three ozone generators are running.
- .17 The harmonic and RFI analyses will include the following:
  - .1 All input data and assumptions including an impedance diagram illustrating the simulated system.
  - .2 Explanation of methods used to perform the analysis.
  - .3 Explanation of study analysis with specific recommendations on harmonic mitigation measures to achieve the specified limits.
  - .4 All calculations and computer printouts used to arrive at the conclusions and recommendations.
  - .5 Individual power supply unit harmonic content and combined total drives harmonic content reflected in the system supply voltage as a percentage of the 60 Hz fundamental under load conditions from no-load to full load in 10 percent load increments.

#### .7 Controls:

- .1 Control panel elevation Drawings showing construction and placement of operator interface devices and other elements.
- .2 Data exchange registers for ozone master PLC to the plant control system.
- .8 Cooling Water System

- .1 Equipment Drawings indicating, as a minimum, materials of construction, anchor bolt requirements, size, location, and loads, equipment weights, empty and flooded, heat exchanger outline dimensions, process connection locations and sizes, design and test pressures, and design temperature.
- .2 Heat exchanger plate arrangement diagram: An exploded view indicating the arrangement of plates for the purpose of disassembly and re-assembly of heat exchanger, as used in the cooling water system.
- .3 The heat exchanger data sheet shall indicate, as a minimum, hot and cold side fluids, flows, inlet and outlet temperatures, specific heats, specific gravities, viscosities, and pressure drops, heat transfer duty, surface, Log Mean Temperature Difference (LMTD), heat transfer rate, number of plates, and maximum number of plates for frame provided, as used in the cooling water system.

# .9 Off-Gas Destruct System

- .1 Preheater kW rating.
- .2 Catalyst manufacturer and material specifications.
- .3 Quantity of catalyst per bed, in kg.
- .4 Discharge gas temperatures.
- .5 Blower capacity and horsepower curves.
- .6 Blower motor size and other connected loads.
- .7 Headloss through entire destruct system at maximum gas flow.
- .8 Written sequence of operation.
- .9 Material Safety Data Sheets (MSDS) as may be applicable.

# .10 Nitrogen Boost

.1 Desiccant type and change intervals required.

# .11 Ozone Dissolution

- .1 A detailed Drawing of proposed ozone diffusion equipment layout for each basin showing gas pipe sizes and lengths, distances between distribution headers, and location of diffusers, supports, and expansion joints.
- .2 A complete assembly Drawing for the diffusers including materials of construction.
- .3 Gas flow versus pressure drop rating curve for the diffusers under new and aged conditions.

- .4 Calculations which delineate the design distribution of gas flow throughout the diffuser system and clearly indicate the difference in gas flow between individual diffusers over the specified design operating gas flow and pressure ranges.
- .5 Diffuser, diffuser connector, balancing orifices, and system head loss curves covering applicable range of gas flow rates.
- .6 Calculations showing that appropriate mixing will be achieved within the diffusion cells for minimum and maximum gas flow rates specified.
- .7 Required performance testing in factory for on-site for acceptance includes:
- .8 Certification of permeability testing and testing for uniformity of air distribution.
- .9 Certification that diffuser grid and manifold piping has been pressure tested as required.
- .10 Diffuser gas flow range units in m3/min (normalized to standard pressure and temperature).
- .11 Water blow-off diffuser gas flow range units in m3/min (normalized to standard pressure and temperature).

# .12 Quality Control Submittals:

- .1 Manufacturer's service reports during equipment fabrication.
- .2 Manufacturer's Certification of Compliance that the factory finish system is identical to the requirements specified herein.
- .3 Special shipping, storage and protection, and handling instructions.
- .4 Provide Manufacturer's printed instructions for installation of all equipment included in this Contract.
- .5 Operation and Maintenance Manual. (Refer to Section 01300 Submittals).
- .6 Suggested spare parts list to maintain the equipment in service for a period of one (1) year and five (5) years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
- .7 List special tools, materials, and supplies furnished with equipment for use prior to and during start-up and for future maintenance.
- .8 Submit seven (7) certified copies of the test results for each Factory Test to the Contract Administrator for review and acceptance. Each equipment item will not be shipped until the Contract Administrator has reviewed and accepted the Test results and advised the Vendor that the equipment is acceptable for shipping. Include in the Test reports the date of the Test, the Test equipment utilized, a list of all instrumentation and calibration

data, Test data presented in tabular form, list of all discrepancies and the corrective actions, and a summary of the Test results.

# 2. PRODUCTS

#### 2.1 General

- .1 Approved Contractors include (in alphabetical order):
  - .1 Fuji Electric Corp. of America.
  - .2 Mitsubishi Electric Power Products, Inc.
  - .3 Ozonia North America, Inc.
  - .4 Wedeco, Inc.
- 2 All skid mounted equipment to be mounted in such a way that connections for off-skid piping and wiring are easily accessibly and that equipment and instrumentation are accessible for maintenance.
- .3 All equipment, piping, valves, instruments, and electrical wiring to be mounted on a structural skid base, for a complete and function system in accordance with Manufacturer's installation instructions.
- .4 Structural skid base shall be designed for the live and dead loads associated with the equipment, and shall be suitable for loads during transport, lifting, and installation.
- .5 Gauges not directly mounted to piping shall be mounted on a common gauge panel on the skid. All gauges located 1.8 meters above finished floor shall be provided with remote indicating transmitters mounted on the common gauge panel not more than 1.2 meters from the finished floor. The gauge panel shall be of Type 316L stainless steel construction and shall be provided with indicating gauges (mechanical gauge with local readout only, or indicating transmitters) for all parameters as recommended by the Contractor.
- 6 Verify that each equipment component is compatible with all other components of the ozone system Equipment, that each equipment component is designed for the purpose intended, and that all ozone system Equipment components, piping, valves, and other devices are constructed of materials compatible for use with oxygen and ozone laden oxygen.
- .7 Design, fabricate, and assemble all equipment in accordance with accepted industry standards. Manufacture individual parts to standard sizes and gauges so that repair parts, furnished at any time, can be installed in the field. Provide parts that are interchangeable for like parts of duplicate units. Provide equipment that has not been in service at any time prior to delivery, except as required by tests.
- 8 Mount all skid mounted equipment using Type 316 stainless steel unistruts, Type 316 stainless steel hardware, etc.

- .9 Piping, valving, and all other equipment in oxygen and ozone gas service shall be cleaned in compliance with the Compressed Gas Association (CGA) Pamphlet G4.1, "Cleaning Equipment for Oxygen Service," latest edition and shall be of suitable materials for the appropriate service.
- .10 All components and materials of construction shall be suitable for the intended service. All parts in contact with either oxygen, ozone gas or ozone solution shall be Type 316 or 316L stainless steel, glass, Teflon, white Viton A, or other ozone-resistant material. Hypalon will not be allowed. For welded assembly use Type 316L stainless steel.
- .11 Pipe all drains on the skid to one hub drain for drainage off skid.
- .12 Except where otherwise specified, structural and miscellaneous fabricated steel used in equipment shall conform to CISC and CSA codes and standards. Design all structural members for shock or vibratory loads (for mechanical vibrations, not seismic vibrations).
- .13 Sound Pressure Level of all equipment not to exceed 85 dBA (corrected to free field conditions) when measured 1 meter in the horizontal plane from any major surface of the equipment and 1.5 meter from the floor with the equipment operating at any point up to and including rated load.

# 2.2 Operational Philosophy

#### .1 General:

- .1 Control of the ozone system is coordinated by a PLC located in the ozone master control panel. This ozone master PLC transmits control signals to the individual ozone equipment skids and valves, and exchanges system operation information with the plant control system. A local Human Machine Interface (HMI) terminal shall be mounted on the front of the ozone master control panel in order to provide operator access to the ozone control system. All critical controls and alarms will be made available to the plant control system by the ozone master PLC.
- .2 The total inlet water flow to both ozone contactors will be obtained from the plant control system. The flow through each ozone contactor will be calculated in the ozone master PLC by dividing the total ozone contactor inlet water flow by the number of ozone contactors online.
- .3 The ozone master PLC will determine when a contactor is online based on whether its respective inlet gate is open and on a signal from the ozone generator PLC that the ozone generator is online.
- .4 Ozone contactor influent and effluent gate status will be supplied to the ozone master PLC by the plant control system.

#### .2 Ozone Dose:

- .1 The applied ozone dose (in mg/L) is manually set by the operator through the plant control system Human Machine Interfaces (HMI) or from the ozone master control panel.
- .2 The ozone generator shall be designed for once-through use of oxygen and variable volume, constant concentration operation in response to ozone demand. Ozone demand is based on the applied ozone dose desired and the flow rate into the ozone contactors as provided to the ozone master PLC by the plant control system.
- .3 The number of diffuser rows on-line in the contactors will be determined based on the gas flow out of the generator and the normal operating gas flow range of the diffusers. In automatic mode, this operation will be controlled by the ozone master PLC. The ozone operator will also have the option of manually overriding the number of on-line rows at either the ozone master control panel or the plant control system HMI.

### .3 Ozone Gas Concentration:

.1 The applied ozone gas concentration (wt O<sub>3</sub>) is manually set by the operator through the main plant HMI or at the ozone master control panel.

### 2.3 Instrumentation and Control

- .1 The equipment provided under this Contract is intended to typically be operated and monitored from the plant control system. As such, many control components which might typically be provided as local indication or local operator interface for a locally operated system have been shown to be transmitters for this system. Additional components which are not specifically shown or specified as transmitters but which are necessary for proper remote operation and control of the equipment shall be provided at no additional cost. Transmitters shall be wired to the local control panel provided with equipment or ozone master control panel provided by the Contractor.
- .2 All communication between the ozone master PLC and other PLCs shall be via Modbus/TCP Ethernet. An industrial network switch shall be provided to connect the ozone master PLC to the plant control system fiber optic ring.
- .3 Instruments in oxygen and/or ozone gas service shall be made of the appropriate materials suitable for the service conditions. Install instruments according to Manufacturer's instructions.
- .4 120 VAC from an external UPS shall be supplied by others for all critical control devices in the control panel including, but not limited to, both skid mounted and non-skid mounted instrumentation and any associated 24V dc power supplies. Contractor to supply a list of the UPS loads required.
- .5 The ozone master control panel shall include a PLC as specified below with control and protective devices to monitor and control the operation of all ozone system components including, but not limited to the LOX system, ozone generator/power supply unit PLCs, cooling water systems, ozone destruct units, ozone analyzers, nitrogen boost unit, ozone

discharge flow, and flow control valves. The panel will include an industrial grade PC as specified below to provide local operator monitoring and control of the complete ozone system. During normal operation, the ozone master PLC will receive ozone flow command signals and ozone start and stop requests from the plant control system via Ethernet.

- .1 Programmable Controllers:
  - .1 All PLC's shall be Modicon Unity hot standby processors complete with the redundant processors. No substitutes. They shall be supplied with Ethernet communication modules in order to enable the PLC to operate as a peer on the Ethernet plant control network.
  - .2 Specific requirements of the PLC outlined in Division 17.
  - .3 Monitor data communications between the ozone master PLC and the plant control system by passing data bits ("heart beat" check).
- .2 Operator Controls and Interfaces: Provide an industrial grade PC with the following features:
  - .1 17 inch color flat screen LCD display.
  - .2 Membrane keypad.
  - .3 NEMA 4X (indoor only).
  - .4 Ethernet port.
  - .5 Provide programming software, license, and download cable.
  - .6 Display screens shall be configured to have the following capabilities:
    - .1 Display alarms and diagnostic data.
    - .2 Monitor system parameters.
    - .3 Operate all control loops in manual and switch loops from auto to manual.
    - .4 Operate all equipment and auxiliaries controlled by the PLC.
    - .5 Adjust PLC set points. (Alarm set point changes shall require PLC programming laptop).
    - .6 Read the status of all digital and analog I/O.

#### 2.4 Electrical

.1 All electrical Work shall comply with requirements of Division 16.

- .2 All electrical components with power requirements exceeding 2 kVA shall be powered at 600 volts, three-phase. Components 2 kVA and below may be powered at 208/120 volts.
- .3 The power supply units are to provide power to all ozone equipment, actuators, instruments, and associated accessories and appurtenances requiring a power supply included within this Specification Package. The power supply unit is to provide power to all power requiring units within ozone generation room and to the Nitrogen Boost Unit housed in the Blower Room
- .4 Provide a laminated copy of the final panel Drawings and wiring and place inside the corresponding panel.
- .5 Provide high efficiency type motors for electric motors greater than 7.5 kW. For electric motors greater than 89.5 kW, provide an efficiency greater than 94%.

# 2.5 Piping and Tubing

.1 Shop-install all piping and tubing within each skid mounted assembly. Unless otherwise specified, provide valves that are the Manufacturer's standard, suitable for the intended service conditions.

Service	Legend	Piping Material	Remarks	
Air High Pressure	AHP	Type 304 SST		
Air Low Pressure	ALP	Type 316L SST	All exposed piping shall be insulated.	
Cooling Water Return	CWR	Type 304 SST	All exposed piping shall be insulated.	
Cooling Water Supply	CWS	Type 304 SST	All exposed piping shall be insulated.	
Gaseous Oxygen	GOX	Type 316L SST	All exposed piping shall be insulated.	
Ozone Gas	OZO	Type 316L SST	All exposed piping shall be insulated.	
Ozone Off Gas	OZG	Type 316L SST		
Ozonated Water (Sample)	OZW	Type 316L SST		

- .2 Provide control and instrumentation tubing, fittings, and valves for instruments of Type 316 stainless steel as specified in Division 17.
- .3 Run all piping in vertical and horizontal planes. Arrange piping to ensure that undue stresses from thermal expansion are not transmitted to equipment components. Do not route piping in locations or at heights that will create tripping hazards or impede the required movement of WTP personnel.

- .4 Do not route water piping directly above power supply units.
- .5 Where possible, locate process valves, instrumentation, and other control devices that require regular operation and/or maintenance at an elevation 1.8 meters above finished floor. Instruments with local indication that are located above 1.8 m from floors shall be provided with remote indicators mounted not more than 1.2 meters from the finished floor.

### 2.6 Valves

- .1 All valves shall include factory-mounted operator, actuator, hand wheel, chain wheel, and accessories for a complete operation. All manual valves mounted 1.8 m above finished floor shall have operator extensions or chains located at an elevation of 1.2 m from the finished floor. Valves shall be same size as adjoining pipe and ends to suit adjacent piping.
- .2 Butterfly Valves for Oxygen, Ozone, Off-Gas, Air Low Pressure and Cooling Water Service:
  - .1 ANSI Class 150 flanged or wafer style, high performance type, Type 316 stainless steel body, Type 316 stainless steel single or double offset disc, Type 316 stainless steel shaft and taper pins, PTFE seat, PTFE stem packing, stainless steel with PTFE thrust washer.
  - .1 Manufacturers and Products:
    - .1 Dezurik; BHP Series.
    - .2 Fisher; A41 Series.
- .3 Ball Valves for Oxygen, Ozone, and Cooling Water Service:
  - ANSI Class 150 flanged style, ASTM A276 GR 316 or ASTM A351/A351M GR CF8M stainless steel body and end piece, full port ASTM A276 Type 316 stainless steel ball, reinforced PTFE seats, stainless steel stem, stainless steel lever operator with vinyl grip, rated 1,500-psi WOG, 150 psi SWP.
    - .1 Manufacturers and Products:
      - .1 Conbraco Apollo, 87-200 Series.
      - .2 CFF, SS3 Series.
- .4 Ball Valves for Air High Pressure Service and Ozonated Water Sampling System:
  - .1 Three-piece, ASTM A276 GR 316 or ASTM A351/A351M GR CF8M stainless steel body and end pieces, full port Type 316 stainless steel ball, threaded ends, reinforced PTFE seats, body seal and stem packing, stainless steel stem, stainless steel lever operator with vinyl grip, rated 1,000-psi WOG, 150 psi SWP.
  - .2 Manufacturers and Products:
    - .1 Nibco; T-595-S6-R-66-LL.

- .2 Conbraco Apollo; 86-500 Series.
- .5 Flow Control Valves for Oxygen, Ozone, and Cooling Water Service.
  - .1 ANSI Class 150 valves with flanged ends, Type 317 stainless steel body, heat treated nickel-or hard chromium-plated 317 stainless steel ball, reinforced PTFE flow-ring seal, reinforced PTFE with stainless steel bearings, and PTFE V-ring packing. Valve to have 300:1 rangeability and equal percentage characteristic.
  - .2 Manufacturer and Products:
    - .1 DeZurik; VPB V-Port Ball Valve.
    - .2 Fisher Controls; Design V150.
- .6 Check Valves for Oxygen, Ozone, and Cooling Water Service:
  - .1 Wafer style, swing check, Type 316 stainless steel body, Type 316 stainless steel disc, Type 316 stainless steel spring and other internals.
  - .2 Manufacturers and Products:
    - .1 Crane; Duo-Chek II.
    - .2 Or approved equal.
- .7 Pressure Relief Valves for Oxygen, Ozone, and Cooling Water Service:
  - .1 Pressure setting and capacity as determined by CONTRACTOR.
  - .2 Threaded cap, full nozzle design, threaded side outlet for piped discharge.
  - .3 Manufacturers and Products;
    - .1 Kunkle; Model 917.
    - .2 Or approved equal.

### 2.7 Safety

- .1 Design, manufacture, and provide all equipment with due regard to safety of operation, accessibility, and durability of parts. Design, manufacture, and provide all equipment to comply with all applicable OHSA, provincial, and local safety regulations.
- .2 Cover all belt or chain drives, fan blades, couplings, and other moving or rotating parts on all sides by a safety guard. Fabricate safety guards using 1.6 mm or heavier galvanised or aluminum-clad sheet steel or 12 mm mesh galvanised expanded metal. Design each guard for easy installation and removal. Provide all necessary supports and accessories for each

guard. Provide supports and accessories for safety guards, including bolts, manufactured of Type 316 stainless steel.

#### 2.8 Lubrication

- .1 Equipment shall be adequately lubricated by systems that require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during start-up or shutdown and shall not waste lubricants.
- .2 Provide lubricants of the type recommended by the equipment Manufacturer and provide lubricants in sufficient quantity to fill all lubricant reservoirs and to replace all consumption during testing, start-up, and operation prior to acceptance of equipment by City.

### 2.9 Accessories

- .1 Identification Plate: Securely mount one (1) 1.6 mm stainless steel identification plate on each component in a readily accessible and visible location. Provide the following information die-stamped on the plate: the identification tag number assigned to the component and the Manufacturer's name, model number, date of manufacture, serial number, and design conditions. Take care to not paint over the equipment tag.
- .2 Lifting Lugs: Provide lifting lugs for components weighing over 45 kg.
- .3 Anchor Bolts: Provide all anchor bolts for equipment supplied in this Equipment Contract.

### 2.10 Equipment Warning Signs

- .1 Permanent warning signs shall be provided by the Contractor and mounted on all mechanical equipment which may be started automatically or from remote locations. Signs shall be in accordance with Provincial regulations. Warning signs shall be 175 mm by 250 mm wide, colored yellow and black, on not less than 18-USS gauge vitreous enamelling stock. Warning signs shall be posted in accordance with the requirements of the 2003 International Fire Code.
- .2 Electrical warning signs as required by the CEC shall be provided. Factory-installed signs on electrical equipment are acceptable. Wording shall conform to CEC standards.

### 2.11 Actuators

- .1 Actuators shall be as specified by the Contractor, unless otherwise specified herein or in the detailed Specifications.
- .2 Actuators may be pneumatic or electrical. See the detailed Specifications for specific requirements for actuators supplied and installed as part of the ozone system.

### 2.12 Instrument Air

.1 Plant instrument air will be provided in both the ozone generator room and the blower room for use on pneumatic actuators or any instrumentation that may require pressurized air to function.

# 2.13 Spare Parts and Special Tools

- .1 Furnish complete all special tools, instruments, and accessories required for the proper maintenance and calibration of all equipment requiring periodic repair and adjustment. Furnish complete any special devices required for lifting or handling.
- 2 Spare parts shall be in suitable boxes clearly marked as to content.

### 3. Execution

# 3.1 Painting

- .1 Factory prepare, prime, and finish all steel (except stainless steel) and iron surfaces. Protect surfaces that will be inaccessible after assembly for the life of the equipment. Ensure all exposed surfaces are finished smooth, thoroughly cleaned, and filled as necessary to provide a smooth uniform base for painting. Paint surfaces beneath identification plates prior to attachment of identification plate to surface.
- .2 Coat machined, polished, and nonferrous surfaces that are not to be painted with a rust preventive compound, LPS-3, LPS Research Labs, Los Angeles, CA, or equal.
- .3 Prepare, prime, and paint surfaces to be painted as specified below. Field painting will be allowed for touch-up only, and required to correct all coatings damaged during shipping and installation.

SURFACE PREP.	PAINT MATERIAL	MIN. COATS, COVER		
ABRASIVE BLAST, OR CENTRIFUGAL	POLYAMIDE, ANTI- CORROSIVE	1 COAT, 2- 5 MDFT		
WHEEL BLAST (SSPC-SP-10)	EPOXY PRIMER	1 COAT, 3 – 5 MDFT		
	POLYURETHANE ENAMEL	2 COATS, 3 MDFT		

- .4 Provide 2 litres of each colour of finish paint with each equipment type for field touch-up painting. All touch-up field painting of equipment supplied with this Equipment Contract is the responsibility of the Contractor
- .5 Include colour cards, the name of the paint Manufacturer and complete descriptive Specifications for the proposed paint system with submittals. The City will select colours.
- .6 Provide holiday testing for repaired coatings, as per the recommendations of the coating Manufacturer and ASTM D5182 and NACE RPO 188 standards.

### 3.2 Cleaning

.7 Clean all equipment, piping, valves, instrumentation, and accessories in oxygen or oxygen/ozone service in compliance with the Compressed Gas Association (CGA) Pamphlet G-4.1, "Cleaning Equipment for Oxygen Service," latest edition. For items cleaned prior to shipment to the construction Site, provide proper packaging for protection from contamination. Provide directions for storage at the Site prior to installation. Pre-cleaned items shall not require further cleaning after installation only if they meet the requirements of the CGA.

# 3.3 Delivery of Equipment and Installation

- .1 The ozone system supplied under this Contract shall be installed by an Installation Contractor and shall be installed in accordance with the equipment Manufacturers' recommendations and directions. The Contractor, at his discretion, may be present to oversee installation of the equipment by the Installation Contractor.
- All equipment will be received, uncrated, and installed by an Installation Contractor at the job Site. Deliver in accordance with the Contract Work Schedule. Arrange for a representative of the Contractor to be present at the job Site during the unloading to inspect the delivered equipment and witness the unloading process. Provide on-site instruction for unloading of the ozone generator, power supply unit, and all other related equipment. Notify the Installation Contractor of any special items necessary for unloading any of the ozone system Equipment, such as special slings, spreader beams, etc. Supplying these special items for unloading shall be the responsibility of the Installation Contractor.

**END OF SECTION** 

### 1. GENERAL

### 1.1 Work Included

- 1 The Contractor shall design and furnish, three (3) ozone generation systems, following the requirements of these Specifications. Major equipment components to be furnished under this Section shall include, but not be limited to, the following:
  - .1 Three (3) ozone generators of equal capacity, two duty and one standby, and three (3) control panels including all local instrumentation and control.
    - .1 Three (3) power supply units (PSUs) with electric power supply equipment.
    - .2 Two (2, one duty and one standby) filters for the oxygen gas supply and two (2, one duty and one standby) feed gas pressure regulators.
    - .3 All actuated valves used for control of the ozone system equipment.

### .2 Work Not Included

.1 See Section 11210-00 – Ozone System General for Work not included relating to all equipment, instrumentation, accessories, and services including those specified herein.

### .3 .References

.1 See Section 11210-00 – Ozone System General for references to be consulted, relating to all equipment, instrumentation, accessories and services including those specified herein.

### .4 Submittals

### .1 General

.1 Include submittals for the ozone generators as part of the Submittal Package in accordance with Section 01300– Submittals.

# .2 Shop Drawings:

- .1 See Section 11210-00 Ozone System General for Shop Drawing requirements common to all pieces of equipment.
- .2 See Section 11210-00 Ozone System General for Shop Drawings specific to the ozone generators.

# .3 Quality Control Submittals:

.1 See Section 11210-00 – Ozone System General for Quality Control Submits common to all equipment, including those specified herein.

# .5 Design Criteria:

- .1 Maximum ozone production, kilograms ozone per day: Each generator shall be capable of producing at least 305 kg/day at a concentration of 10-12% (weight) and at least 458 kg/day at a concentration of 5-6% (weight).
- .2 Minimum ozone production, kilograms ozone per day: Each ozone generator shall be capable of producing as low as 50 kg/day.
- .3 Under normal operating conditions, Generator 1 will be dedicated to Contactor 1; Generator 3 will be dedicated to Contactor 2; and Generator 2 will serve as a backup to Generators 1 and 3. The duty units will alternate between Generators 1 and 2 and between Generators 2 and 3 on a regular basis to balance operating times. All three (3) ozone generators may operate simultaneously for a short time to allow the standby ozone generator to ramp up to the required ozone production before the duty ozone generator shuts down to serve as the standby unit. The following table outlines typical operating criteria:

Scenario	Plant Water Flow (ML/d)	Ozone Dose (mg/L)	Ozone Dose (kg/d)	Ozone Concentration (%)	Number of Contactors On-line	Number of Generators On-line
Maximum Plant Flow; Average Ozone Dose	407	1.5	610	10-12%	2	2
Maximum Plant Flow, Maximum Ozone Dose	407	2.25	915	10-12%	2	3
Maximum Plant Flow, Maximum Ozone Dose	407	2.25	915	5-6%	2	2
Average Plant Flow, Average Ozone Dose	258	1.5	386	10-12%	2	2
Minimum Plant Flow, Minimum Ozone Dose	100	0.5	50	10-12%	1	1

- .4 Under extreme taste and odour conditions, all three (3) generators may be used to generate ozone for both ozone contact trains.
- Normal operation will be variable volume, constant concentration operation to provide an operator determined applied ozone dose over variable water treatment plant flows.
- .6 The operating pressure of the ozone generator shall be determined by the Contractor.
- .7 The Contractor shall be responsible for sizing control valves (flow and or pressure control) to allow turndown for the full range of gas flows as required.
- .8 Downstream pressure losses are to be determined including the following: skid-mounted ozone outlet piping, fittings, valves, and instrumentation described in this

Specification; piping from the ozone generators to the ozone contact tanks; piping to the ozone dissolution system, including valves and instruments as described in these Contract Documents; and the ozone dissolution system with approximately 6.6 m of water depth over the diffusers.

- .9 Ambient Conditions: The ozone generators and power supply units will be located indoors in a ventilated and heated space. Ambient temperatures within the ozone generator room will be maintained between 10°C and 40°C and up to 100 percent relative humidity.
- .10 Inlet Oxygen Temperature: 32°C, maximum.
- .11 Open Loop Cooling Water Inlet Temperature: 2°C to 26°C.
- .12 Vessel Gas Side Design Pressure Rating: 172 kPa, minimum.
- .13 Vessel Coolant Water Side Design Pressure Rating: 241 kPa, minimum.
- .14 Maximum Coolant Water Side Pressure Drop: 34 kPa.
- .15 Maximum Gas Side Temperature Rise: 11°C.
- .16 Maximum Coolant Water Temperature Rise: 5.5°C.
- .17 Feed Gas Quality:
  - .1 Gaseous oxygen will be supplied at greater than or equal to 99.5 percent. This will be diluted using a side stream of air, outlined in Section 11210-05 Nitrogen Boost. The final ratio of nitrogen to oxygen in the feed gas to the generators shall be determined by the Contractor.
  - .2 Dewpoint Temperature: Less than or equal to minus 62°C.
  - .3 Particulates: Filtered to 10 microns.

# .6 Power Supply:

- 1.1 External power from normal utility supply/emergency diesel engine driven generator to each power supply unit will be provided at 600 volt, three phase, 60 Hz for main power distribution. In the event of normal supply failure to the respective power supply unit, the emergency supply will come into operation over a 600-volt automatic transfer switch. Provide each power supply unit with a thermal magnetic circuit breaker equipped with a handle to be used as a disconnect which is lockable by a key-actuated mechanical interlock.
- .2 Provide a three-phase control power transformer in each power supply unit to meet all 120/208 volt AC power distribution requirements of the power supply unit and the corresponding ozone generator control panel. For any 24-volt DC power requirements within the panel, install redundant linear power supply units in the respective panel.

Provide internal panel lighting with door-operated switches of the 120-volt AC fluorescent type.

- .3 120 VAC from an external UPS, supplied by others for all critical control devices in the control panel including, but not limited to, both skid mounted and non-skid mounted instrumentation and any associated 24V dc instrument power supplies. Contractor to supply a list of the UPS loads required.
- .4 All Equipment and instruments supplied as part of the ozone system package will be powered from the power supply units as designed by the Contractor.

### 2. PRODUCTS

### 2.1 General

- .1 Provide equipment skid-mounted with all components pre-piped and pre-wired within the limits of the package so as to require a minimum of field installation, including, but not limited to, all electrical, instrumentation, and control systems as described in these Specifications and as shown on the Drawings. Items not to be skid mounted are shown on the Drawings as such.
- .2 Provide both the generator skid and power supply unit skid with single points of connection for cooling water supply and return, providing ANSI 150 class flanges drilled to B16.5 standards, and located at skid edge.
- .3 Ensure that the ozone generator equipment, including generator and power supply unit, will fit within the space allotted and will not require additional space for maintenance. Design the access doors to swing away from the gas ports and piping.
- .4 Each ozone generator shell and power supply unit with its associated local control panel shall have its own structural support system:
  - .1 Provide a skid made of a structural steel system to meet the requirements of ASTM A36 and capable of safely supporting and handling the specified equipment.
  - .2 Each supporting system shall be equipped with bolt holes to allow the supports to be mounted on a concrete slab.
  - .3 Factory assemble, prime and finish paint all skids and/or supports as specified in Section 11210-00 Ozone System General.

# 2.2 Oxygen Gas Particulate Filter

.1 Two gaseous oxygen cartridge-type particulate filters shall be provided, complete with valves and appurtenances. The filters shall be provided either in parallel in the gaseous oxygen supply piping at the ozone equipment room or one filter shall be provided on each ozone generator skid. If the filters are provided in parallel as part of the off-skid gaseous

oxygen supply piping, isolation valves shall be provided upstream and downstream of each filter, see Drawings.

- .2 The gaseous oxygen filter system shall have a design rating which will satisfy the following conditions:
  - .1 Gaseous Oxygen Flow Rate (Max): 570 m³/h or the gas flow associated with the maximum ozone production from three generators operating at 5-6% O<sub>3</sub> concentration, which ever is greater.
  - .2 Hydrostatic Test Pressure: 1034 kPa.
  - .3 Design Temperature: Plus 66°C to minus 46°C.
- .3 The filters shall retain particles greater than 0.1 micron in size with 98 percent efficiency and particles greater than 0.40 micron in size with 100 percent efficiency. The filter shall be fitted with a differential pressure indicating transmitter that will be wired back to the ozone master PLC for monitoring and alarming.
- .4 The filter shall be cleanable and replaceable and housed in a cylindrical Type 316 stainless steel shell with flanged connections, bottom pullout design, gas tight, quick-opening type. The shell shall be ASME Code designed and constructed. The filter, shell, and gasket materials shall be suitable and cleaned for oxygen service.
- .5 The gas pressure loss through the filter shall not be greater than 3.4 kPa when the filter is clean and not greater than 7 kPa when the filter is saturated at the maximum gas flow rate.

# 2.3 Pressure reducing station

- .1 Provide two on-skid pressure-reducing valves in parallel on the GOX inlet piping to each generator.
- .2 Size the pressure reducing station for the full range of gas flows.
- .3 The pressure reducing station shall decrease the pressure of the GOX entering the generators to the normal ozone generator operating internal gas pressure range determined by the Contractor.

#### 2.4 GOX Flow Measurement

- .1 Provide an on-skid mass flow meter on the GOX inlet piping to each generator.
- .2 The GOX flow meter shall measure the inlet GOX flow.
- .3 Provide an orifice flow meter in parallel with the mass flow meter for calibration purposes.

### 2.5 Ozone Generator

.1 Horizontal shell and tube, water-cooled, corona discharge type, medium frequency, multitube dielectric assembly contained in a pressure vessel with hinged, gas-tight access doors.

- .2 Ozone production shall be controlled by varying the applied voltage, frequency, or current.
- .3 Ozone shall be generated by passing oxygen through a uniform corona discharge produced by applying high voltage electrical current through a gap formed between two electrodes. The generators shall be designed for once-through use of oxygen.

### .4 Generator Construction

- .1 Construct all components including shell, tubes, bulkheads, flanges, supporting legs, and dished heads of Type 316L stainless steel.
- .2 Provide insulation on the exterior generator shell between the inside faces of the end flanges. Insulation shall be cellular glass, 38 mm thick, FOAMGLAS, Owens-Corning Fiberglass, or approved equal. Attach to generator shell and projecting piping connections per Manufacturer's instructions. Jacket shall be 0.4 mm aluminum.
- .3 Provide washers for all stainless steel nuts and bolts on access door flanges; lightly coat same with anti-seize compound prior to assembly.
- .4 Provide all stainless steel shell exteriors, including the access doors, buffed to a uniform No. 2B finish.
- .5 Double butt-welded seam construction. All weld scale should be removed and the surface ground and polished, pickled and passivated.
- .6 Design the ozone generators, including the shell and tube, to safely withstand an internal pressure of 1.5 times the design operating pressure and to resist any thermal shock.
- .7 Design and construct the generator in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII, Unfired Pressure Vessels. Shell shall bear the Code stamp.
- .8 Registration of the pressure vessel with the Manitoba Department of Labour, and any other Authority having jurisdiction is the responsibility of the Contractor, including all fees and applications. Registration will include but is not limited to, the following:
  - .1 Ozone generator shell.
  - .2 Pressurized piping on skid mounted equipment.
  - .3 Pressurized fittings on skid mounted equipment.
  - .4 Pressurized valves on skid mounted equipment.
- .9 Provide at least one sight glass on each end cover (dished head) for viewing dielectrics while the generator is operating.
- .10 Hinges and davits shall be designed to support the weight of the dished heads in the full open or any intermediate position.

### .5 Dielectric Tubes:

- .1 Certify voltage breakage strength of not less than 1.5 times the maximum operating voltage under design conditions.
- .2 Open on at least one end.
- .3 Connect the dielectric tubes to the incoming power source with Type 316L stainless steel conductors.
- .4 Construct ozone generator dielectric tubes to resist thermal shock and to evenly distribute the applied electrical charge over the entire dielectric surface without arcing.
- .5 Provide protection for dielectric tubes to prevent shorting dielectric tubes from damaging the shell and the tube structure of the ozone generator.
- .6 Provide current measurement circuitry integral to the ozone generator power supply to annunciate dielectric tube failure as the cause of shutdown.
- .7 Provide one of the following systems, listed "fused" or "electronic", for protection of the equipment in case of a dielectric tube failure:
  - .1 Fused: Each dielectric shall be individually fused with fuses capable of interrupting within a time compatible with the necessary protection of all components of the power supply unit. When a dielectric fails, the short circuit created during the time necessary for the fuse to interrupt and clear the short-circuits shall not lead to any damage to the shell or power supply unit components. The impedance of the load shall be continuously monitored and compared to factory set limits leading to the shutdown of the ozone generator when the limits are reached. This protection shall be set in such a way that the generator will automatically stop when 10 percent of the dielectric tubes are not powered due to dielectric tube failure and/or individual fuse failure.
  - .2 Electronic: Provide short circuit protection which shall detect the short circuit when a dielectric tube fails and immediately shutdown the ozone generator within a time sufficiently short to avoid any damage to the shell or power supply unit components.

## .6 Electrical and Power Supply Unit

- .1 Provide a skid mounted power supply unit to serve each generator, containing all ozone generator electrical and control components for one generator, housed in a single environment and noise controlled enclosure.
- .2 The power supply units are to provide power to all ozone equipment, actuators, instruments, and associated accessories and appurtenances requiring a power supply included within this Specification Package. The power supply unit is to provide power

to all power requiring units within ozone generation room and to the nitrogen boost unit housed in the blower room.

- .3 Provide a power supply unit including, but not limited to, an input isolation transformer, a power controller, rectifier, inverters, reactors and output high voltage transformer, and harmonic mitigation equipment (if required).
- .4 Furnish all necessary high-voltage wiring and protection devices installed in the power supply unit package. Provide all circuit breakers and disconnect switches lockable in the "OFF" position with up to three locks.
- .5 Design all components, current carrying and otherwise, for a maximum surface temperature of 55°C when the ozone generator is operating at 100 percent of rated power capacity.
- .6 The power supply unit shall, as a minimum, include a transformer, an 18-pulse rectifier, and an inverter to produce a single-phase, medium frequency voltage from the 600-volt, three-phase, 60-Hz power supply. The enclosure for the power supply unit shall be NEMA 12 or better.
- .7 Provide the power cabling required to connect the high voltage transformer in the power supply unit and the ozone generator. The cable is to be rated for at least 5,000 volts and capable of the maximum voltage between the units.
  - .1 Terminate power cables in conduit at the generator within an EEMAC sized and CSA approved terminal box. Make terminations using compression lugs and prefabricated stress cones. Exposed power terminations will not be acceptable.
  - .2 Provide all necessary cables, lugs, and termination kits required for the power circuit installation.
  - .3 The installation of the power circuit will be performed by an Installation Contractor in the presence of the Contractor. The Contractor will be responsible for the performance of the completed installation.
- .8 Control panels and power supply units shall be provided which meet the Canadian Electrical Code.
- .9 Each generator must present a balanced three-phase load plus or minus 5 percent.
- .10 The ozone generators shall have a minimum true RMS power factor of 0.9 from 30 to 100 percent of rated output. The Contractor shall provide all equipment necessary to meet this requirement.
- .11 Current Harmonic Distortion at the connection point of the ozone system to the 600-volt, 60-Hz, three-phase supply shall not exceed the limits in IEEE 519-1992 Table 10.3 on the TDD=5 percent line, as modified for pulse count by paragraph 10.4, IEEE 519-1992, with the RMS of the ozone system fundamental load current used

- as IL. Provide current injection type static VAR compensators (Square-D Accusine or approved equal) as necessary to achieve this. Passive components such as reactors, capacitors, and filters are not permitted.
- .12 The inverter components shall be capable of sustaining a direct short circuit at its output terminals and automatically shutdown without damage to any component.
- .13 The power supply unit cabinet shall have separate compartments for low voltage, high voltage, and control. The cabinet shall be cooled to prevent the internal temperature from rising above 40°C assuming an ambient temperature of 38°C. Design compartments in accordance with recognized industry standards such as CSA and EEMAC. Use interchangeable plug-in printed circuit boards and power conversion components wherever possible. Provide gold-or silver-plated plug-in contacts.
- .14 Size all current carrying components of the power supply unit to carry at least 120 percent of the anticipated amperage when the ozone generator is operating at rated capacity. Under no loading condition will the applied electrical voltage field exceed 67 percent of the certified breakdown voltage of the dielectric tubes supplied. For the power supply unit, provide adjustable built-in capability to limit the current to the value required at 100 percent of the rated capacity of the ozone generator, to prevent damage to the power supply or the vessel in the event of an overload condition or a short circuit in the vessel.
- .15 Provide a power supply cabinet of EEMAC 12 or better construction, providing accessibility to all enclosed components from at least two directions. Provide cooling for the enclosure by internally filtered forced air-cooling system with a water-cooled heat exchanger or air conditioner unit; using water to directly cool the electrical components will not be accepted. The system will draw air either from the inside of the cabinet, the room, or from both, through a filter and cooling coil and discharge to power supply unit components requiring cooling. Provide filters of the disposable type and that are readily accessible for replacement. Provide cooling coils of copper tube and aluminum fin construction. Rate power supply unit components exposed to cooling water for a minimum of 860 kPa. Provide a means of collecting and draining accumulated condensation from the cooling coil. Ensure that the maximum heat rejection from a single generator/ power supply unit pair, with the generator operating at design ozone production capacity, is no greater that 40,000 Btu/hr under all ambient room conditions. Cooling water for the heat exchanger shall be from the closed side of the cooling water system. Any additional cooling equipment required to meet the maximum heat discharge requirements will be the responsibility of the Vendor, and all associated energy consumption will be included with the overall energy consumption in the equipment evaluation.
- .16 Mount an ambient temperature switch in the power supply unit enclosure; wire the switch to shut down the generator on high cabinet temperature.

- .17 Provide current–fed power supply units equipped as follows:
  - 1 Provide power circuits containing as a minimum:
    - .1 Network rectifier bridge.
    - .2 Iron-core smoothing reactor or smoothing capacitor.
    - .3 Inverter bridge.
    - .4 Closed-loop control circuit.
    - .5 Active power controller.
    - .6 Dry type HV transformer provided with vibration isolators.
  - .2 Provide an electronic protection system containing as a minimum:
    - .1 Rectifier or inverter over current protection.
    - .2 Over voltage protection at the ozone generator shell, at the smoothing capacitor, and at the low voltage resonant circuit capacitor.
    - .3 Over frequency protection.
    - .4 Over current protection.
    - .5 High voltage, short circuit protection.
  - .3 Provide the following inverter protection:
    - .1 Current Limitation: Constantly electronically monitor the output current and compare it to a factory set maximum trip detector as necessary to protect the thyristors.
    - .2 Short Circuit Protection (if required): Measure the off time in the thyristors. When the off time falls below 80 microseconds in any of the output circuits, the system is considered to have a short circuit and ensure that the inverter is tripped from service and shutdown all current and voltage to the primary of the transformer.
    - .3 Impedance Protection (if required): Continuously monitor the impedance of the load (inductive and capacitative load of the transformer and generator) and compare to factory set limits. Ensure that variance beyond the factory set limits results in a shutdown.
    - .4 Continuously monitor voltage and frequency and compare with factory set limits.

- .18 Provide voltage-fed power supply units equipped as follows:
  - .1 Provide power circuits containing as a minimum:
    - .1 Network rectifier bridge.
    - .2 Choke input capacitor bank filter.
    - .3 Inverter bridge.
    - .4 Repetition rate frequency controller.
    - .5 Step-up transformer.
  - .2 Provide an electronic protection system containing as a minimum:
    - .1 Rectifier over current protection.
    - .2 Line over voltage/under voltage protection.
  - .3 Provide the following inverter protection for voltage-fed units:
    - .1 Factory set the maximum frequency and power. Provide controls to restrict operation to these maximum values.
    - .2 Provide the step-up transformer with a high temperature limit switch.
    - 3 Provide the inverter with an electronic fault sensor that will lock-off operation when a fault occurs.
- .19 Size all components conservatively with respect to design operating current and frequency to ensure long life under the specified operating conditions. Design transformer insulation system for a maximum ambient temperature of 40°C and an average coil rise of 150°C. However, be conservative in the transformer design, such that average coil rise does not exceed 80°C at the transformer's rated kVA capacity. Provide lifting lugs, rolling trays, or other acceptable means to facilitate the removal and installation of transformers with a standard forklift.
- .20 Provide the power supply unit with all appropriate protection against damage to the power supply unit and generator under reasonably foreseeable conditions including, but not be limited to:
  - .1 Provide an automatic current limiting device to limit the current controlled by the power supply unit under any operating condition, including surge or short circuit, to the maximum combined design current of the power supply unit and generator.
  - .2 Provide an automatic ramp-up control limiting the speed of rate change from one power setting to another.

- .3 Provide overvoltage protection of the rectifier and inverter.
- .4 Provide overvoltage protection at the generator, at the smoothing capacitor, and at the low voltage resonant circuit capacitor (if applicable).
- .5 Provide overfrequency protection.
- .6 Provide overcurrent protection.
- .7 Provide automatic shutdown on high temperature in the incoming isolation and high voltage transformers.
- 8 Provide fail-safe control circuits to maintain last control settings upon failure of control logic.
- .9 Provide a safety interlock on the power supply cabinet to prevent ozone generator operation while the power supply door is open.
- .10 Provide solid-state power relays for overcurrent, overfrequency, ground fault, high temperature, and other protective features described herein. Use three phase relays, where appropriate, as manufactured by Basler, or approved equal.
- .11 Provide each power supply unit with all necessary equipment to protect the power supply unit and the power system behind the point of common coupling, from voltage distortion and line notching. Design each power supply unit to operate from a power bus that may contain up to 5 percent voltage distortion and 22,800-volt microsecond line notches as defined by IEEE 519. Design each single and combined set of installed power supply units to limit voltage distortion to a maximum total of 5 percent and 22,800-volt microsecond line notches, as defined by IEEE Standard 519. Provide detailed information and/or Drawings with submittals to show how the protection is accomplished.
- .21 Provide access to the power supply unit via the front of the enclosure through an approximately full-sized gasketed door with chromium-plated or stainless steel three-point latch and hinges.
- .22 Provide and install an electronic circuit monitor for each power supply unit.
- .23 Install and harness all control power, CT, PT, and communications wire within the equipment lineup.
- .24 Equip the electronic circuit monitors to accept inputs from industry standard instrument transformers (120 V AC secondary PTs and 5A secondary CTs).
- .25 Provide digital sampling of the current and voltage signals at a rate high enough to provide accurate rms sensing and valid data from waveform analysis beyond the 30th harmonic (fundamental of 60 Hz).

- .26 Store all setup parameters required by the circuit monitors in nonvolatile memory (no battery backup) and retain all setup parameters in the event of a control power interruption.
- .27 Maintain, in nonvolatile memory, a maximum and minimum value for each of the instantaneous values reported in the circuit monitor, as well as the time and date of the highest peak for all of the peak demand readings.
- .28 Equip the circuit monitors with an integral LED display to provide local access to metered quantities.
- .29 Report the following instantaneous readings by the circuit monitor:
  - .1 Frequency.
  - .2 Current, per phase rms.
  - .3 Current, 3 phase average rms.
  - .4 Current, apparent rms.
  - .5 Voltage, phase-to-phase and phase-to-neutral.
  - .6 Power factor, per phase.
  - .7 Power factor, 3 phase total.
  - .8 Real power, 3 phase total.
  - .9 Reactive power, 3 phase total.
  - .10 Apparent power, 3 phase total.
- .30 Report the following demand readings by the circuit monitor:
  - .1 Average demand current, per phase.
  - .2 Peak demand current, per phase.
  - .3 Average demand, real power.
  - .4 Predicted demand, real power.
  - .5 Peak demand, real power.
- .31 Report the following energy readings by the circuit monitor:
  - .1 Accumulated energy.

- .2 Accumulated reactive energy.
- .32 Report the following harmonic distortion readings by the circuit monitor:
  - .1 Individual and total current harmonic distortion values, up to the 30th harmonic.
  - .2 Individual and total voltage harmonic distortion values up to the 30th harmonic.
- .33 Connecting and networking circuit monitors: All data and calculated values shall be accessible to the generator PLC by means of an Ethernet port mounted on the monitor. Communication protocol shall be Modbus/TCP.
- .34 Configure and program each circuit monitor to provide the data list described above in a well-defined memory location. This data will be communicated via Modbus/TCP Ethernet to the ozone generator PLC.
- .35 Certification Description: All equipment shall be UL and/or CSA listed.
- .36 Acceptable power monitors shall be power measurement limited PML 7350, complete with display units and Ethernet card or approved equal.

## .7 Piping, and Valves:

- .1 Provide Type 316L stainless steel for oxygen and ozone piping, cleaned to CGA G4.1 standard.
- .2 Shop install all interconnecting piping and tubing within each skid-mounted assembly.
- .3 Provide ANSI 150 class flanged ends for all piping between skid-mounted equipment components and vent piping that is 65 mm in diameter and larger. For piping 50 mm in diameter or less, provide welded ends. All interconnecting piping will be supplied and installed by an Installation Contractor.
- .4 To control ozone gas flow, provide actuated stainless steel V-port ball valves.
- .5 Except where otherwise specified, provide stainless steel body and trim valves of Manufacturer's standard, appropriate for the intended service and compatible with connecting piping.
- safety valve with ozone resistant gasket material with capacity as required to provide thermal relief protection for gas side of generator for the condition in which the coolant inlet and outlet valves are closed and the generator is operating at maximum applied power. Provide a separate Type 316L stainless steel safety valve for overpressure protection for the condition where pressure regulating valves at the LOX vaporizer piping fail full open based on full flow conditions.
- .7 Cooling water pressure relief valve as required.

- .8 Provide a vent with stainless steel ball valve for depressurizing and purging each generator prior to maintenance. Provide a lock for each vent valve to prevent accidental opening during normal operation. Provide vent valve locks that are identically keyed on all generators.
- .9 As a minimum, provide the following valves and instruments on each generator skid:
  - .1 Ozone Generator Inlet:
    - .1 Manual isolation valve for oxygen and cooling water streams.
    - .2 Flow valves for oxygen and cooling water streams with visual indication, remote actuation and open/closed position switches.
    - .3 Pressure control valve(s).
    - .4 Pressure indicating transmitters with high and low set points. One each for the oxygen and cooling water inlet.
    - .5 ASME pressure relief valve (sized to relieve the full capacity of the pressure-regulating valve in the wide-open position with an inlet gas pressure of 345 kPa).
    - .6 ASME pressure relief valve for cooling water system.
    - .7 Mass flow indicating transmitter (thermal dispersion type) on the oxygen inlet.
    - .8 Cooling water flow indicating transmitter.
    - .9 Temperature indicating transmitters for each of the oxygen inlet and cooling water inlet.

### .2 Ozone Generator Outlet:

- .1 Pressure indicating transmitter with high-level set point on the ozone outlet.
- .2 Ozone temperature indicating transmitter.
- .3 Cooling water temperature indicating transmitter.
- .4 Ozone concentration analyzer.
- .10 All automatic operated valves shall be provided with a mechanical adjustment to limit the rate of change for opening and closing the valve. The Contractor shall be responsible to adjust the speed of these valves to address safety concerns

## 2.6 Instrumentation and Controls

- .1 General: All instrumentation, control and electrical components provided under this Section shall comply with the requirements outlined in Division 17.
- .2 Generator PLC: Each power supply unit shall be provided with an integrally mounted control panel. The panel shall include all control and protective devices and functions as recommended by the Contractor for a complete and operational system. Interlocks and alarms shall be determined by the Contractor. All application programming, in house testing, and start-up services of the PLCs, shall be performed by the Contractor. As a minimum, each panel shall incorporate the following general control concepts to allow interface with external systems and devices.
- .3 Programmable Controllers:
  - .1 The PLC to operate as a peer on the Ethernet peer-to-peer network. The PLC must be able to interface, communicate, and be programmed over the Ethernet networks.
  - .2 Specific requirements of the PLC are outlined in Division 17.
  - Monitor data communications between the ozone generator PLC and the ozone master PLC by passing data bits ("heart beat" check).
  - .4 Operator Controls and Interfaces:
    - .1 Provide an industrial grade operator interface computer with the following features:
      - .1 Color flat screen display.
      - .2 Membrane keypad.
      - .3 NEMA 4X (indoor only).
      - .4 Ethernet port.
      - screens shall be configured to have the following capabilities: 1) Display alarms and diagnostic data. 2) Monitor system parameters. 3) Operate all control loops in manual and switch loops from auto to manual. 4) Operate all equipment and auxiliaries controlled by the PLC. 5) Adjust PLC control set points (Alarm set point changes shall require PLC programming laptop). 6) Read the status of all digital and analog I/O.
    - .2 Each power supply unit panel shall be provided with the following face-panel mounted devices:
      - .1 Control power "ON/OFF" selector switch.

- .2 Power supply "RUNNING" pilot light.
- .3 Power supply "OFF" pilot light.
- .4 Power supply "FAULT" pilot light.
- .5 Manual/Automatic Modes of Control:
  - .1 Manual Mode (Implemented via control logic within the ozone generator PLC):
    - .1 Start and stop is manual.
    - 2 The generator produces ozone in response to a 4 to 20 mA control signal, manually controlled at the front of the power supply unit. The 4 to 20 mA signal corresponds to a 0 to 100 percent setting selected manually at the power supply unit panel.
    - .3 Generator oxygen inlet valve is locally operated within the power supply unit panel based on operator entered percent ozone concentration. Coolant water valves are locally operated within the power supply unit panel.
  - .2 Automatic Mode (Implemented via control logic within the ozone generator PLC):
    - .1 Generator starts and stops in response to manual or automatic control signals originating from the ozone PLC and transmitted via Ethernet to the generator PLC.
    - .2 Generator power level is controlled in response to manual or automatic control signals originating from the ozone master PLC and transmitted via Ethernet to the generator PLC.
    - .3 Inlet gas, outlet gas, and coolant water valves are operated in response to manual or automatic control signals originating from the ozone master PLC and transmitted via Ethernet to the generator PLC.
    - .4 The number of diffuser rows is controlled in response to manual or automatic control signals originating from the ozone master PLC and transmitted via Ethernet to the generator PLC.
    - .5 The ozone master PLC will control ozone generation levels within each ozone generator according to the ozone flow rates requested by the plant control system.
- .6 The ozone master control panel will calculate the required ozone gas flow rate and generator settings for each online ozone contactor by multiplying the operator entered dosage set point by the calculated ozone contactor inlet water flow.
- .7 Protective devices shall function in both the "Manual" and "Automatic" models. As a minimum, all protective devices as shown on the Drawings, or specified herein, shall be

furnished as part of each ozone generator and associated power supply and shall be connected to alarm and/or shutdown of the generator system as indicated. All alarms and protective trips shall be wired to PLC inputs. The following list provides general requirements to establish minimum acceptable alarming and shutdown criteria.

- .1 High-pressure differential alarm across the GOX particulate filter.
- .2 High dewpoint alarm.
- .3 High High dewpoint alarm and shutdown.
- .4 Low generator inlet oxygen flow alarm and shutdown.
- .5 High generator inlet oxygen temperature alarm only.
- .6 Low generator inlet oxygen temperature alarm only.
- .7 High generator discharge ozone temperature alarm only.
- .8 High High generator discharge ozone temperature alarm and shutdown.
- .9 Low generator coolant water flow alarm and shutdown.
- .10 Low power supply unit coolant water flow alarm and shutdown.
- .11 High generator coolant water outlet temperature alarm only.
- .12 High high generator coolant water outlet temperature alarm and shutdown.
- .13 High power supply unit coolant water outlet temperature alarm and shutdown
- .14 Power supply unit over-current alarm and shutdown.
- .15 Power supply unit over-voltage alarm and shutdown.
- .16 High power supply unit enclosure or component temperature alarm and shutdown.
- .17 Dielectric tube failure alarm and shutdown (if required).
- .18 Ozone leak detected by ambient analyzers:
  - .1 High level alarm
  - .2 High High level alarm shutdown and initiate emergency ventilation.
- .19 Oxygen leak detected by ambient analyzers: High-level alarm and initiate emergency ventilation.

- .20 High generator oxygen inlet pressure alarm.
- .21 Low generator inlet oxygen pressure alarm and shutdown.
- .22 High high generator inlet oxygen pressure alarm and shutdown.
- .23 High power supply unit coolant water pressure alarm and shutdown.
- .24 High generator coolant water pressure alarm and shutdown.
- .25 High dew point in inlet oxygen feed alarm and shutdown.
- .26 Ozone generator will not operate if ozone destruct system is not operating alarm and shutdown.
- .27 Cabinet door open alarm and shutdown.
- .28 Power supply unit transformer temperature high alarm and shutdown.
- .29 Power supply unit inverter temperature high alarm and shutdown.
- .30 Inverter Fault alarm and shutdown.
- .8 Emergency stop (Both local and remote initiated) alarm and shutdown.
- .9 Hardwired emergency stop push button to provide immediate generator shutdown in both manual and automatic modes.
- .4 Power supply monitoring (plus or minus 2 percent accuracy) as follows:
  - .1 Display incoming voltage with phase selector switch.
  - .2 Display incoming amperage with phase selector switch.
  - .3 Display incoming power (kW).
  - .4 Display outgoing frequency.
  - .5 Display outgoing voltage (high voltage going to ozone generator after high voltage step-up transformer. Provide appropriate potential transformers or calculate based on step up transformer ratio).
  - .6 Display outgoing amperage (amperage going to ozone generator after high voltage stepup transformer. Provide appropriate current transformers or calculate based on step up transformer ratio).
  - .7 Each power supply unit shall be supplied with a power monitor. The power monitor shall include a display, an Ethernet communication port, and shall be supplied with any special power supplies, current transformers and terminal blocks as needed. One (1)

complete set of programming software and programming cables will be provided by the Contractor.

- .8 One elapsed time 6-digit meter showing the total time in hours that the unit has been powered shall be supplied if the power monitor does not include this functionality.
- .9 All programming of the power supply monitor shall be the responsibility of the Contractor. The data from the power monitor shall be transferred to the generator PLC, properly scaled to metric engineering units and then transferred to the ozone master PLC.
- .5 Each generator PLC shall communicate to the ozone master PLC. Equipment status, control signals, and interlocks, shall all be communicated to the ozone master PLC.
- .6 If the power supply unit and generator are mounted on separate skids, the generator PLC shall be factory mounted on the power supply unit skid and factory wired to all power supply unit skid-mounted components. The generator skid shall be provided with a remote I/O rack and suitably sized terminal boxes to collect all electrical power and signal conductors from all generator skid-mounted components (power and signal in separate boxes) for communication to the PLC located within the power supply unit skid. Panel construction shall be NEMA 12 or better to match power supply construction. Internal and external components, assembly, and workmanship shall be as specified by the Contractor.
- .7 The generator/ power supply unit panel shall include a Modicon Unity PLC complete with redundant processors and Ethernet communication modules as specified in Division 17. Provide all necessary cables, connectors, termination, and software to allow monitoring of the power meter.

## .8 Power Supply Control:

- .1 Power supply on/off operation shall be controlled within the body of the power supply enclosure using a main line contactor or circuit breaker. Circuitry shall be provided to ramp thyristor "gating" to a minimum level prior to the contactor opening or closing. Power supply shall be equipped with main line and thyristor fuses for short circuit and overload protection.
- .2 Power supply feeders shall be suitably protected from faults and overloads and a disconnecting means shall be provided in accordance with CSA at the switchgear.
- .3 Signal isolation shall be provided.
- 9 The ozone generator shall be capable of being remotely started, stopped, and reset upon a condition which results in a shutdown of the generation system.

### .10 External Interfaces:

- .1 Provide the following discrete data outputs to the master ozone PLC, at a minimum:
  - .1 All status bits for ozone generators, valves, equipment, alarms, first out alarms, hand switch positions, purge, heartbeat signal, and emergency stop.
  - .2 Accept the following discrete data inputs from the master ozone PLC, at a minimum: Reset, run, stop, emergency stop, heartbeat signal, open/close signals for valves, start/stop signals for equipment, purge, alarm reset, and run timer reset.
  - .3 Provide the following analog data outputs in scaled metric engineering units to the master ozone PLC, at a minimum:
    - All values acquired from the circuit monitor including but not limited to input power, applied current, applied voltage, applied frequency.
    - .2 Dewpoint of inlet oxygen.
    - .3 Inlet gas flow.
    - .4 Outlet ozone concentration.
    - .5 Inlet gas pressure.
    - .6 Inlet gas temperature.
    - .7 Outlet gas temperature.
    - .8 Coolant water inlet temperature.
    - .9 Coolant water inlet pressure.
    - .10 Generator coolant water flow.
    - .11 Power supply unit coolant water flow.
    - .12 Generator coolant water outlet temperature.
    - .13 Power supply unit coolant water outlet temperature.
    - .14 Air temperature within the power supply unit.
    - .15 Ozone generator kW.
    - .16 Ozone production rate.
    - .17 Ozone generator kWh.

# .11 Functional Requirements:

- .1 All alarm lights and external interface signals shall be maintained until the event causing the alarm has been cleared and the RESET button has been pressed. Where alarms are indicated on the front of panels, the alarm shall have a silence button to shut off any audible alarms, but keep any illuminated alarm indications active until the cause of the alarm is corrected. The alarm indicating lights shall be of the push to test type. The OIT alarm annunciator function shall include an alarm silence button to shut off any audible alarms. Alarms shall remain active on the OIT alarm page until the cause of the alarm is corrected and the OIT alarm reset button has been pressed.
- .2 If the ozone generator is in the MANUAL or OFF mode, RESET shall occur when the local RESET button is pressed momentarily. If the ozone generator is in the PLC mode, RESET shall occur when the local RESET button is pressed or the PLC RESET input signal is momentarily TRUE.
- .3 PLC run signal will be a maintained output.
- .4 For an ozone generator trip condition, provide separate alarms indicating first out alarm condition. Any subsequent alarms shall also be indicated. There shall only be one first out alarm indication per shutdown.
- .5 Provide masking for all alarm conditions based on process conditions, e.g. if generator is not running, mask the low temperature alarm.
- .6 In the event power is lost, the ozone generator shall not automatically restart when power is restored; a RESET shall be required.
- A safety interlock shall be provided on the power supply unit and local control panel enclosures and the high voltage termination boxes to prevent generator operation when a door is open. Provide externally operable disconnect switch lockable in the OFF position to prevent access to high voltage components when power is connected.
- .8 Short circuit detection shall be provided to shutdown the ozone generator when a dielectric tube fails (if required).
- .9 The gas side low-pressure switch shall protect personnel from exposure to high voltage by preventing the main circuit breaker from closing when the head of the generator is open.

### 2.7 Accessories

.1 As specified in Section 11210-00, Ozone System General.

## 2.8 Factory Finishing

.1 As specified in Section 11210-00, Ozone System General.

# 2.9 Source Quality Control

- .1 Factory Inspections: Inspect control panels for required construction, electrical connection and intended function.
- .2 Factory Tests and Adjustments:
  - .1 Test all equipment and control panels actually furnished as specified in Section 11210-08, Ozone System Performance Testing. All skid-mounted equipment shall be pre-piped, pre-wired, and factory tested for proper functional performance, operation, and wiring.
- .3 Hydrostatic Test: Each ozone generator shall be subjected to a hydrostatic test prior to shipment. Shop test pressure shall be in accordance with ASME Section VIII pressure vessel code rating of the unit held for not less than 1 hour. Any leaks discovered during the test shall be repaired and the unit re-tested. Provide certified copy of test report. At the option of the City, hydrostatic test may be witnessed by the Contract Administrator or City.

## 2.10 Spare Parts and Special Tools

- .1 Supply the following:
  - .1 Dielectric Assemblies: 5 percent of one generator load, beyond those broken during initial shipment or installation.
  - .2 Dielectric Fuses (if used): 5 percent of one generator load.
  - .3 Gaskets: Two sets of all required gaskets (including bulkhead and connection piping) for each generator
  - .4 Gaskets: One (1) complete set of gaskets and O-ring seals for each cooling water pump.
  - .5 Sight Glass with Gaskets: One complete replacement set for one generator.
  - .6 Fuses and LED Type Light Bulbs: One (1) complete replacement set for one (1) generator. Two (2) complete replacement sets for one power supply unit.
  - .7 Relays and Timers: One of each size and type for one power supply unit.
  - .8 Control transformers and amplifiers: one of each size and type.
  - .9 Complete circuit board replacement set for one power supply unit.
  - .10 Dielectric Electrode Electrical Wire: 0.25 kg
  - .11 Compression Bolts: One set per heat exchanger, complete with all nuts, washers, collars, etc.

- .12 Provide one (1) set of cleaning equipment (brushes, extension rods, dams, and hoses, if required) for cleaning the dielectric tubes and the ozone generator stainless steel tubes, and sufficient cleaning fluid for one cleaning cycle of each generator.
- .13 Special Tools: One complete set of special tools required to dismantle equipment.
- .14 The Contractor shall supply its own ozone wet test kit and dew point cups during startup and performance testing. These instruments will remain the property of the Contractor.

### 3. EXECUTION

### 3.1 Installation

- .1 Provide Manufacturer's printed instructions for installation of all equipment except dielectrics to the Installation Contractor.
- .2 Installation of the dielectrics shall be performed by the Contractor. Proper installation of the dielectrics is to be completed prior to issuance of the Certification of Proper Installation. Coordinate timing of installation of the dielectrics with the Installation Contractor.

### 3.2 Shipping

.1 Items not to be skid mounted shall be shipped loose with the equipment.

# 3.3 Field Finishing

.1 All equipment is to be factory finished. Field painting of equipment shall be restricted to touchup painting only. Supply sufficient quantities of paint as may be necessary for field touchup painting. Field touchup painting will be performed by the Contractor.

# **END OF SECTION**

### 1. GENERAL

### 1.1 General

#### .1 Work Included

- .1 The Contractor shall furnish a skid mounted Cooling Water System, to cool the ozone generators and power supply units. The Contractor shall be responsible for designing and furnishing a complete cooling water system as specified herein. Major components of the equipment to be furnished shall include, but not be limited to the following:
  - .1 Three cooling water plate and frame heat exchangers.
  - .2 Three internal cooling loop pumps.
  - .3 Process instrumentation and controls required to operate valving to conform to the operating conditions and requirements specified herein and shown on the Drawings.
  - .4 Any other appurtenances not shown that are necessary for a completely operational cooling water system for the ozone generation system.

### .2 Work Not Included

- .1 See Section 11210-00 Ozone System General for Work not included relating to all equipment, instrumentation, accessories, and services including those specified herein.
- .2 All piping between the cooling water system skids and the generators and power supply unit skids, between the open loop cooling water pumps, the open-loop water source and the cooling water skid, and between the cooling water system skids and the open loop cooling water return, as outlined in the Drawings.
- .3 Supply of the open loop cooling water pumps.

# 1.2 References

- .1 National Sanitation Foundation (NSF) Standard 61
- .2 American Society of Mechanical Engineers (ASME).
- .3 American National Standards Institute (ANSI).
- .4 Tubular Exchanger Manufacture Association (TEMA).

## 1.3 Submittals

#### .1 General:

- .1 Include submittals for the cooling water system as part of the Submittal Package in accordance with Section 01300 Submittals.
- .2 Additional requirements per Division 17.

# .2 Shop Drawings:

- .1 See Section 11210-00 Ozone System General for Shop Drawing requirements common to all pieces of equipment.
- .2 See Section 11210-00 Ozone System General for Shop Drawings specific to the cooling water system.

# .3 Quality Control Submittals:

.1 See Section 11210-00 – Ozone System General for Quality Control Submits common to all equipment, including those specified herein.

## 1.4 Design Criteria

- .1 Size the cooling water system to accommodate the cooling requirements for three ozone generator/power supply units. Ensure that all three generator/ power supply units may be cooled at once.
- .2 Ensure that the allowable temperature rise in the cooling water across each equipment component complies with the recommendations of the Manufacturer.
- .3 Flow Rates and Pressures: Contractor to determine the required flow rates and pressures for the open and closed cooling water loop.
- .4 Open loop cooling water supply temperature range: 2°C to 26°C.
- .5 Ozone System Closed Loop Cooling Water:
  - .1 Pressure Drop: 34 kPa, maximum.
  - .2 Design Pressure: 862 kPa, minimum.
  - .3 Design Temperature: 93°C, minimum.
  - .4 Fluid: Distilled water.
- .6 Ozone System Open Loop Cooling Water:
  - .1 Pressure Drop: 34.5 kPa, maximum.

- .2 Design Pressure: 862 kPa, minimum.
- .3 Design Temperature: 93°C (200°F), minimum.
- .4 Fluid: Filtered process water.
- .7 Heat Transfer Rate: The cooling water system shall be designed to exchange the total amount of heat rejected to the closed cooling loop from three ozone generators and power supply units.

### 2. PRODUCTS

### 2.1 General

- .1 The cooling water heat exchanger will be used to remove heat from a closed cooling loop by transferring it to the open loop cooling water.
- .2 All materials of construction, adhesives, etc., shall be suitable for potable water service.
- .3 Use temperature controlled flow control valves to automatically monitor and control the open-side flows of cooling water to the cooling system.
- .4 Provide a single point of connection for cooling water supply and a single point of connection for cooling water return at each generator and power supply unit skid boundary. Splitting of coolant flow between the generator shell and the power supply unit shall be accomplished on the generator skid.
- .5 Provide closed loop cooling water additives, NSF Standard 61 approved, for use in potable water service to control biofouling and corrosion.
- .6 All heat shall be rejected to the cooling water. No fins external to the power supply unit cabinet or any other means of enhanced heat rejection to ambient atmosphere will be allowed.
- If additional pressure is required for the closed cooling water loop for cooling either the generator or power supply unit, the Contractor shall supply a boost pump on the skid to provide the additional pressure. Contractor shall size the closed loop cooling water pump such that it can accommodate a larger impeller to increase flow or head by at least 25%.

### 2.2 Heat Exchangers

- .1 The heat exchanger shall be plate and frame type with individual removable plates contained in a common carrier assembly. The heat exchangers shall be designed, manufactured, and tested in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, and shall be so stamped with the code symbol.
- .2 The heat exchanger shall be provided with a single pass, counter-flow, looped flow, U-arrangement.

- .3 The heat exchanger frame shall be sized to allow a minimum capacity expansion of 25 percent by addition of plates.
- .4 The process connection shall be studded port type designed to connect to ANSI B16.5 standard 150-pound raised face flanges. Bolt holes shall straddle vertical centerlines.

### .5 Materials

- .1 Plates: Plates shall be constructed of 316 stainless steel and shall incorporate nonclog patterns.
- .2 Gaskets: Gaskets shall be EPDM and shall be of a snap-on design or shall be attached to plates with an adhesive.
- .3 Frame, Supports, Carrying and Guide Bars:
  - .1 Frame support steel, carrying bar, and guide bar shall be of carbon steel construction.
  - .2 Where nozzles penetrate frame, a liner of the same materials as the plate shall be used.
- .4 Bolting: Compression bolts shall be alloy steel with an inert coating of zinc or cadmium to protect against corrosion.

### .6 Manufacturers

- .1 Alfa-Laval, Inc.
- 2 Graham Manufacturing Co., Inc.

## 2.3 Instrumentation and Controls

- .1 The cooling water system shall be controlled by the ozone master PLC. Equipment status, control signals, and interlocks, shall be wired to this PLC.
- .2 The open loop cooling water pumps will be controlled by the ozone master PLC. Start commands will be issued by the PLC when the pumps are required to operate. Pump running, ready and in computer control mode (from Computer-off-Hand switch) statuses will be wired from the pump back to the ozone master control panel. The Contractor shall program this functionality into the ozone master PLC and provide I/O and termination points in the ozone master control panel.
- .3 Ozone system shutdown based on the cooling water system failure will be initiated from the ozone master PLC.

#### **COOLING WATER SYSTEM**

## .4 Manual/Automatic Modes of Control:

- .1 Manual Mode (Implemented via an operator input on either the local HMI or a control room HMI and control logic within the ozone master PLC):
  - .1 Start and stop is manual.
  - .2 Open loop cooling water inlet valve and the internal cooling water circulation pump are manually controlled via operator inputs on either the local HMI or a control room HMI and control logic within the ozone master PLC.
- .2 Automatic Mode (Implemented via Control Logic within the ozone master PLC):
  - 1 The cooling water system starts and stops in response to system start and stop commands from the ozone master PLC.
  - .2 Open loop cooling water inlet valve and the internal cooling water circulation pump are operated automatically by the ozone master PLC.

#### .5 External Interfaces:

- .1 Provide the following discrete data outputs, at a minimum:
  - .1 All status bits for pumps, valves, equipment, alarms, first out alarms, hand switch positions, purge, heartbeat signal, and emergency stop.
  - .2 Start/Stop signal to open loop cooling water pumps.
- .2 The ozone master PLC shall be programmed to accept the following discrete data inputs via Ethernet communication from the plant control system, at a minimum: Reset, run, stop, emergency stop, heartbeat signal, open/close signals for valves, start/stop signals for equipment, start/stop signals from open loop cooling water pumps, purge, alarm reset, and run timer reset.
- .3 The ozone master PLC shall be programmed to provide the following analog data outputs via Ethernet communication to the plant control system in scaled metric engineering units, at a minimum:
  - .1 Open loop cooling water flow.
  - .2 Open loop cooling water temperature at heat exchanger inlet.
  - .3 Open loop cooling water temperature at heat exchanger outlet.
  - .4 Closed loop cooling water temperature at heat exchanger inlet.
  - .5 Closed loop cooling water temperature at heat exchanger outlet
  - .6 Closed loop cooling water flow.

#### **COOLING WATER SYSTEM**

.7 Closed loop circulation pump operational status.

#### 2.4 Electrical

- .1 Electrical: Meet the requirements of Division 16 Electrical
- .2 Power supply to the skid will be provided from the ozone power supply unit by the Contractor.
- 3 120 VAC from an external UPS shall be supplied by others for all critical control devices in the control panel including, but not limited to, both skid mounted and non-skid mounted instrumentation and any associated 24V dc power supplies. Contractor to supply a list of UPS the loads required.

## 2.5 Accessories

.1 Equipment Identification Plate: 16-gauge stainless steel with 6.5mm die-stamped equipment tag number securely mounted in a readily visible location.

# 2.6 Factory Finishing

.1 Prepare, prime, and finish paint all nonstainless steel surfaces such as carbon steel supports, etc., in accordance with Section 11210, ozone system general.

# 2.7 Spare Parts and Special Tools

.1 Supply the following:

Item	Quantity
Nozzle gaskets	Two per exchanger
Plate gaskets	Ten percent of a single exchanger's total
Compression bolts complete with all two nuts, washers, collars, etc.	Two
Complete set of keys, dowels, pins, etc.	One per cooling water pump
Complete mechanical seal	One per cooling water pump
Special tools required for maintenance and dismantling	One

## 3. EXECUTION

# 3.1 Field Quality Control

.1 Functional Tests: Test complete assemblies for proper alignment, connection, and operation.

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# **COOLING WATER SYSTEM**

# **3.2** Performance Tests:

- .1 Factory Testing: The heat exchanger shall be factory assembled and hydrotested to 1.5 times its design pressure. Certificates of hydraulic and thermal performance testing shall be submitted for review.
- .2 Performance test equipment as specified in Section 11210-08, Ozone System Performance Testing.

# **END OF SECTION**

## 1. GENERAL

#### 1.1 Work Included

- .1 The Contractor shall furnish three (3) off-gas destruct systems to destroy ozone off-gassed within the ozone contact tank. The Contractor shall be responsible for designing and furnishing the off-gas destruct system, following the requirements of these Specifications. Major components of the equipment to be furnished under this Section shall include, but not be limited to, the following:
  - .1 Four (4) off-gas pressure and vacuum relief valves (PVRV).
  - .2 Two (2) off-gas demisters, one (1) per contactor, and associated appurtenances as shown on the Drawings.
  - .3 Two (2) manual and two (2) automated off-skid isolation valves.
  - .4 Three (3) complete off-gas destruct skids.
  - .5 Process instrumentation and controls required to operate valving and off-gas destruct systems to conform to the operating conditions and requirements specified herein and shown on the Drawings.

## 1.2 Work Not Included

- .1 See Section 11210-00 Ozone System General for Work not included relating to all equipment, instrumentation, accessories, and services including those specified herein.
- .2 All external gas piping between the contactors and the demisters; the demisters and destruct skid; and piping downstream of the destruct system skid, as outlined in the Drawings.
- .3 PVRV installation in the contactor roof.

## 1.3 References

- .1 CGA Pamphlet 4.1
- 2 American National Standards Institute (ANSI), American Society of Mechanical Engineers (ASME), National Electrical Manufacturer's Association (NEMA).
- .3 Anti-friction Bearing Manufacturer's Association (AFBMA).
- .4 Occupational Safety and Health Association (OSHA) Couplings, belts, etc. shall include all-metal coupling guard.

## 1.4 Submittals

#### .1 General:

- .1 Include submittals for the off-gas destruct system as part of the Submittal Package in accordance with Section 01300 Submittals and Section 11210-00 Ozone System General.
- .2 Additional instrumentation and control requirements per Division 17.

## .2 Shop Drawings:

- .1 See Section 11210 Ozone System General for Shop Drawing requirements common to all pieces of equipment.
- .2 See Section 11210 Ozone System General for Shop Drawings specific to the off-gas destruct system.

## .3 Quality Control Submittals:

.1 See Section 11210 - Ozone System General for Quality Control Submittals common to all equipment, including those specified herein.

# 1.5 Design Criteria

- .1 The off-gas ozone destruct system shall receive moisture and ozone-laden oxygen and air from the top of the ozone contact basins, precondition the gas to eliminate moisture from being applied to the catalyst bed, and destroy the residual ozone prior to discharging the off-gas.
- .2 Each destruct system shall be sized to serve a single ozone contactor, with one system serving as a backup to the other two systems, operating singularly or in parallel under normal operating conditions.
- 3 Size the gas flow capacity of each demister, catalyst unit, and blower to handle all gas flows anticipated during normal operation up to and including a maximum gas flow of either 300 m<sup>3</sup>/hr or the gas flow associated with the maximum ozone production from one generator operating at 5-6% O<sub>3</sub> concentration, whichever is greater.
- .4 Each catalyst unit shall have a sufficient amount of catalyst to handle the maximum ozone production rate of one generator, assuming a 75 percent transfer efficiency into the water, or 115 kg/day ozone, whichever is greater.
- .5 The off-gas ozone destruct system shall be designed to maintain a pressure inside the contactor of minus 50 mm water column, under conditions stated here in.
- .6 Inlet Oxygen/Ozone Temperature Range: 2°C to 28°C.
- .7 Inlet Oxygen/Ozone Relative Humidity: 100 percent.

- .8 Maximum Ozone Concentration: 12 percent (or maximum concentration from generator, whichever is higher).
- .9 Power Supply: 600-volt, three-phase, 60-Hz.
- .10 The equipment will be located on top of the ozone contact tank in an enclosed area with the ozone generators. Ambient temperature will be between 10°C and 40°C. Relative humidity may be as high as 100%. Provide all components and controls suitable for low concentration ozone enriched atmosphere.
- .11 Minimum Demister Performance: Remove 99.9 percent of entrained droplets of size 3 microns or greater.
- .12 Maximum outlet ozone concentration in discharge 0.1 ppm (by volume).
- .13 Minimum Pre-heater Outlet Temperature: 17°Celsius (30°F) above incoming oxygen/ozone temperature.

## 2. PRODUCTS

## 2.1 Demister(s):

- .1 Furnish one demister for each of the two ozone contact basin off-gas lines. The demisters shall separate entrained moisture from the ozone vent gas.
- 2 Maximum Face Velocity at the Demister: 1.5 m/sec, or a maximum differential pressure drop of 19mm water column.
- .3 Materials
  - .1 Type 316L stainless steel wire mesh.
  - .2 Type 316L stainless steel support grid suitable for directly mounting the demister into the off-gas piping between two flanges.
  - .3 Gaskets shall be expanded PTFE or 100% White Viton A.
- .4 Manufacturers
  - .1 Koch-Glitsch York

## 2.2 Off-Gas Destruct Skid(s)

- .1 The destruct skid(s) will be used to destroy ozone in the off-gas for release to the outside.
- .2 Furnish three ozone off-gas destruct skids with all components pre-piped and pre-wired within the limits of the skid so as to require a minimum of field installation.

- 3 Supply the off-gas destruct skids(s) complete with pre-heater, catalytic destruct unit, blower, electric motor, motor starter, instrumentation, local control panel, flanged inlet and outlet piping connections, piping, valves, electric power feed, remote control, and status annunciation connections and all necessary appurtenances. All items listed to be mounted within the confines of the skid package(s).
- .4 Catalytic destruct unit(s) shall be thermal catalytic type for the destruction of ozone, employing a pre-heater to raise the temperature of the incoming oxygen/ozone prior to exposing it to the catalyst. Each catalytic destruct unit shall be provided with a full load of catalyst for each unit (shipped loose).
- .5 Any surfaces on the ozone destructor which operate with a surface temperature of more than 50°C shall be properly insulated and covered with 0.4 mm thick aluminum jacketing. Insulation shall be CSA rated, preformed, sectional, rigid cellular glass, FOAMGLAS as manufactured by Owens-Corning Fiberglas, or approved equal.
- .6 Maximum Face Velocity through Destructor: 0.7 m/sec.

#### .7 Pre-heater

- .1 Provide a pre-heater to increase the temperature of the gas a minimum of 17°C above incoming oxygen/ozone temperature.
- .2 Maximum Oxygen/Ozone Temperature Leaving Pre-heater: 60°C.
- .3 Provide an immersion type pre-heater mounted in the oxygen/ozone stream upstream of the catalyst bed.
- .4 Provide pre-heater of the gas tight design, with threaded compression fittings and non-asbestos synthetic washers to prevent leakage of gas into the terminal housing. Design the unit for use with moist ozone-laden oxygen gas.
- .5 Control pre-heater with temperature indicating controller. Controller shall be capable of differential temperature control and of providing a low temperature alarm in the event that the differential temperature drops below a preset amount. Pre-heater shall have a CSA approved SCR power controller that modulates the power to the pre-heater to maintain the differential temperature set point. Use of cycling on/off control of the heater to maintain a set point shall not be permitted. The power controller shall be installed within the control panel.

### .6 Materials

.1 Construct of 316 or 316L stainless steel with non-asbestos synthetic gaskets.

### .7 Manufacturers

.1 Watlow.

- .2 Chromalox.
- .3 Approved equal.

# .8 Catalytic Destruct Unit

- .1 The catalyst material shall be a non-hazardous based material suitable for catalytic ozone destruction at gas temperatures of 15°C and above.
- .2 Provide a differential pressure indicating transmitter across the catalyst bed.
- .3 Provide flanged inlet and exit connections, and a single threaded drainpipe and drain valve with each destructor.
  - .1 Provide catalyst trays or removable access panels in addition to fill and drain ports complete with shut off valves.

#### .2 Materials

- .1 Provide gaskets and seals that are resistant to oxygen, ozone, heat, and creep.
- .2 Use type 316L stainless steel construction.

#### .3 Manufacturers

- .1 Catalyst: Provide catalyst material manufactured by Carus Chemical Company, "Carulite".
- .2 Approved equal

## .9 Contactor Off-Gas Blower(s)

- .1 Off-gas blowers shall be single width, single inlet, non-overloading, non-sparking centrifugal type, for 600-volt, three-phase, 60-Hz operation. Blowers shall not be cantilevered.
- .2 Suction Pressure at Blower: To be determined by Contractor.
- .3 The off-gas destruct system shall be designed to automatically maintain a constant vacuum of 50 mm of water column inside the contactor. This may be accomplished using an automated vacuum control valve on the destructor skid; an automated "air bleed" valve between the catalyst bed and the blower; or by providing the blower with an adjustable frequency drive. The Contractor shall not rely on venting of the pressure/vacuum relief valves (neither the ones mounted in the off gas piping nor the ones mounted on the roof of the contactor) as a means of controlling the vacuum.
- .4 Losses to be included in head loss calculations for blower sizing include: approximately 20 m of piping and one line-sized isolation valve between the contactor and the destruct skid, and approximately 25 m of discharge piping from the destruct skid to the exhaust

vent outside the building. Assume that the off-gas pipe velocity will be limited to 10 meters per second.

- .5 Maximum Motor Speed of Blower: 3,600 rpm.
- .6 The blower housing shall have a drain connection at the low point and a cleanout door or other means to access its interior.
- .7 The wheel and shaft assembly shall be dynamically balanced at the factory prior to shipping. The first critical speed of the rotating assembly shall be not less than 125 percent of the maximum recommended speed.
- .8 Bearings shall be heavy-duty grease-lubricated antifriction type with an AFBMA L-10 rating of 100,000 hours continuous operation. Use bearing lubricant that is compatible with both oxygen and ozone.
- .9 Flexible connections shall be furnished for installation in the blower suction piping. The connection shall be flanged end to ANSI standards, full diameter for connection to the blower without the use of reducers.
- .10 Provide each blower with a continuous duty electric drive motor. Supply motors that are totally enclosed, fan-cooled (TEFC), squirrel cage induction type rated 600 volts, 60 Hz, 3 phase. Construct motors for a Class B temperature rise and use Class F insulation. Mount motors with adjustable base plates. Ensure that motors will not overload when blower operates at minimum inlet temperature, maximum inlet pressure, and minimum discharge pressure operating conditions. Connect motors directly to the blowers with a flexible coupling. Provide guards for all exposed rotating shafts and couplings. Locate motor starters in the respective field panel, including surge protection.
- .11 Blowers shall be direct connected to the drive motor by means of a flexible coupling. Each coupling shall have a power rating of not less than 1.25 times the motor nameplate rating when the misalignment is within the Manufacturer's tolerance limit. Coupling shall include all-metal coupling guard in accordance with OSHA requirements.
- .12 A differential pressure transmitter shall be provided with each blower to continuously monitor the blower performance. The transmitters shall be provided with all tubing, required fittings, and stainless steel shutoff cocks.

#### .13 Materials

- .1 Blower housing and wheel shall be cast aluminum.
- .2 Provide gaskets, seals, and other non-metallic components constructed of materials suitable for use with oxygen and ozone-in-oxygen (Teflon or White Viton A).

.3 Flexible connections for the blower suction piping shall be White Viton A or Teflon and Type 316L stainless steel, designed for 635 mm (25 inches) water column vacuum.

## .14 Manufacturers

- .1 Cincinnati Fan.
- .2 Howden Buffalo.
- .3 Approved equal.

# .10 Discharge Silencer

- .1 Provide one discharge silencer for use with each off-gas destruct skid.
- .2 Supply silencers of the straight-through annular adsorption type.
- .3 Supply silencers with a pressure drop not exceeding 25 mm of water column at the maximum air discharge rate specified

#### .4 Materials:

.1 Construct silencers of materials suitable for use with ozone-laden oxygen gas, with a high relative humidity.

## 2.3 Valves:

- .1 Pressure and Vacuum Relief Valve(s)
  - .1 Furnish four (4) off-gas pressure and vacuum relief valves (PVRV) to protect the ozone contact tank and off-gas system from extremes of pressure. Furnish two (2) PVRVs, one to be inserted on the roof of each contactor, and two (2) PVRVs to be inserted in the off-gas piping of each contactor above the demister.
  - .2 Size PVRVs to relieve at a pressure setting of 130 mm water column and a vacuum setting of 100 mm water column at a gas flow rate as high as the capacity of a single destruct blower.
  - .3 Each PVRV shall have a flanged connection to exhaust vent piping. Exhaust piping will be supplied and installed by an Installation Contractor.

# .4 Materials:

- .1 Type 316 stainless steel valve body and seat.
- .2 Teflon diaphragm.

- .5 Manufacturers
  - .1 Varec, 2020B.
  - .2 Shand and Jurs.
  - .3 Approved equal.

#### .2 Off-Skid Isolation Valves

- .1 Provide four (4) off-skid isolation valves: One (1) manual valve following each demister (2 total) and two (2) actuated valves on the interconnecting piping between the demisters and the destruct skids, see Drawings for specific locations. Valves will be shipped loose and installed by an Installation Contractor.
- .3 Within the off-gas destruct skid provide the following valves as a minimum:
  - .1 Provide two (2) off-gas inlet skid isolation valves per skid, one (1) manual and one (1) actuated.
    - .1 The actuated isolation valve shall also be a flow valve with remote actuation and open/closed position switches.
  - .2 Valving required for automated vacuum control to be determined by the Contractor.
  - .3 Provide one (1) check valve downstream of the blower.
    - .1 Double Disk Check Valve, 75 to 200 mm for ozone gas service.
    - Wafer style, suitable for mounting between two ANSI 150, B16.5 flanges. Type 316 stainless steel body, shaft, disk, and spring, Teflon seat, rated 1900 kPa at 38°C.
    - .3 Manufacturers
      - .1 Mueller Stream Specialty Model 72
      - .2 APCO Series 9000.
  - .4 Provide one (1) manual isolation valve downstream of the silencer.

# 2.4 Piping

- .1 Materials
  - .1 Inlet and outlet piping Type 316L stainless steel per Section 11210 00 Ozone System General.

# 2.5 Instrumentation and Control

- .1 All instrumentation, control, and electrical components provided under this Section shall comply with Division 17.
- .2 All control power shall be 120-volts, single-phase, 60-Hz.
- .3 As a minimum, provide the following instrumentation for each off-gas destruct system
  - .1 Off-skid instrumentation
    - .1 Pressure indicating transmitter with negative scale upstream of demister, with gauge protector.
    - .2 Differential pressure transmitter across each demister.
    - .3 Medium concentration ozone gas analyzer downstream of the demister.
  - .2 On-skid instrumentation:
    - .1 Heater inlet temperature indicating transmitter.
    - .2 Heater outlet temperature indicating transmitter
    - .3 Catalytic destruct unit differential pressure indicating transmitter
    - .4 Catalytic destruct unit outlet temperature indicating transmitter.
    - .5 Differential pressure transmitter across each blower
    - .6 Vent gas low concentration ozone analyzer on the blower discharge

## 2.6 Electrical

- .1 Electrical: Meet the requirements of Division 16 Electrical
- .2 Power supply to the skid will be provided from the ozone power supply unit by the Contractor.
- .3 120 VAC from an external UPS shall be supplied by others for all critical control devices in the control panel including, but not limited to, both skid mounted and non-skid mounted instrumentation and any associated 24V dc power supplies. Contractor to supply a list of the UPS loads required.

# 2.7 Programmable Controllers:

.1 Specific requirements for I&C hardware and software are detailed in Section Division 17.

2 The off gas destruct system shall be controlled by the ozone master PLC. All I/O shall either be hard wired to I/O cards located in the ozone master control panel (wiring by others. Contractor to provide I/O cards and termination points in the ozone master control panel) or wired to an ozone master PLC remote I/O rack located within the off gas destruct control panel (Contractor to provide rack, remote I/O communication modules, I/O cards, termination points for all off-skid I/O and wiring and termination points for all on-skid I/O).

# 2.8 Operator Controls and Interfaces:

.1 An HMI shall be installed within or near the ozone master control panel for local access.

## 2.9 Manual/Automatic Modes of Control:

- .1 All application programming, in house testing, and start-up services of the Contractor PLCs shall be performed by the Contractor. The Contractor shall supply an operating description and sample graphic screen printouts to the Control System Integrator for the purpose of operator interface configuration.
- .2 Manual Mode (Implemented via Control Logic within the ozone master PLC):
  - .1 Start and Stop is manual.
  - .2 Vacuum control responds to a manual set point received from the plant control system.
  - .3 Isolation valves are manually operated.
  - .4 Blower START/STOP is manual.
- .3 Automatic Mode (Implemented via Control Logic within the ozone master PLC):
  - .1 The off gas destruct system starts and stops in response to system start and stop commands from the ozone master PLC.
  - .2 Vacuum control responds to a manual set point received from the water treatment plant control system operator interface network.
  - .3 Isolation valves are operated automatically by the ozone master PLC.
  - .4 Blower START/STOP is controlled automatically from the ozone master PLC.
- .4 All protective devices shall function in both the "Manual" and "Automatic" modes. As a minimum all protective devices shown on Drawings, or specified herein, shall be furnished as part of each off gas destruct system and shall be connected to alarm and/or shutdown the off gas destruct system as required. The Contractor shall review the listing and make the final determination of alarms and shutdowns.

## 2.10 External Interfaces:

- .1 At each panel, provide the following operator controls and interfaces at the front of panel:
  - .1 Computer-Off-Hand selector switch for destructor (heater).
  - .2 CONTROL POWER ON indicating light. Destructor (heater) ON indicating light.
  - .3 Indication of destructor (heater) exit temperature.
  - .4 Destructor (heater) HIGH TEMPERATURE alarm indicating light.
  - .5 HIGH OFF-GAS TEMPERATURE alarm indicating light for gas at the catalytic destruct unit exit.
  - .6 LOW OFF-GAS TEMPERATURE alarm indicating light for gas at the catalytic destruct unit exit.
  - .7 Blower exit OZONE CONCENTRATION.
  - .8 HIGH OZONE CONCENTRATION alarm indicating light.
  - .9 Computer-Off-Hand selector switch for blower.
  - .10 BLOWER RUNNING TIME elapsed time meter.
  - .11 Blower ON indicating light.
  - .12 BLOWER MOTOR OVERLOAD alarm indicating light.
  - .13 Isolation valve open indicating light.
  - .14 Isolation valve closed indicating light.

## **2.11 Functional Requirements:**

- .1 At each panel, provide the following functions:
  - .1 All alarm lights and external interface signals shall be maintained until the event causing the alarm has been cleared and the RESET has occurred. Where alarms are indicated on the front of panels, the alarm shall have a silence button to shut off any audible alarms, but keep any illuminated alarm indications active until the cause of the alarm is corrected. The alarm indicating lights shall be of the push to test type.
  - .2 Motor overload relays shall manually reset. Restart of blower motor after an overload shall be disabled until the condition has cleared and the RESET occurred.
  - .3 RESET shall occur when the local RESET button is pressed momentarily, or a momentary reset is provided by the ozone master PLC. After a RESET, the ozone

master PLC shall not issue a RUN command until an external RUN command has been received.

- .1 The blower RESET shall occur when the local RESET button is pressed momentarily.
- .2 Stop destructor on HIGH HEATER or HIGH OFF-GAS TEMPERATURE alarm.
- .3 In the event power is lost, the unit shall automatically restart upon regaining power.
- .4 Disable LOW OFF-GAS TEMPERATURE alarm for a preset, adjustable time interval following start of temperature control.

#### 2.12 Electrical

- .1 Electrical: Meet the requirements of Division 16, ELECTRICAL.
- 2 External power supply to each destruct skid field panel will be provided at 600 volt, 3 phase, 60 Hz for main power distribution. Provide an incoming fused disconnect switch with a handle in each panel. Prevent enclosure door from being opened with switch closed and prevent switch from being closed with door open.
- .3 Three-phase, 60-Hz. 208/120-volt power shall be transformed from the 600-volt supply in the control panel furnished with the power supply unit to power all skid-mounted equipment and instruments which require 208/120-volt power.
- .4 120 VAC from an external UPS shall be supplied by others for all critical control devices in the control panel including, but not limited to, both skid mounted and non-skid mounted instrumentation and any associated 24V dc power supplies. Contractor to supply a list of the UPS loads required.
- .5 Include with the control panel a motor starter for the blower and power controller for the heater.

## 2.13 Spare Parts and Special Tools

- .1 Supply the following:
  - .1 Complete set of gaskets.
  - .2 Complete set of bearings
  - .3 One complete set of special tools required to dismantle equipment.
  - .4 One spare heater element.
  - .5 One set of fuses for each destruct skid.

.6 One full-vessel catalyst change for each destruct skid.

## 2.14 Factory Finishing

.1 Prepare, prime, and finish paint all non-stainless steel surfaces such as carbon steel supports, etc., in accordance with Section 11210-00, Ozone System General.

### 2.15 Accessories

.1 As specified in Section 11210-00, Ozone System General.

# 2.16 Source Quality Control

- .1 Factory Inspections: Inspect control panels for required construction, electrical connection and intended function.
- .2 Factory Tests and Adjustments: Test all equipment and local control panels actually furnished. All skid-mounted equipment shall be pre-piped, pre-wired, and factory tested for proper functional performance, operation, and wiring. Provide factory testing of instrumentation and control system per Section 11210-07, Ozone System Contractor Services. Factory tests may, at the option of the City, be witnessed by the City and/or Contract Administrator.

## 3. EXECUTION

## 3.1 Field Quality Control

- .1 Test complete assemblies for proper alignment, connection, and operation.
- .2 Clean all piping, valves and components to Manufacturer's requirements, or as per CGA G4.1 where Manufacturer's cleaning requirements are not specified.

# 3.2 Testing:

- .1 Test equipment as specified in Section 11210-07, Ozone System Contractor Services, and 11210-08, Ozone System Performance Testing.
- 2 Field measurements of the sound pressure levels from the equipment specified under this Section shall be performed in accordance with ANSI S1.13, Methods for the Measurement of Sound Pressure Levels.

# **END OF SECTION**

## 1. GENERAL

#### 1.1 Work Included

.1 The Contractor shall furnish one (1) nitrogen boost skid to provide a side stream of air to the ozonation system equipment. The Contractor shall be responsible for designing and furnishing the nitrogen boost system specified herein.

# 1.2 Work Not Included

- .1 See Section 11210-00 Ozone System General for Work not included relating to all equipment, instrumentation, accessories, and services including those specified herein.
- .2 All external gas piping between the nitrogen boost skid and the gaseous oxygen (GOX) feed to the generators, as outlined in the Drawings.

#### 1.3 References

- .1 The following is a list of standards which may be referenced in this Section:
  - .1 National Electrical Manufacturers Association (NEMA):
    - .1 NEMA 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
    - .2 NEMA MG 1, Motors and Generators
  - .2 American Society of Mechanical Engineers (ASME) Section VIII, Division 1.
  - .3 ASME/ANSI B31.3.

#### 1.4 Submittals

- .1 General:
  - .1 Include submittals for the nitrogen boost skid as part of the Submittal Package in accordance with Section 01300– Submittals and Section 11210-00, Ozone System Performance Testing.
  - .2 Additional requirements per Division 17.

## .2 Shop Drawings:

- .1 See Section 11210-00 Ozone System General for Shop Drawing requirements common to all pieces of equipment.
- .2 See Section 11210-00 Ozone System General for Shop Drawings specific to the nitrogen boost skid.

# .3 Quality Control Submittals:

.1 See Section 11210-00 – Ozone System General for Quality Control Submits common to all equipment, including those specified herein.

## 1.5 Design Criteria

- .1 The nitrogen boost skid is to produce a side stream of air to supplement the flow of GOX to the ozone generators ozone. Condition the gas to eliminate moisture prior to introducing the airflow to the GOX line.
- .2 Nitrogen boost skid(s) sizing and flow capacity to be determined by the Contractor based on ozone generator feed requirements.
- .3 Material Handled: Ambient Air.
- .4 Inlet Temperature: 5°C to 40°C.
- .5 Plant elevation is approximately 236.5 m above mean sea level (MSL).

#### 2. PRODUCTS

## 2.1 General

- 1 Furnish the nitrogen boost skid as a complete system that includes, but is not limited to the following items:
  - One (1) horizontal receiver with required safety valve, pressure gauge with block valve, automatic condensate drain with inlet strainer and isolation valve, and manual blowdown valve located at the low point in the receiver.
  - .2 Two (2) air compressors (duty/standby) with 1.0 micron inlet particulate filter(s)
  - .3 One (1) aftercooler.
  - .4 Two (2), particulate filters upstream of the air compressor.
  - .5 One (1), one (1.0) micron coalescing filter upstream of desiccant dryer.
  - .6 One (1) pair of pressure-swing desiccant dryer towers with muffler, pressure rated for a minimum of 1035kPa.
  - .7 One (1) 0.1 micron absolute particulate filter downstream of dryer.
  - .8 Pressure-reducing valve(s).
  - .9 Flow control valve(s).

- .10 One (1) orifice or venturi flow meter.
- .11 One (1) dew point analyzer.
- .12 One (1) outlet connection for nitrogen boost feed to GOX line.
- .13 One (1) check valve.
- .14 One (1) manual isolation valve downstream of all other elements on the skid prior to skid outlet.
- .15 Process instrumentation and controls required to operate the nitrogen boost unit to conform to the operating conditions and requirements specified herein and shown on the Drawings.
- .16 The system shall be preassembled with all associated valves, dryers, filters, instruments, wiring, local control panel, and piping on a skid prior to shipment to the field.

## 2.2 Air Compressors

- .1 Provide two (2) rotary type, oil free air compressors.
- .2 One hundred percent oil free. Lubricated compressors with oil removal filter will not be allowed.
- .3 Automatic unloading during start-up.
- .4 Mount motor and compressor on common steel base attached to receiver/tank with an adequate number of vibration isolators.
- .5 Compressor connected to motor by V-belt drive system with guard, and convenient method of belt tensioning.
- .6 Capable of operating continuously at an ambient and inlet air temperature of 40°C at specified output without overheating.
- .7 Equip with combination air intake filter/silencer, and discharge cushion chamber.
- 8 Provide valve assemblies that can be individually removed without disturbing the head and inlet or discharge piping.
- 9 Provide adjustable tapered roller bearings that can be mounted on each end of the crankshaft to take both radial and thrust loading.
- .10 Capacity: To be determined by Contractor.
- .11 Operating discharge pressure: To be determined by Contractor.

## .12 Air Receiver/Tank

- .1 One (1) horizontal air receiver with compressor assemblies mounted on tank.
- .2 Design working pressure: To be determined by Contractor.
- .3 Corrosion allowance: 1.6 mm.
- .4 ASME-rated pressure gauge with gauge cock.
- .5 Automatic condensate blow-down valve located at low point in receiver/tank.

# .13 Aftercooler (Air or Water-Cooled)

- .1 Receiver/tank mounted
- .2 Maximum working pressure of at least 1035 kPa.
- .3 Placed between compressor discharge and receiver/tank skid.
- .4 Rated capacity: To be determined by Contractor.

## .14 Air Compressor Controls

- .1 ON/OFF cyclic operation.
- .2 Enclosure: NEMA Type 4 panel for indoor installation to house complete control system including:
  - .1 Control power transformer.
  - .2 Computer/Off/Hand switch.
  - .3 Pressure switches.
  - .4 Relays.
  - .5 System pressure indicator.
  - .6 Indicating light(s).
  - .7 Combination Breaker Type motor starter (NEMA Size 1 minimum) with overload protection.
- .3 Control Panel: Mount in accessible location on receiver/tank.
  - .1 Prewired control components.
  - .2 Control Components: Operate on 120-volt ac power supply.

.3 Power Supply: 600 volts, 3-phase, 60-Hz.

#### .15 Materials

.1 Welded steel receiver bearing ASME code stamp with inspection openings shall be provided.

# .16 Manufacturers

- .1 Quincy; QRDS
- .2 Champion (GardnerDenver): MTO-II
- .3 Atlas Copco: SF Oil-free orbiting scroll compressor
- .4 Powerex : STS, or STD Scroll Tank Mount Air Compressors

# 2.3 Desicant/Dryer

- .1 General
  - .1 The desiccant material shall be a nonhazardous based material suitable for decreasing the moisture content of air.
  - .2 Provide desiccant trays or removable access panels for ease of desiccant replacement.
  - .3 The dryer shall achieve a minimum Pressure Dew Point (PDP) of -60°C on a continuous basis.
  - .4 Manufacturers
    - .1 Hankison
    - .2 Approved equal.

## 2.4 Accessories

- .1 Flexible Discharge Connection:
  - .1 Manufacturers
    - .1 Senior Flexonics (U.S. hose corp)
    - .2 Approved equal
- .2 Safety Valves:
  - .1 Relief pressure and capacity to be determined by Dryer Manufacturer.

## .2 Materials:

- .1 Bronze body, bronze base, disc with steel spring, top outlet, and malleable iron lifting lever. In accordance with ASME Code for Unfired Pressure Vessels.
- .3 Manufacturers:
  - .1 Consolidated.
  - .2 Crosby.
- .3 Automatic Condensate Blowdown Valve:
  - .1 Operation: Float-actuated snap action discharge valve.
  - .2 Furnish with inlet, vent, and drain connection.
  - .3 Working Pressure: 1035 kPa.
  - .4 Materials:
    - .1 Float and Lever Linkage: Stainless steel.
    - .2 Valve and Seat: Hardened chrome steel.
    - .3 Body and Cap: Cast iron.
  - .5 Manufacturer:
    - .1 Armstrong; No. 71A.
    - .2 Approved equal.
- .4 Pressure Control Valve:
  - .1 Cast iron body with neoprene diaphragm.
  - .2 Pressure regulator size and set point to be determined by Contractor.
  - .3 Manufacturers:
    - .1 Fisher
    - .2 Approved equal
- .5 Flow Control Valve:
  - .1 V-notch ball,

- .2 Globe
- .3 See Section 11210 Ozone System General
- .4 Manufacturer:
  - .1 Fisher
  - .2 Approved equal.
- .6 Flowmeter:
  - .1 An orifice plate or venturi flow meter shall be used.
  - .2 110 VAC, 60 HZ, 4 -20 mA output
- .7 Check Valve:
  - .1 See Section 11210 Ozone System General
- .8 Dew point analyzer:
  - .1 Supplied with filter, two isolation valves, exhaust coil, adsorber, visual moisture indicator, sensor holder, and cable.
  - $.2 100^{\circ}$  to  $+ 20^{\circ}$ C sensor range
  - .3 110 VAC, 60 HZ, 4 -20 mA output
  - .4 34 bar maximum pressure rating
  - .5 Polycarbonate NEMA 4X enclosure
- .9 Manual Isolation Valve
  - .1 See Section 11210 Ozone System General
- .10 Piping
  - .1 Shall be SST316L, as per Section 11210 Ozone System General

# 2.5 Instrumentation and Controls

- .1 All instrumentation and control components provided under this Section shall comply with Division 17.
- .2 The nitrogen boost skid shall be controlled by the ozone master PLC. Equipment status, control signals, and interlocks shall either be hard wired to I/O cards located in the ozone master control panel (wiring by others. Contractor to provide I/O cards and termination

points in the ozone master control panel) or wired to an ozone master PLC remote I/O rack located in the nitrogen boost control panel (Contractor to provide rack and remote I/O communication modules, I/O cards and termination points).

- .3 Specific requirements for I&C hardware and software are detailed in Division 17.
- .4 There will be no ozone system shutdown signals initiated from the nitrogen boost unit.
- .5 The nitrogen boost skid will be shutdown upon HIGH-HIGH dewpoint alarm.
- .6 Protective devices shall function in both the "Manual" and "Automatic" control modes. The following list provides general requirements to establish minimum acceptable alarming and shutdown criteria.
  - .1 HIGH dewpoint alarm
  - .2 HIGH HIGH Dewpoint alarm and nitrogen boost skid shutdown.
- .7 Manual/Automatic Modes of Control:
  - .1 Manual Mode (Implemented via control logic within the ozone master PLC):
    - .1 Start and stop is manual.
    - .2 One of the duplex air compressors is locally operated at the nitrogen boost skid control panel.
    - .3 The active compressor is chosen locally at the nitrogen boost skid control panel.
  - .2 Automatic Mode (Implemented via control logic within the ozone master PLC):
    - .1 The nitrogen boost system starts and stops in response to system start and stop commands from the ozone master PLC.
    - .2 The duplex air compressors are operated either automatically from the ozone master PLC.
    - .3 Air compressor switch over is based on an activity period determined by the Contractor and set in the ozone master PLC.

## .8 External Interfaces:

- .1 Provide the following discrete data inputs to the ozone master PLC, at a minimum:
  - .1 All status bits for compressors, valves, equipment, alarms, first out alarms, hand switch positions, pressure switches, purge, heartbeat signal, and emergency stop.

- Accept the following discrete data outputs from the ozone master PLC, at a minimum: Reset, run, stop, emergency stop, heartbeat signal, open/close signals for valves, start/stop signals for equipment, purge, alarm reset, and run timer reset.
- .3 Provide the following analog data inputs to the ozone master PLC in scaled metric engineering units, at a minimum:
  - .1 Duplex compressor operational pressure.
  - .2 Air receiver internal pressure.
  - .3 Airflow leaving the nitrogen boost skid.
  - .4 Dew point of air leaving the nitrogen boost skid.

#### 2.6 Electrical

- .1 Electrical: Meet the requirements of Division 16 Electrical
- .2 Power supply to the skid will be provided from the ozone power supply units by the Contractor. Provide redundant supply.
- .3 120 VAC from an external UPS shall be supplied by others for all critical control devices in the control panel including, but not limited to, both skid mounted and non-skid mounted instrumentation and any associated 24V dc power supplies. Contractor to supply a list of the UPS loads required.

# 2.7 Spare Parts and Special Tools

- .1 Supply the following:
  - .1 Air compressor V-belts: One (1) set.
  - .2 Dew point analyzer intake filter cartridges: Two (2) sets.
  - .3 Air intake particulate filter replaceable elements: Two (2) sets.
  - .4 Coalescing filter cartridges: One (1) set.
  - .5 Post desiccant particulate filter cartridges: One (1) set.
  - .6 Special tools: One set.

# 2.8 Factory Finishing

- .1 Prepare, prime, and finish coat in accordance with Section 11210, Ozone System General.
- .2 Furnish Manufacturer's standard enamel finish, color as selected.

# 2.9 Source Quality Control

- .1 Factory Inspections: Inspect control panels for required construction, electrical connection, and intended function.
- .2 Factory Tests and Adjustments: Test all equipment and control panel function.
- .3 Furnished and provide certified test results.

# 3. EXECUTION

## 3.1 General:

- .1 Install equipment on skid on vibration isolators in accordance with Manufacturer's instructions.
- .2 Piping: Equip with full-size discharge connection, check valve, and isolation valve.

## 3.2 Testing

- .1 Vibration Test:
  - .1 System shall not develop amplitudes of vibration in excess of Manufacturer's recommendations.
  - .2 Test with units installed and in normal operation.
  - .3 If units exhibit vibration in excess of the limits specified, adjust or modify as necessary. Units which cannot be adjusted or modified to conform, as specified by Manufacturer shall be replaced.
- .2 Test equipment as specified in Section 11210-07, Ozone System Contractor Services, and 11210-08, Ozone System Performance Testing.

# **END OF SECTION**

## 1. GENERAL

#### 1.1 Work Included

.1 The Contractor shall design and furnish a complete ozone dissolution system specified herein. The Contractor shall be responsible for, but not limited to designing and furnishing the diffusers, flow control valves, gas flow meters, valves, piping manifolds within the contactor and pipe supports within the contactor for the dissolution system in the two ozone contactor basins.

#### 1.2 Work Not Included

- .1 See Section 11210 Ozone System General for Work not included relating to all equipment, instrumentation, accessories, and services including those specified herein.
- .2 External gas piping between the ozone generators and the diffuser flow control manifold, and from the flow control manifold to the diffuser pipe manifold within the contactors, as outlined in the Drawings.

# 1.3 References

- .1 See Section 11210 Ozone System General for references to be consulted, relating to all equipment, instrumentation, accessories and services including those specified herein.
- .2 The following is a list of standards which may be referenced specifically in this Section:
  - .1 American National Standards Institute (ANSI)
  - .2 American Society for Testing and Materials (ASTM):
  - .3 Compressed Gas Association (CGA) Pamphlet G-4.1, "Cleaning Equipment for Oxygen Service".
  - .4 American Water Works Association (AWWA)

## 1.4 Submittals

#### .1 General

.1 Include submittals in accordance with Section 01300 – Submittals and Section 11210-00 Ozone System General.

# .2 Shop Drawings

.1 See Section 11210-00 – Ozone System General for Shop Drawing requirements common to all pieces of equipment.

.2 See Section 11210 – Ozone System General for Shop Drawings specific to the dissolution system.

## .3 Quality Control Submittals:

.1 See Section 11210 – Ozone System General for Quality Control Submits common to all equipment, including those specified herein.

# 1.5 Design Criteria

- .1 Provide a system layout and diffuser distribution that promotes uniform gas distribution and optimum ozone transfer within the dissolution cell (Cell 1) of each contactor. Floor dimensions of the ozone diffusion cell in each contact basin will be 2.5 by 11.0 m.
- .2 Four equal rows of diffusers shall be provided in each contactor. Rows two and three shall be looped together. Gas flow to rows two and three shall be controlled by a single flow control valve and flow meter combination. Gas flow to rows one and four shall be controlled by a dedicated flow control valve and flow meter for each row.
- .3 Multiple diffuser and generator operational modes may be used by the Contractor to deliver the required gas flows. This may involve altering the number of operating diffusers within the dissolution tank.
- .4 Furnish complete, engineered systems. Details such as header supports and spacing, diffuser spacing, etc., shall be defined by and be the responsibility of Contractor and shall be consistent with requirements in this Section.
- .5 Design the ozone dissolution system so that upon completion of installation, diffusers are level to within plus or minus 6.4 mm of a common horizontal plane.
- .6 Water depth above diffuser centerline: 6 m minimum, 7.2 m maximum.
- .7 Range of operating pressures: As determined by Contractor.
- .8 Ozone transfer efficiency: Minimum 90%.

## 2. PRODUCTS

## 2.1 General

- .1 Use Type 316L stainless steel for all metal components of the diffuser and distribution system, including piping, bolts, nuts, washers, fittings, and supports.
- .2 Design and furnish fixed header and ozone dissolution fine bubble system as a complete package including, but not necessarily limited to: droplegs, gas manifolds, distribution headers, diffusers, supports, drainlines, header joints, valves, controls, instruments, accessories, and miscellaneous appurtenances.

Each ozone diffuser system shall include a blow-off system as a means to dispel water from each row of the diffuser piping when a contactor's status is changed from off-line to on-line.

## 2.2 Piping

- .1 Piping shall be welded, grooved end or flanged, Type 316L stainless steel pipe as specified in Section 11210-00. Flanges shall be used to facilitate installation and removal of the piping and diffusers.
- .2 Piping shall be provided complete with all fittings, couplings, anchors, gaskets, bolts, nuts, pipe supports, end caps, connections, appurtenances, and accessories which are required for proper installation and system function in an ozone-containing environment.
- .3 The distribution manifolds and headers shall be shop fabricated to the greatest extent possible.
- .4 Provide expansion joints that allow movement in the vertical and horizontal directions as necessary in the manifold piping and diffuser grid.
  - Pipe sizing shall be such that, at the maximum airflow rate, the air velocity through the connection to the drop piping; manifold, and diffuser grid piping shall be less than 12 m/s and the air velocity through the diffuser grid piping shall be less than 3 m/s.
- .5 Piping to each diffuser flow control manifold, located in the ozone equipment room, shall include a provision for connecting other gases (such as plant instrumentation air) for diffuser testing purposes. Isolation valves shall be provided to facilitate diffuser testing.
- .6 The Contractor shall terminate the piping for the dissolution system in each of the contact cells at a flanged connection located 0.5 m from the contactor wall, and 0.5 m above the top of the diffuser grid.

#### 2.3 Diffusers:

- .1 Diffusers shall be fine bubble dome type consisting of a Type 316L stainless steel holder with orifice control nozzle, stainless steel bolt and washer, diffuser and bolt gaskets, and stainless steel threaded pipefitting. Do not use clips to hold down diffuser assemblies.
- .2 The diffuser shall be porous ceramically bonded alumina with a permeability of 0.85 to 1.5 standard cubic metres per minute per square metre of diffuser area per 25 mm of material at 50 mm water column pressure differential for 21°C air at 25 percent relative humidity.
- .3 Each diffuser assembly shall include flow control devices sized to provide equal flow distribution through the system.
- .4 Gasket material shall be Gore-Tex or White Viton A.

# 2.4 Pipe Supports:

.1 All pipe supports within the ozone contact basins shall be Type 316L stainless steel.

- .2 Pipe supports shall compensate for the sloping floors of the contactors to maintain all diffusers at the same elevation. Pipe supports shall be such that tops of diffusers are 300 mm above the high point of the contactor floor.
- .3 One support for each section of piping shall include an integral device for rotational adjustment during installation. All adjusting devices and mechanisms shall provide locking to secure the piping in position after final adjustment and alignment.

## 2.5 Instrumentation and Controls

- .1 General: All instrumentation, control, and electrical components provided under this Section shall comply with the requirements outlined in Division 17.
- .2 Both local and remote modes of control shall be available for the ozone flow control valves to each ozone contactor. Local control shall be available either from the actuator or from a local control station if the actuator controls are not easily accessible by an operator standing on the plant floor. Remote control shall be achieved through the ozone master PLC. A local Computer-Off-Hand switch shall determine whether the control valve is in the local or remote control mode.
  - .1 Computer (Remote) control mode general: Flow control valve position and resultant flow to each set of diffusers will be controlled by the ozone master PLC.
  - .2 Protective devices shall function in both the "Hand" and "Computer" positions of the C-O-H switch. As a minimum, all protective devices as shown on the Drawings or specified in the Detailed Ozone Specifications hereinafter, shall be furnished as part of the Contract.
- 3 Functional Requirements: All alarms shall be maintained until the event causing the alarm has been cleared and a RESET has occurred. Where alarms are indicated on the front of panels the alarm shall have a silence button to shut off any audible alarms, but keep any illuminated alarm indications active until the cause of the alarm is corrected. The alarm indicating shall be of the push to test type.

## 2.6 Electrical

- .1 Electrical: Meet the requirements of Division 16 Electrical
- .2 Power supply to the skid will originate from the ozone power supply unit.
- .3 120 VAC from an external UPS shall be supplied by others for all critical control devices in the control panel including, but not limited to, both skid mounted and non-skid mounted instrumentation and any associated 24V dc power supplies. Contractor to supply a list of the UPS loads required.

# 2.7 Spare Parts and Special Tools

.1 Supply the following:

ITEM	QUANTITY
Complete ozone diffuser assembly Including diffuser, holder, and gaskets	6
Gaskets	6 sets (diffuser gasket and bolt gasket)

## 3. EXECUTION

# 3.1 Testing

- .1 Factory Testing: Test diffuser grid and cell manifold piping to 172 kPa.
- .2 Field Test: After installation, the basins shall be filled with water to a depth not less than 150 mm above the top of the diffusers, and test gas will be applied to the dissolution system over the design range flow rates to check for leaks and uniform distribution. All leaks in the piping and diffuser assemblies shall be repaired and the system retested until all leaks have been satisfactorily repaired. Identify diffuser assemblies that are found to be defective; any defective diffusers may not be counted as a spare. Uniform distribution shall be demonstrated, and any maldistribution corrected as demonstrated by retesting.

# **END OF SECTION**

## 1. GENERAL

#### 1.1 Work Included

- .1 Provide, complete as designed by Contractor, all the instrumentation necessary to regulate, monitor, and control the flow of:
  - .1 Oxygen gas to each generator.
  - .2 Cooling water to each ozone generator/PSU.
  - .3 Air to each generator inlet oxygen gas piping.
  - .4 Ozone-laden oxygen gas to each ozone contactor.
  - .5 Ozone-laden oxygen gas to each ozone destruct system.
- .2 Provide ozone monitoring equipment as shown on Process and Instrumentation Drawings including but not limited to:
  - .1 Two dewpoint monitors: one to measure the humidity of the oxygen feed to the ozone generators downstream of the nitrogen boost feed introduction, and one to measure the humidity of the nitrogen boost feed alone.
  - .2 Two ambient oxygen monitors to measure the oxygen level in the Ozone Generation Room.
  - .3 Four ambient ozone monitors to measure the ozone level in the Ozone Generation Room.
  - .4 Three high concentration ozone monitors to measure the ozone concentration at the outlet of each ozone generator.
  - .5 Two medium concentration ozone monitors to measure the ozone concentration in the off-gas at the off-gas outlet at each contactor.
  - .6 Three low concentration ozone monitors to measure the ozone level downstream of each ozone destruct unit.
  - .7 Two dissolved ozone sampling systems, one for each contactor. Include four dissolved ozone monitors to measure the amount of ozone dissolved in water, two for each ozone contactor.
  - .8 Three gas mass flow elements to measure oxygen flow, one to each ozone generator.
  - .9 Six gas mass flow elements to measure ozone flow, three to each of the ozone contactors.

- .10 Two portable ozone leak detectors.
- .3 Other instrumentation and equipment required but not specified in this Section shall meet equipment requirements as specified in Division 17.
- .4 Calibration of instruments, performance testing, training, and start-up/commissioning services.

## 2. PRODUCTS

# 2.1 Dewpoint Analyzer

- .1 Dewpoint Analyzer will meet the following requirements.
  - .1 Type: Single output, NEMA enclosure, solid state design, loop powered display.
  - .2 Operation: Receive signal from probe and convert signal into an isolated 4 to 20 mA signal proportional to dewpoint level.
  - .3 Physical: NEMA 4 enclosure, local indicator, rack or wall mounted.
  - .4 Performance: Accuracy plus or minus 3°C, operating temperature −110°C to 60°C pressure dewpoint, repeatability plus or minus 1°C.
  - .5 Sensor Type: Thin film aluminum metal oxide, physical pressure rating to 5,000 psig.
  - .6 Manufacturer: Panametrics MIS 2, or approved equal.
- .2 A high dewpoint temperature alarm will be monitored by the Ozone Master System PLC. The PLC will shut down the generator if the alarm condition occurs.

## 2.2 Gas Flow Element and Transmitter

- .1 Flow element and transmitter will meet the following requirements:
  - .1 Unit will employ the thermal dispersion principles of operation with no moving parts and will be Factory Mutual approved.
  - .2 Provide flanged integral flow body sensor and flow conditioning plate to sense mass flow, compensating for changes in temperature and pressure. Use Type 316 stainless steel for all wetted parts.
  - .3 Use remote electronics housed in a NEMA 4X enclosure with integral digital LCD flow rate indicator. Flow range for indicator and analog output signal will be determined by Contractor.
  - .4 Factory calibrate the transmitter for process fluid, temperature and pressure as noted. Factory size the insertion length of the sensor element for best flow accuracy.

- .5 Transmitter will operate from 120V ac power and will provide an isolated 4 to 20 mA dc output signal linearly proportional to mass flow into a load impedance in the range of 0 to 600 ohms without load adjustments for a 24V dc supply. Provide system accuracy and repeatability of plus or minus 1 percent of full scale.
- .6 Manufacturer: Sierra or Kurz.

## 2.3 Ambient Oxygen Gas Monitor

- 1 The oxygen gas detection system will measure and display oxygen gas concentration in the ozone generating area. The system will provide audio and visual alarms when preset limits are exceeded. Provide relay output for alarms.
  - .1 Provide a system consisting of a monitor/readout unit and oxygen gas sensor units. House the monitor/readout unit in a NEMA 4X enclosure, suitable for wall mounting. Provide access to the inside of the enclosure, monitor front panel and wiring connections through a hinged, front facing, full length door. Supply the door with a shatterproof window of sufficient size to allow the viewing of all meters and alarm indicating lights. Provide wiring access into the enclosure via a removable entry plate on the bottom surface of the enclosure.
  - .2 Provide a range of 0 to 25 percent oxygen concentration by volume for the monitor/readout unit.
  - .3 Provide a three-digit LED display for the purpose of displaying the value of each sensor. Configure the readout to read any value between 0.0 and 99.0 and display units in percent.
  - .4 Supply the monitor with a separate indicating light for caution, warning and alarm for each oxygen sensor.
  - .5 Provide two separate alarm set point levels for each sensor.
  - .6 Provide a minimum of two relays for each set point level. Provide all relays with time delays adjustable from 0 to 15 minutes to prevent chatter or control oscillation. Provide form C relays, SPDT rated for 5 Amp resistive at 120V ac.
  - .7 The system will operate on 120V ac, 60-Hz.
  - .8 Provide an oxygen sensor of the electrochemical fuel cell-type, not requiring the periodic addition of reagents, and having a useful life for a minimum of 1 year.
  - .9 No periodic maintenance other than periodic checking of sensor unit function shall be required. Periodic sensor checking or actual adjustment of the sensor units shall be accomplished by one person at the sensor unit location.
  - .10 Manufacturer: Teledyne Analytical, Model 3350, or approved equal.

# **2.4** Ozone Monitor (Low Concentration)

- .1 Low concentration ozone monitors shall meet the following requirements:
  - .1 Provide an ozone leak monitor of the low concentration, ultraviolet absorption ozone photometer-type capable of measuring ozone concentration in air and oxygen between 0 and 10 parts per million by volume with repeatability of one percent or two digits, whichever is greater. Provide a unit with an accuracy of 3 percent or greater and a normal cycle time interval of 20 seconds or less. Provide a unit with a sample gas flow rate of a nominal 1 litre per minute. Provide a unit with an analyzer output signal drift of less than 0.5 percent per day and less than 1.0 percent per week.
  - .2 Provide an analyzer equipped with a microprocessor and that performs the ozone analysis based on the Beer-Lambert law.
  - .3 Provide an analyzer with temperature and pressure compensation.
  - .4 House the analyzer in a NEMA 4X wall-mount enclosure. Provide access to the inside of the enclosure, monitor front panel and wiring connections through a hinged, front facing, full length door. Supply the door with a shatterproof window of sufficient size to allow the viewing of all meters and alarm indicating lights. Provide wiring access into the enclosure via a removable entry plate on the bottom surface of the enclosure.
  - .5 Provide an analyzer capable of displaying and transmitting an output signal in multiple ranges over the ozone measurement range.
  - .6 Operate the analyzer on a 120V ac plus or minus 10 percent, 60-Hz. Provide the unit with an isolated 4 to 20 mA dc output capable of driving loads up to 500 ohms. Provide the unit with a built in indicator to display ozone concentration.
  - Provide two DPDT alarm relays for remote indication that can activate at individually adjustable set points of measured ozone level.
  - .8 Furnish the ambient monitors with integrally mounted sampling pumps, pressure regulating valves, rotameters, flow regulating valves, and appurtenances, as required.
  - .9 Acceptable Manufacture(s): IN USA, Inc., Series IN-2000, PCI Ozone 500 Series LC, or approved equal.

# 2.5 Ozone-In-Oxygen (High or Medium Concentration Monitor)

- .1 High or medium concentration ozone monitors shall meet the following requirements:
  - .1 Provide ozone-in-oxygen analyzer of a high concentration ultraviolet adsorption photometer-type, capable of measuring ozone concentration in air and oxygen between 0 to 15 percent by weight (high concentration) and 0 to 9,999 parts per million by volume (medium concentration) with repeatability of 1 percent or digit, whichever is greater. The accuracy of the unit will be 3 percent or better and the normal cycle time

interval will be 20 seconds or less. The sample gas flow rate will be a nominal 1 litre per minute. Analyzer output signal drift will be less than 0.5 percent per day and less than 1.0 percent per week.

- .2 Each analyzer shall be equipped with a microprocessor and shall perform the ozone analysis based on the Beer-Lambert law.
- .3 Each analyzer shall include temperature and pressure compensation.
- .4 .Each analyzer shall be housed in a NEMA 4X wall-mount enclosure. Provide access to the inside of the enclosure, monitor front panel and wiring connections through a hinged, front facing, full length door. Supply the door with a shatterproof window of sufficient size to allow the viewing of all meters and alarm indicating lights. Provide wiring access into the enclosure via a removable entry plate on the bottom surface of the enclosure.
- .5 Each analyzer shall be capable of displaying and transmitting an output signal in multiple ranges over the ozone measurement range.
- 6.6 Each analyzer shall operate on a 120V ac plus or minus 10 percent, 60-Hz. Provide each unit with an isolated 4 to 20 mA dc output capable of driving loads up to 500 ohms. Provide each unit with a built in indicator to display ozone concentration.
- .7 Provide each analyzer with two DPDT alarm relays for remote indication that can activate at individually adjustable set points of measured ozone level.
- .8 Supply filters on the sample-in line and zero gas line with each analyzer.
- .9 Provide each analyzer with an integral ozone destruction unit to prevent venting sampled ozone to the atmosphere.
- .10 Furnish each medium concentration monitor with an integrally mounted sampling pump, pressure regulating valves, rotameters, flow regulating valves, and appurtenances, as required to provide and maintain the sample volume within the analyzer manufacture's guidelines.
- .11 .Acceptable Manufacture(s): IN USA, Inc., Series H, PCI Ozone 500 Series HC, or approved equal.

# 2.6 Dissolved Ozone Analyzer and Sampling System

- .1 Dissolved Ozone Sampling System:
  - .1 Provide a complete, Contractor designed, dissolved ozone sampling system for each ozone contactor.
  - .2 The sampling system for each contactor shall have the following components: sample locations in cells 2 and 6, 2 sample pumps, flowmeters with low flow alarm, two

#### **OZONE SYSTEM INSTRUMENTATION**

dissolved ozone analyzers, and a sample panel. Off-panel piping to be supplied and installed by an Installation Contractor.

- .3 Sample pump shall be provided to carry the sample from the ozone contactor to the sampling panel located in the Ozone Equipment Room and discharge the sample back to the contactor. Sample pump shall provide a minimum flow rate of 20 L/min for the ozone analyzer. Size pump to provide adequate suction lift assuming a minimum water surface elevation in the ozone contactor of 242.0 m.
- .4 All equipment for the sampling system for each contactor shall be panel mounted on an aluminum plate with aluminum support channels. All mounting hardware shall be 316 stainless steel.

# .2 Dissolved Ozone Analyzer:

- .1 Provide an ozone-in-water analyzer/transmitter capable of the accurate determination of ozone-in-water in the range 0.0 to 10.0 mg/L. Provide a unit with a built-in LCD display with a minimum of 2 cm high characters. Provide an internal battery to maintain unit calibration in case of power failure. Use solid state electronics; supply all boards of the plug-in-type to allow for easy replacement.
- .2 House the analyzer/transmitter in a NEMA 4 enclosure. Provide access to the inside of the enclosure, monitor front panel and wiring connections through a hinged, front facing, full length door. Supply the door with a shatterproof window of sufficient size to allow the viewing of all meters and alarm indicating lights. Provide wiring access into the enclosure via a removable entry plate on the bottom surface of the enclosure.
- .3 Operate the unit on 120V ac, 60-Hz. Provide the unit with an isolated 4 to 20 mA output signal capable of driving loads up to 500 ohms, and dual form C alarm relay contacts rated for 2A at 125V ac. The unit will operate in an ambient environment of 2°C to 35°C with 95 percent relative humidity noncondensing.
- .4 Provide an ozone-in-water sensor of the electrochemical cell type. As ozone diffuses through the membrane, electrochemical reactions take place at the cathode and anode in the presence of the electrolyte. The resulting current flow is proportional to the amount of ozone diffusing through the membrane.
- .5 Provide an analyzer capable of operating in an ambient environment of 2°C to 35°C and at a water sample pressure up to 20 psig.
- .6 Provide a unit to produce accurate ozone readings of plus or minus 1 percent signal and sensor signal drift of less than 0.5 percent per month.
- .7 Supply a recharge kit for the sensors.
- .8 Furnish the sensors with an in-pipe flow chamber and appurtenances, as required, to provide a sensor mounting point in the ozonated water sample flow stream.

# **OZONE SYSTEM INSTRUMENTATION**

.9 Acceptable Manufacture(s): Orbisphere or Rosemount.

# 2.7 Portable Ozone Leak Detector

- .1 Provide two portable ozone leak detectors:
  - .1 Microprocessor controlled, thin film semiconductor ozone detector.
  - .2 Range: 0.01 to 1 ppmv.
  - .3 Hand held, battery operated, highly ozone specific, with built-in micro-pump.
  - .4 Acceptable Manufacture(s): IN USA, Inc., or approved equal.

# 3. EXECUTION – Not Used

## 1. GENERAL

#### 1.1 Work Included

- .1 Requirements for Contractor to provide services of the Manufacturers' Representative, and special services required of the Contactor and/or Manufacturer, that include, but are not limited to the following services:
  - .1 Submittal preparation,
  - .2 Services during detailed design,
  - .3 Factory testing,
  - .4 Field testing,
  - .5 Services during installation, and
  - .6 Training.
- .2 Only those Contractor services, including trips to the jobsite or training classroom, receiving prior written acceptance by the Contract Administrator, shall act to fulfill the specified services. Submit written requests to Contract Administrator at least twenty-one (21) calendar days prior to providing the services.
- 3 Coordinate Contractor's services with Contract Administrator to avoid conflict with other on-site activities.

#### 1.2 Submittals

#### .1 General:

.1 Include submittals from this section as part of the Submittal Package in accordance with Section 01300 – Submittals and Section 11210-00 Ozone System General.

# .2 Testing Plan:

- .1 Provide seven (7) copies of the proposed test schedules and plans at least thirty (30) calendar days prior to start of related testing for approval by the Contract Administrator. Include:
  - .1 List of all equipment to be tested.
  - .2 Tests which will be performed for each related piece of equipment.
  - .3 Test plan.
  - .4 Test procedure.

- .5 Time and date for each test in daily stages.
- .6 List of Subcontractors and Manufacturers present for each test.
- .7 Blank inspection reports for start-up check of the ozone system equipment for review by Contract Administrator. Revise inspection reports based on Contract Administrator's review.
- .2 Qualifications and experience records of proposed Contractor's or Manufacturers' Representatives who will assist testing of equipment and conduct training sessions at least twenty one (21) calendar days prior to furnishing services.
- .3 Completed Certificate of Satisfactory Installation, where specified for specific materials or equipment.
- .4 Test reports in format acceptable to Contract Administrator.
- .5 Certification of calibration of testing equipment, when so specified.

# 1.3 Services During Detailed Design

- .1 Refer to Section D16 of Part D Supplemental Conditions.
- .2 It is intended that process and instrumentation drawings, mechanical details, electrical drawings, narrative description of control system, summary of control functions, summary of monitoring functions, description of alarms, and other information to describe the control system, pertaining to the supplied equipment will be submitted by the Contractor to the Contract Administrator for inclusion in Contract Documents for other phases of this project, including the equipment installation Contract. Documents supplied by the Contractor shall be made to conform to the document standards of this project.

# **1.4** Factory Testing

- .1 Provide factory testing in the Manufacturer's shop, prior to shipment of the equipment to the jobsite location, as specified herein.
- .2 The equipment shall be given the Manufacturers' standard quality control inspections and tests to ensure that the workmanship and the quality of materials used in the manufacture of the equipment conform to the specified requirements. The factory test may be witnessed by the City and Contract Administrator, and the Contractor must prepare a final report to ensure the equipment meets the Specifications.
- 3 Testing of all equipment supplied under this Contract to ensure proper communication among local control panels prior to the ozone production testing.
- 4 Test each ozone generator with dedicated power supply unit to verify that the operation and performance meets the specified production and concentration criteria.
  - .1 305 kg/day at 10-12 percent weight concentration, 2-hour demonstration.

- .2 458 kg/day at 5-6 percent weight concentration, 1-hour demonstration.
- .3 50 kg/day at 10-12 percent weight concentration, 1-hour demonstration.
- For each generator, the minimum test data recorded will include the time, oxygen flowrate, inlet oxygen pressure, temperature, and dew point, ozone-in-oxygen concentration (percent by weight), ozone production (kg/d), power consumption (kW), power factor (pf), cooling water flowrate (L/s) and cooling water inlet and outlet temperatures (°C). The ozone concentration shall be monitored online and continuously, using ultraviolet analyzers. Analyzer accuracy shall be confirmed using approved Iodometric Method for the Determination of Ozone in a Process Gas developed by the International Ozone Association Standardization Committee.
- .6 Test ozone control system elements, both hardware and software, to demonstrate that ozone control system satisfies the requirements of this Specification, including:
  - .1 Loop-Specific Functions: Demonstrate functions shown on P&IDs, described in Specification Sections 11210-00 to 11210-08 and as required elsewhere in this Section.
    - 1 One of each type function; e.g., if there is sequence control for several identical items, demonstrate controls for one.
    - 2 One of each type of function in each control panel; e.g., but not limited to HMI-based annunciator operation, controller operation, and HMI-based recorder operation.
    - .3 All required and shown functions for 80 percent of loops.
  - .2 Non-Loop-Specific Functions:
    - 1 Capacity: Demonstrate that ozone control system subsystems have required spare capacity for expansion. Include tests for both storage capacity and processing capacity.
    - .2 Timing: Include tests for timing requirements.
    - .3 Diagnostics: Demonstrate online and offline diagnostic tests and procedures.
- .7 Any equipment that fails to meet the requirements specified herein shall be modified as necessary and retested from the start.
- .8 The factory testing shall be conducted at a location selected by the Contractor where the test can be conducted in strict accordance with the Specifications. All factory testing shall be conducted and witnessed prior to the shipment of any equipment to the jobsite. All equipment will be tested at a single location.
- .9 The Contractor shall notify the Contract Administrator of the factory testing date at least three (3) weeks before the test is to occur. All airfare, travel, living costs, and salary costs of

the Contract Administrator's first trip to this factory witness test shall be the responsibility of the Contract Administrator. All other costs associated with the factory test, including setup and operation of an appropriate ozone destruct system for the test, shall be the complete responsibility of the Contractor.

- .10 Failed Factory Test: The failure of any ozone generator to meet the specified production requirements, from the minimum to maximum production rates at the specified ozone concentrations and power consumption, over the entire test will constitute a failed factory test for that piece of equipment.
- .11 If a failed factory test occurs, the Contractor may reschedule another identical factory test, within a reasonable time, but not longer than eight (8) weeks, unless extended by the Contract Administrator, after the first failed test date. The Contractor shall be responsible to pay for all travel and living costs and normal billing hourly rates for the Contract Administrator on the second and all subsequent factory testing.

# 1.5 Services During Installation

- .1 Manufacturers' Representatives from the Manufacturers of component Products and subsystems shall resolve assembly or installation problems attributable to, or associated with, their Products and systems, whether or not an installation check is specifically required in the Specifications.
- .2 Competent and experienced personnel shall represent the Manufacturers of all equipment and systems as may be necessary to resolve assembly or installation problems at the Work Site which are attributable to, or associated with, the equipment furnished. Contractor's services shall be performed by personnel who are specifically qualified for the services being provided. Services provided by the Manufacturer's local or regional equipment representative will not be acceptable. Manufacturer's Representative who is leading training of the City's personnel shall be familiar with O&M requirements as well as with the specified equipment.

## 1.6 Field Testing

- .1 Test and document that ozone control system is ready for operation.
  - 1.1 Check ozone control system for proper installation, calibration, and adjustment on a loop-by-loop and component-by-component basis. Loop tests shall be performed for all installed instrumentation. Each loop test shall include actual actuation of the transmitter/pressure switch/limit switch with verification the actual signal is received at the PLC I/O module. For analog I/O, PLC standard software shall be used to verify calibration at 0, 10, 50, and 100 percent of span. For discrete I/O, verification of the I/O module point indicating LED is sufficient. Analog loop test shall use live process where practical, or simulated process by use of hand loaders and process simulators.
  - .2 Calibrate each active control component (except simple hand switches, lights, gauges, and similar items) and each PLC I/O module.

- .3 In conjunction with Control System Integrator, confirm that ozone control system, including application programming software, is ready for operation.
  - .1 Perform complete I/O checkout of all I/O. Verify complete loop from the field device through the HMI graphic image for each I/O point. Analog I/O shall be checked at 0, 50, and 100 percent of range and actual HMI display of engineering units verified.
  - .2 Test interlocks and communications with PLCs on loop-by-loop basis.
- .4 Perform local and manual tests for each loop before proceeding to remote and automatic modes.
- .5 Where possible, verify test results using visual confirmation of process equipment and actual process variables. Unless otherwise directed, exercise and observe devices supplied by others, as needed to verify correct signals to and from such devices and to confirm overall system functionality. Test verification by means of disconnecting wires or measuring signal levels is acceptable only where direct operation of plant equipment is not possible.
- .2 Check and test all supplied equipment. Testing shall include, but not be limited to, checking for proper rotation, alignment, speed, excessive vibration, and noisy operation. This activity shall also include any necessary tuning of equipment to insure that it is ready for performance testing.

# 1.7 Manufacturer's Certification of Satisfactory Installation

.1 The Contractor shall, along with the Contract Administrator, inspect the installation of the ozonation system equipment (including all miscellaneous instrumentation and valves). All errors shall be corrected. Once all identified installation errors have been corrected and reexamined by the Contractor, the Contractor shall provide a completed Form 102 Certification of Satisfactory Installation stating that all of the equipment has been properly installed in accordance with the Manufacturer's recommendations and directions, that it has been serviced with the proper initial lubricants (if applicable), that the proper electrical and mechanical connections have been made.

## 1.8 Performance Testing

.1 Ozone system performance testing shall be as specified in Section 11210-08, Ozone System Performance Testing.

## 1.9 Training of City's Personnel

## .1 General:

.1 Contractor shall provide for training of designated City personnel in the operation and maintenance of the ozone system including all components provided under this Contract.

- .2 Training shall not commence until O&M Manuals have been approved and provided to City's personnel, and until an accepted detailed lesson plan has been reviewed and accepted by the Contract Administrator for each training activity.
- .3 Training shall consist of both classroom and hands-on sessions conducted at time and location acceptable to the Contract Administrator.
- .4 Contractor shall designate a person responsible for scheduling and coordinating all training.
- .5 Training sessions may be videotaped if the City so chooses. If sessions are to be videotaped, City will be responsible for providing all necessary videotaping equipment.
- 2 Contractor personnel shall provide detailed system training including, as a minimum, the following:
  - .1 System operations philosophy.
  - .2 System Control:
    - .1 Loop Functions: The understanding of loop functions including interlocks.
    - 2 Loop Operation: For example, adjusting process variable set points and control, annunciator acknowledgment and resetting, etc.
    - .3 Interfaces with other loops and subsystems.
  - .3 Operator interface/system set points.
  - .4 Component performance requirements.
  - .5 Component functions.
  - .6 Component maintenance.
  - .7 Component troubleshooting.
  - .8 Instrument operation, maintenance, troubleshooting, replacement, and calibration procedures.
- .3 Major component Manufacturers shall provide detailed maintenance instruction, in addition to the above requirements, for major components as required in the detailed equipment and instrument Specifications.
- .4 Classroom training shall be conducted during regular working hours on weekdays at a location to be designated by the Contract Administrator. Provide 20 paper copies of all overheads and slides used for training.

.5 Coordinate training periods with Contract Administrator to comply with Contract Work Schedule.

# 2. PRODUCTS (Not Used)

# 3. EXECUTION

# 3.1 Manufacturer's Services

- .1 A Manufacturer's Representative shall be present at Site or classroom designated by the Contract Administrator for minimum person-days listed below, excluding travel time.
- .2 Ozone Control System:
  - .1 Five (5) Working Days for field testing.
- .3 Ozone Generators/Power Supply Units and Off-Gas Destructor Systems:
  - .1 Fifteen (15) Working Days for field testing.
- .4 Ozone Dissolution System:
  - .1 Three (3) Working Days for field testing.
- .5 Cooling Water System (Cooling Water Skids):
  - .1 One (1) Working Day for field testing.
- .6 Overall System Training:
  - .1 Thirteen (13) Working Days, not necessarily consecutive. Allow for 3 separate trips to Site.

# 1. GENERAL

#### 1.1 Work Included

- .1 Ozone System shall be Performance Tested to Determine:
  - .1 Ozone production.
- .2 The test for each ozone system shall be conducted by the Contractor under the observation of the Contract Administrator.
- 3 The City will provide power to operate the ozone system during all testing. The City shall provide liquid oxygen utilized by the equipment and distilled water and anti-scaling agent for the cooling water system during all testing and start-up.
- .4 The Contractor shall collect all data, compile the performance test results, including the calibration data, and submit three copies of the reports to the Contract Administrator. Within fourteen (14) Calendar Days after completion of the performance test for each ozone system, one hard copy of the raw data shall be provided to the Contract Administrator.
- .5 At least fifty six (56) Calendar Days prior to the proposed testing date for the ozone system, the Contract Administrator shall notify the Contractor of the testing date and the Contractor shall submit a report detailing the proposed performance testing procedure and schedule. This submission shall include the following:
  - .1 Instruments to be used for measurements.
  - .2 Relative precision of the instruments and methods of calibration.
  - .3 Data sheets for recording measurements.
  - .4 Procedures for making calculations, including example calculations.
  - .5 Procedures for documenting compliance.
- .6 Testing of the ozone system shall not proceed without the Contract Administrator's approval of the test procedures.
- .7 Results of the performance tests for a given testing criteria shall be averaged and then corrected, if necessary, to conform to the design ambient conditions. The methods used in data correction and reduction shall be mutually agreed upon by the Contractor and the Contract Administrator.

## 2. PRODUCTS

#### 2.1 GENERAL

.1 The Contractor shall provide all instruments, calibration chemicals, and other supplies necessary for conducting the system tests.

## 2.2 Instruments/Measurements

- .1 All gas phase ozone concentrations shall be determined using the UV type ozone monitors provided in the system.
- .2 Gas flow shall be measured using the flowmeters provided under this Contract.
- .3 Meters shall be calibrated just prior to and immediately following the test. If the meter has drifted by more than 3 percent, the meter shall be recalibrated and the test repeated until such time that the drift in the meter is less than 3 percent.
- .4 The dew point of the dry feed gas to the ozone generators shall be measured by the dew point monitor. Temperature and pressure of the feed gas shall be measured on the generator skid.
- .5 The flow, pressure, and temperature of the closed loop cooling water and gas streams shall be measured with the instruments provided under this Contract. Instruments shall be calibrated within fourteen (14) Calendar Days of the test. These readings will not be corrected to account for errors inherent in the equipment. Direct readings will be used as corrected. Accuracy errors for all instruments will belong to neither the Contract Administrator nor the Contractor.
- .6 The skid-mounted ozone analyzer will be used for the performance tests. Span settings will be adjusted in accordance with the Manufacturer's recommendations to account for the temperature of the sample cell, pressure inside the sample cell, and feed-gas density.
- .7 For power factor and harmonic distortion tests use Dranetz, Model No. PP4300 Analyst 3Q or equivalent instrument to document results. Provide any CTs and PTs required for connections to the instrument

## 3. EXECUTION

## 3.1 General

- .1 Contractor shall observe the requirements of the operation and maintenance manual, the plant safety and Provincial Regulations at all times.
- .2 Contract Administrator will verify that there is adequate ozone sink at all times for the ozone being produced.

# 3.2 Maximum System Power, LOX, and Cooling Liquid, Power Factor, and Harmonic Distortion

.1 To demonstrate compliance with minimum, intermediate, and maximum production, each ozone generator shall be tested individually at production rates as described below.

Design Condition	Percent Concentration (% wt)	Ozone Production (kg/day)
Maximum	5-6	458
Intermediate	10-12	305
Minimum	10-12	50

- .2 If the equipment fails to meet either the minimum or maximum production levels, modifications shall be made as necessary at the Contractor's cost to cause the equipment to meet these performance requirements and the equipment shall be retested until such time that these criteria are met.
- .3 The production level shall be set and the system allowed to stabilize for a period of not less than 1 hour before the first data are recorded. The test duration for this production level shall be not less than two (2) hours from the time the first data are recorded, with the test ending after the data are recorded after the second hour. Data shall be recorded at 20-minute intervals.
- .4 Test data and calculations for the test at such specified test capacity shall include as a minimum:
  - .1 Ozone Generators:
    - .1 Power factor for each generator. Record power factor from full load to no load.
    - .2 Inlet gas flow, temperature, dew point, and pressure.
    - .3 Outlet gas flow, pressure, temperature, and ozone concentration.
    - .4 Ozone production rate (kilograms per day).
    - .5 Cooling water flow, pressure, inlet and outlet temperature.
    - .6 Operating time.
- .5 Harmonic Distortion:
  - .1 Record test data for report. Perform test on each ozone generator.

- .2 With ozone generator connected to the normal utility source, measure the following to show parameters within specified limits:
  - .1 Total and individual current harmonic distortion (up to and including 35th harmonic) under following load conditions: 1) Ozone generator running at full load.
  - .2 Power factor at input side of each ozone generator. Documented verification that power factor is maintained at 0.90 as the load goes down from 100 percent to 30 percent.
  - .3 Voltage total harmonic distortion (THD) under following conditions: Ozone generator running at full load.

# FACTORY APPLIED MAINTENANCE AND CORROSION PROTECTION COATINGS

## 1. GENERAL

#### 1.1 Work Included

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

## 1.2 Submissions

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

# 1.3 Quality Assurance

.1 This Specification is intended to be a minimum reference standard. The Contractor may submit for review alternative coating systems for specific items of equipment which provide equal or better corrosion protection and maintenance service than those specified herein.

#### 2. PRODUCTS

# 2.1 Surface Preparation

- .1 Immersion Service: After degreasing, dry blast all ferrous components to a white metal finish in accordance with Steel Structures Painting Council (SSPC)-SP5 to a degree of cleanliness in accordance with National Association of Corrosion Engineers (NACE) No. 1 and obtain a 50 micron blast profile.
- .2 Non-immersion Service: After degreasing, dry blast all ferrous components to a near white finish in accordance with SSPC-SP10 to a degree of cleanness in accordance with NACE No. 3 and obtain a 50 micron blast profile.

# 2.2 Prime Coating

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

# 2.3 Assembly

- .1 For items which are to be bolted together before shipment, clean surfaces and coat before the parts are assembled.
- .2 Continuous weld all welded connections, sealing the mating surface completely. On completion of the welding and fettling, treat all weld seams with phosphoric acid solution. Rinse and thoroughly dry before the prime is applied.

## FACTORY APPLIED MAINTENANCE AND CORROSION PROTECTION COATINGS

- .3 Where dissimilar metals are mated insulate the mating surfaces from one another to provide protection against corrosion. Insulate bolts, nuts, washers, and rivets in a similar manner.
- .4 Use 304 stainless steel or better for all nuts, bolts, washers and similar fittings for immersion service. For non-immersion service, use 304 stainless or zinc or cadmium plated nuts, bolts, washers, and similar fittings. Clean and coat the inner face of non-threaded bolt holes as required for other surfaces.

#### 3. EXECUTION

# 3.1 Inspection

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

## 3.2 Protection

- .1 Protect all coated equipment adequately against damage, dust, moisture, and scratching during shipment, off-loading and storage on-site. If, in the opinion of the Contract Administrator, the coating is damaged during shipment to the extent that touch up would not be satisfactory, return and re-coat the equipment at the Contractor's cost.
- .2 Make good damage to coatings occurring at any time prior to the application of any further coatings.

## 3.3 Application Conditions

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

## **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 Canadian Electrical Code 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 Canadian Standards Association (CSA) approved.

## .2 Standard of Workmanship:

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

#### 1.3 Submittals

- .1 Submit samples as required where specified in Division 16 and 17.
- .2 Refer to Section 01300 Submittals for general requirements for submittals.
- .3 Indicate materials, methods of construction and attachment of support wiring, diagrams, connections, recommended installation details, explanatory notes and other information necessary for completion of Work. Where equipment is connected to other equipment, indicate that such items have been coordinated, regardless of the Section under which the adjacent items will be supplied and installed.
  - Adjustments made on Shop Drawings by the Contract Administrator are not intended to change the Contract price. If adjustments affect the value of the Work state such in writing to the Contract Administrator prior to proceeding with the Work.
- .4 Manufacture of Products shall conform to revised Shop Drawings.

## **ELECTRICAL GENERAL REQUIREMENTS**

# 1.4 Operation and Maintenance Manuals

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

## 1.5 Product Handling

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

## 2. PRODUCTS

#### 2.1 Selected Products and Equivalents

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

# 2.2 Quality of Products

- .1 All Products provided shall be Underwriters Laboratories Inc. (UL) or CSA approved, or approved by local authority having jurisdiction in the area where the equipment is going to be installed.
- .2 If Products specified are not approved as specified above, obtain special approval from the local regulatory authority. Pay all applicable charges levied and make all modifications required for approval.
- .3 Products provided, if not specified, shall be new, of a quality best suited to the purpose required and their use subject to approval by the Contract Administrator.

# 2.3 Uniformity of Manufacture

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

# **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).

#### **SCOPE OF SUPPLY**

# 1. GENERAL

- .1 Refer to Sections 11000 through 11210.
- .2 This Section describes the Electrical Division scope of supply for the Ozone Equipment electrical package.
- .3 The Contractor shall furnish all necessary components to provide a complete and fully functioning Ozone 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 ozone equipment.
  - .1 Each component shall be designed for the environmental conditions of the space in which the component is located. All ozone system equipment will be located indoors.
  - .2 Indoor areas will be mechanically ventilated and heated, not air-conditioned. Temperatures in the equipment areas will be between 10°C and 40°C, and relative humidity will be as high as 100 percent..
  - .3 Plant elevation is approximately :  $232 \pm 50$  m above mean sea level (MSL).

# 1.3 Scope of Supply

- .1 See 11210-00 Ozone System General.
- .2 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.
  - 2 All variable frequency drives (VFD) and control devices as required to supply a complete electrical system.
  - .3 All wires and cables as required to supply complete electrical system.
  - .4 All junction boxes and pull boxes as required to supply complete electrical system.
  - .5 All wire and box connectors as required to supply a complete electrical system.
  - .6 All other components as required to supply complete electrical system.

# **SCOPE OF SUPPLY**

- .7 Where required three-phase, 60 Hz, 208/120Volt power shall be transformed from the 600 Volt supply in the control panel furnished with the power supply unit to power all skid mounted equipment and instruments which require non-critical 208/120 Volt power.
- .3 External conduit and wiring between separate equipment/skid packages is to be provided by the Installation Contractor.
- .4 Termination of external wiring between separate equipment/skid packages is to be provided by the Contractor.
- 2. PRODUCTS NOT USED
- 3. EXECUTION NOT USED

#### WIRES AND CABLES 0 - 1000 V

## 1. GENERAL

#### 1.1 Work Included

- 1 Provide a complete system of wiring, making all connections necessary for the installation of each Process Unit as required. A Process Unit is a Supplier package or individual process equipment as specified in other Sections.
- .2 External conduit and wiring between separate equipment/skid packages is to be provided by others.

# 1.2 References, Codes, and Standards

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

## 2. PRODUCTS

# 2.1 Wires

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

#### 2.2 Teck Cable

- .1 Conductors:
  - .1 Grounding conductor: copper.
  - .2 Circuit conductors: copper, size as required by the applicable codes.

## .2 Insulation:

- .1 Type: ethylene propylene (EP).
- .2 Chemically XLPE rated type RW90, 600 V.
- .3 Inner jacket: polyvinyl chloride (PVC) material.
- .4 Armour: interlocking aluminum.

#### WIRES AND CABLES 0 - 1000 V

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

#### .7 Connectors:

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

## 2.3 Control Cables

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

#### 3. EXECUTION

#### 3.1 Installation of Teck Cable 0 - 1000 V

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

# 3.2 Installation of Control Cables

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

#### 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.

## JUNCTION BOXES AND PULL BOXES

# 1. GENERAL

## 1.1 Work Included

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

# 2. PRODUCTS

## 2.1 Junction Boxes and Pull Boxes, Weatherproof

- .1 Materials:
  - .1 Type 316 L stainless steel or cast aluminum, National Electrical Manufacturer's Association (NEMA) 4X suitable for outdoor locations.

# 2.2 Junction Boxes and Pull Boxes for Corrosive Process Areas

- .1 Materials:
  - .1 Stainless steel or cast aluminum, suitable for corrosive areas.

## 3. EXECUTION

## 3.1 Installation

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

#### WIRE AND BOX CONNECTORS 0-1000 V

## 1. GENERAL

#### 1.1 Work Included

.1 Provide a complete system of wiring, making all connections necessary for the wiring installation on each Process Unit as required. A Process Unit is a Supplier package or individual process equipment as specified in other Sections.

# 1.2 Special Codes

.1 Install and rate power cables in accordance with the applicable Electrical Code requirements, or in accordance with Insulated Power Cable Engineers Association (IPCEA) requirements where permissible.

#### 1.3 References

- .1 Canadian Standards Association (CSA) C22.2 No. 65 Wire Connectors.
- .2 Electrical and Electronic Manufacturers of Canada (EEMAC) 1Y-2, Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).

#### 2. PRODUCTS

# 2.1 Materials

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

#### **2.2** Wire Connectors

.1 Use 3M "Scotchlock", self-insulated connectors for hand twist wire joints for lighting, small power, and control wiring.

#### WIRE AND BOX CONNECTORS 0-1000 V

- .2 Use T & B non-insulated ring type compression lugs for terminating No. 10 American wire gauge (AWG) and smaller motor connections. Tape with rubber and scotch tape. Lugs to accept ten (10) 32 x 3/8" machine bolts.
- .3 Terminate conductors No. 8 AWG and larger with Thomas & Betts Colour-Keyed compression connectors Series 54000, or on lugs provided with equipment.
- .4 Thomas & Betts "KOPR-SHIELD" compound Series CP8 on all terminations for compression connectors.

## 3. EXECUTION

## 3.1 Installation

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

#### 3.2 Wire Connectors

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

## 1. GENERAL

# 1.1 Scope of Work

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

# 1.2 References

.1 National Electrical Manufacturer's Association (NEMA) Contactors and Motor-starters.

# 1.3 Starter Requirements

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

#### 1.4 Shop Drawings and Product Data

.1 Submit Shop Drawings in accordance with Section 16010 - Electrical General Requirements and Section 01300 - Submittals.

#### .2 Indicate:

- .1 Mounting method and dimensions.
- .2 Starter size and type.
- .3 Layout of identified internal and front panel components.
- .4 Enclosure types.
- .5 Wiring diagram for each type of starter.
- .6 Interconnection diagrams.

## 1.5 Operation and Maintenance Data

.1 Provide operation and maintenance (O&M) data for motor starters for incorporation into manual specified in Section 16010 - Electrical General Requirements and Section 01730 - Operation and Maintenance Manuals.

.2 Include operation and maintenance data for each type and style of starter.

## **1.6** Maintenance Materials

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

## 2. PRODUCTS

# 2.1 Materials

.1 Starters to NEMA Standards.

# 2.2 Enclosure

.1 All individually mounted motor starters shall be enclosed in a general purpose sheet steel enclosure unless in wet areas where they shall be watertight Electrical and Electronic Manufacturers of Canada (EEMAC) 4.

# 2.3 Manual Motor Starters

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

#### .2 Accessories:

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

## 2.4 Full Voltage Non Reversing (FVNR) Magnetic Starters

- .1 Combination magnetic starters shall be of size, type, rating, and enclosure type as required by local applicable codes with components as follows:
  - .1 Contactor solenoid operated rapid action type.
  - .2 Motor overload protective device in each phase, manually reset from outside enclosure.
  - .3 Wiring and schematic diagram inside starter enclosure in visible location.
  - .4 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.
- 2 Combination type starters shall include fused disconnect switch, or motor circuit interrupter, or circuit breaker with operating lever on outside of enclosure to control the disconnect switch, or the motor circuit interrupter or the circuit breaker, and provision for:
  - .1 Locking in "OFF" position with up to three (3) padlocks.
  - .2 Independent locking of enclosure door.
  - .3 Provision for preventing switching to "ON" position while enclosure door open.

#### .3 Accessories:

- .1 Pushbuttons, selector switches: heavy duty labelled to identify control function.
- .2 Indicating lights: Heavy duty L.E.D. type red pilot light to indicate energized motor circuit and where called for, green pilot light to indicate de-energized motor circuit. Pilot lights to be push-to-test transformer type.
- .3 In addition to standard, one (1)-N/O and one (1)-N/C spare auxiliary contacts unless otherwise indicated.

# 2.5 Full Voltage Reversing (FVR) Magnetic Starters

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

- .2 Mechanical and electrical interlocks to prevent both contactors from operating at same time.
- .3 Three (3) overload relays with heater elements, manual reset.

#### .2 Accessories:

- .1 Pushbuttons selector switches: Heavy duty labelled to identify control function.
- .2 Indicating lights: Heavy duty L.E.D. type, red pilot light to indicate energized motor circuit and where called for, green pilot light to indicate de-energized motor circuit. Pilot lights to be push-to-test transformer type.
- .3 In addition to standard, one (1)-N/O and one (1)-N/C spare auxiliary contacts per contactor unless otherwise indicated.

# 2.6 Equipment Identification

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

# 2.7 Approved Manufacturers

- .1 Approved motor starter manufacturers are: Schneider Electric, Cutler-Hammer, Square D, and Allen Bradley.
- .2 Multilin motor protector relays are preferred for large motor protection.

## 3. EXECUTION

#### 3.1 Installation

- .1 Install starters.
- .2 Ensure correct fuses and overload devices elements installed.

## 3.2 Starter Verification

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

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

# 3.3 Overload Relays

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

# 3.4 Field Quality Control

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

## 1. GENERAL

#### 1.1 Standards

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

## 1.2 Tests

# .1 Factory testing

- .1 VFD units are to be factory tested prior to shipment. Provide confirmation from factory of actual tests completed and results.
- .2 Provide certified copies of production test results required by CSA and Electrical and Electronic Manufacturer's Association of Canada (EEMAC) to the Contract Administrator, prior to acceptance of the equipment.

# .2 Field testing

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

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

## 2. PRODUCTS

# 2.1 Variable Frequency Drives

- .1 VFD as supplied by one of the following acceptable Manufacturers:
  - .1 ABB.
  - .2 Mitsubishi.
  - .3 Toshiba.
- .2 Variable speed controller shall be electronic adjustable frequency and voltage output unit.
- .3 The VFD shall employ a minimum 6-pulse PWM (pulse width modulated) inverter system utilizing Insulated Gate Bipolar Transistors (IGBT) power switching devices and come complete with line reactors or DC link filters.
- .4 The drive shall be rated for continuous duty while operating a NEMA design induction motor of the sizes and operating voltages as shown in the following schedules and indicated on the Drawings. Drive output shall be sized for a 1.0 motor service factor. The VFD shall have a current rating at least 10% in excess of the motor full load amp rating. Overload service factors of 110% for thirty (30) minutes and 135% for one (1) minute must be provided to ensure adequate safety margins. VFD selection shall be based on load current at constant torque ratings. Do not size VFD's based on variable torque maximums.
- .5 The VFD shall have a fixed bridge type converter (PWM) with a minimum of 98% input displacement power factor over a 10 to 100% speed range. The efficiency shall be a minimum of 97% for all inverters when operated at full speed and load.
- .6 Input voltage shall be as indicated on motor schedules and Drawings (line voltage variation ±10%). Based on 347/600 volt systems (Not 575 V). Line frequency variation ±5%. Output voltage shall vary with motor speed to nominal motor voltage. Speed stability shall be ±1%. Drive shall match torque characteristic of load.
- .7 Input frequency setting signal will be 4 to 20 mA. Output speed monitoring signal shall be 4 to 20 mA.

#### .8 Enclosure:

on the control of the

#### .9 Protective devices to be incorporated are:

- .1 Fast acting electronic circuit board protective devices for protection of electronic components.
- .2 Line reactor, DC link or filter in the drive input to protect electronic components from transient voltage conditions.
- .3 Integral electronic motor overload protection adjustable up to 150% of motor rating for 60 seconds.
- .4 Overcurrent instantaneous trip 250%.
- .5 Programmable short-circuit protection.
- .6 Programmable ground fault protection.
- .7 Overvoltage/overcurrent DC bus monitor/protection.
- .8 Undervoltage protection.
- .9 Loss of phase and phase unbalance protection.
- .10 Inverter over-temperature protection.
- .11 Capable of running without motor for start-up.
- .12 Output filter package (as required) to limit motor voltage to 1200 volts maximum at motor terminals. A reflective wave trap mounted at the motor may be used to accomplish this.
- .13 Longlead (motor feeder) filter package, as required for these installations. Contractor is responsible to determine where this will be required, and must indicate as to the requirement or non-requirement of longlead filter package components in their submittals.
- .14 Maximum acceptable noise level is 80dBA at 1m.
- .10 Operation features:

- .1 Integral flush mounted display in VFD cover with keypad for programming, monitoring and operating of drive, accessible through password or other acceptable security measure only. Remote keypads, completely duplicating functions of integral keypads, shall also be provided for all VFD(s) located inside a fan plenum. The remote keypads in these cases shall be located adjacent to the door entering the plenum.
- .2 Fault shutdown and indication.
- .3 Automatic restart following power outage.
- .4 Ability to disconnect motor load for setup or trouble.
- .5 Manual speed control (potentiometer or keypad).
- .6 Adjustable maximum and minimum speed.
- .7 Acceleration and deceleration time adjustment.
- .8 Controller "stop" interlock from a NC dry contact.
- .9 Drive fault contact.
- .10 Stop/start push buttons on key pad.
- .11 Transient voltage protection.
- .12 Provide three (3) dry "C" type contacts programmable for any combination of the following:
  - .1 Running (output frequency being generated).
  - .2 Fault lockout.
  - .3 Stopped.
  - .4 At speed.
  - .5 Under speed.
  - .6 Forward/Reverse.
  - .7 Low reference.
  - .8 Manual/Auto Mode.
  - .9 Local/Remote Mode.
- .13 Soft start sequence.

- .14 Minimum of three (3) skip frequencies.
- .15 Provide Computer/Off/Hand selector switch. Keypad C/O/H is not an acceptable replacement.
- .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/transmission control protocol (TCP).
- .11 Environmental Capabilities: The drive shall operate without mechanical or electrical damage under any combination of conditions as follows:
  - .1 Ambient temperature 10° to 40°C.
  - .2 Humidity 0 to 100% (noncondensing).
  - .3 Vibration up to 0.5 g.
  - .4 Altitude: Plant elevation is  $232 \pm 50$  m above mean sea level (MSL).
- .12 Diagnostic and indicating features:
  - .1 Power On indication.
  - .2 Percentage speed indicator.
  - .3 Overload indication.
  - .4 Short circuit indication.
  - .5 Ground fault indication.
  - .6 Overvoltage indication.
  - .7 Undervoltage indication.
  - .8 High temperature (controller).
  - .9 AC voltmeter (output).
  - .10 AC ammeter (output).

## VARIABLE FREQUENCY DRIVES

- .11 Inverter ready.
- .12 Inverter fault.
- .13 External fault.

#### .13 Cooling System:

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

#### .14 Normal Distribution

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

#### 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.

## VARIABLE FREQUENCY DRIVES

- .5 Motor frame.
- .6 Motor horsepower (hp).
- .7 Motor full load amps.
- .8 Motor conductor size.
- .9 Ground conductor.
- .10 Length of conductors from VFD to Motor.
- .11 Motor master control panel (MCP) or fuse and overload.

#### .2 Installation

- .1 Identify mounting requirements including concrete pads for all floor mounted equipment.
- .2 Contractor shall make provisions for the wiring of all interlocks including (but not limited to) vibration switch, freeze stats, and fire alarms to the VFD. These interlocks will be active in both the Hand (local) or Auto (remote) configurations.
- .3 Contractor shall ensure that all safety interlocks, control and stop commands shut down the drive as per Manufactures recommended procedure (example, ramp to stop, ramp and hold, or coast to stop). Contactors on the line or load side of the drive are not an approved method of control.
- .4 VFD and motor isolation switch shall be labelled with proper shutdown procedures as follows:

## "Caution"

- "\* Ensure VFD is stopped before operating this switch".
- "\* Record all faults before resetting".
- .5 Motor supply cables/conductors shall be run in conduits separate from supply feeders to line side of VFD. No conductors (supply or motor feeders) are to be taped or otherwise bundled within the conduits.

## .3 Field Quality Control

- .1 Contractor shall be responsible for complete commissioning of each variable speed drive to satisfaction of the Contract Administrator and the City. Contractor shall allow for factory representative to completely calibrate all drive circuits after installation on-site.
- .2 Contractor shall be responsible to bring Factory representative back to reset, repair, and re-commission the VFD during the warranty period if problems arise with the normal

## VARIABLE FREQUENCY DRIVES

operation of the VFD. This includes prevention of any motor shaft voltages exceeding 1.5 volts when referenced to ground.

#### .4 Software

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

## "Caution"

- "\* Ensure VFD is stopped before operating this switch".
- "\* Record all faults before re-setting".
- .4 All Drawings, manuals, parameter settings, and test reports are to be included with the O&M Manual Electrical Section. This manual shall be issued in both Hard Copy and Electronic format.

#### **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, starters, and items provided under Section 17 for example, pressure, flow, float, solenoid valves, panels, pneumatic electric switches, transducers, etc. Some or all of the preceding items are interconnected under Part 3 of this Specification.

## 2. PRODUCTS

## 2.1 AC Control Relays

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

#### 2.2 Relay Accessories

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

# 2.3 Sealed Contact Oil Tight Limit Switches

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

#### **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: Canadian Standards Association (CSA) Type four (4), lever or push type, contact rating: EEMAC A-600.

## 2.4 Solid State Timing Relays

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

# 2.5 Instantaneous Trip Current Relays

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

## 2.6 Operator Control Stations

.1 Enclosure: CSA Type one (1), surface mounting

#### 2.7 Pushbuttons

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

## 2.8 Selector Switches

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

# **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.

## 1. GENERAL

# 1.1 Requirements of Work

- .1 Supply, and provide warranty for a complete and fully documented instrumentation and control (I&C) system as shown on the Drawings and specified herein. The I&C system will form a subsystem of the overall plant control system and contains vendor component subsystems specified in this and other Sections of the Specification.
- .2 Component subsystems of the I&C system will include, but are not limited to, the following:
  - .1 Primary elements and transmitters.
  - .2 Final control elements.
  - .3 I&C field devices.
  - .4 I&C junction boxes, local control panels, and marshalling panels.
  - .5 Specialized Instrumentation cables.
  - .6 Instrument cables 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.
  - .7 Instrumentation power supplies.
- .3 Ensure the correct functionality of any equipment supplied under other Divisions of this Specification.
- .4 Documentation provided by the Contractor shall include as a minimum:
  - .1 Equipment descriptive data.
  - .2 Equipment installation instructions, service manuals, operation and maintenance (O&M) manuals, bills of materials, and recommended spare parts lists.
  - .3 Schematics and interconnection wiring diagrams sealed by a Professional Engineer registered in the Province of Manitoba.
  - .4 Records of conductor identification, field terminals, cable lists and all other information necessary for the installation of the equipment.
  - .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 For the programmable logic controller (PLC) based control system, the Contractor shall provide detailed documentation of the system hardware and software. Minimum software documentation shall include a detailed operating description, flow charts that

describe the functionality of the PLC program, a memory map, and the PLC program 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 Diagrams (P&IDs) Depict the general intent of the control systems and are to be used as the governing document for the scope of Work.
  - .2 Instrument Index A sorted index of the detailed information for the devices shown on the P&IDs. The index lists the appropriate support documentation for the devices' supply and installation. The instrument index is the controlling document for the supply of materials.
  - .3 *Input/Output Index* A sorted index of the control system I/O points shown on the P&IDs, giving the supporting documentation as per the instrument index.
  - .4 Instrument Specification Sheets Detail the relevant data for the supply of devices.
  - .5 Instrument Loop Diagram (ILD) Shows typical interconnections and hook-up of devices. The Contractor is to produce an ILD for each device and record all relevant information on each sheet for submission at the completion of the Work. Fill in all terminal and wiring numbers etc. from the Shop Drawing as they become available. A set of 'B' size (11" x 17") ACAD Drawings and associated files will be made available to the successful bidder. Where an ILD is not shown for wiring of simple devices provide a legible sketch for as-built information.
  - .6 Location Drawings Indicate in plan and/or elevation views where the instrument elements are physically located. These Drawings are provided to assist the 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.
  - .8 *Detailed Specification* lists qualifications, quality of materials and workmanship, and supplementary information.

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

<b>ASTM D883-89</b>	Terms Relating to Plastics			
IEEE 100-88	Dictionary of Electrical and Electronic Terms			
ISA RP7.1-56	Pneumatic Control circuit Pressure Test			
ISA RP12.6-87	Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations			
ISA S5.4-76	Instrument Loop Diagrams			
ISA S18.1-79	Annunciator Sequences and Specifications			
ISA S51.1-79	Process Instrumentation Terminology			
NEMA 250-85	Enclosures for Industrial Controls and Systems			
NEMA ICS 1-88	General Standards for Industrial Controls and Systems			
NEMA ICS 2-88	Industrial Control Devices, Controllers, and Assemblies			
NFPA 70-90	National Electrical Code (NEC)			
SAMA PMC 17-10-63	Bushings and Wells for Temperature Sensing Elements			
UBC-88	Uniform Building Code			
UL 1012-89	Power Supplies			
UL 94-80	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances			
Weik, Martin H.	Communications Standard Dictionary, Van Nostrand Reinhold Co., 1983			

## .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, Canadian Standards Association (CSA) Standards, Underwriters Laboratories of Canada (ULC) and the applicable building codes, whether specifically shown on Drawings or not.
- .3 Give all required notices, submit Drawings, obtain all permits, licenses and certificates and pay all fees required for this Work.

# .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 Division 17.

## .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 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.
  - .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** Site

.1 The ozone equipment area is located indoors and is mechanically heated and ventilated but not air conditioned. Temperatures will range between 10 and 40 degrees Celsius. Relative Humidity will be as high as 100 percent.

## 1.4 **Documentation**

#### .1 Submittals

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

- .3 Stamp and sign the Shop Drawing to show approval, indicating the above has been complied with. If Contractor revisions are too extensive, return the submission to the Manufacturer for revision, then repeat the Shop Drawing approval process before submitting them to the Contract Administrator.
- .4 Manufacture of Products shall conform to Shop Drawings marked as reviewed by the Contract Administrator and returned to the Contractor.
- .5 Refer to Division 1 for further information on Shop Drawing submittals.

#### .2 O&M Manuals

- .1 Refer to Division 1 for general O&M manual submittal information.
- .2 In addition to the requirements specified in Division 1, provide the following information:
  - .1 Table of Contents Arrange contents sequentially by systems under Section numbers. Label tabs of dividers between each to match Section numbers in the Table of Contents.
  - .2 Systems Descriptions A brief synopsis of each system typed and inserted at the beginning of each Section. Include sketches and diagrams where appropriate.
  - .3 O&M instructions of all equipment and controls These operating instructions need not be Manufacturer's data but may be typewritten instructions in simple language to guide the City in the proper O&M of this installation.
  - .4 A copy of all wiring diagrams complete with wire coding.
  - .5 Include type and accuracy of instruments used.
  - .6 Set of final reviewed Shop Drawings.
  - .7 Provide a tabulated list of all consumables utilized (fuses, lamps, etc.) indicating where used, type, rating and reorder details.

#### 2. PRODUCTS

#### 2.1 General

- .1 Refer to the requirements of Division 1.
- .2 Selected Products.
  - .1 Provide Products and materials that are new and free from all defects.

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

## 2.3 Identification

- .1 Refer to Division 16 for general identification requirements. Provide lamacoid nameplates with 6 mm black lettering on white background. Identify the loop tag number (where applicable) and the device name, function, and instrument range or setpoint value on the nameplate.
- .2 Where it is not possible to attach a lamacoid nameplate to a field instrument component, provide the component with a stainless steel metal tag firmly wired to the device and identified with the loop tag number.
- .3 Identify all wires where they terminate at the marshalling panels, junction boxes, control panels, and field devices with a heat shrink sleeve with machine printed labelling.
- .4 Clearly mark all panels, pull boxes, junction boxes, etc. to indicate the nature of service.
- .5 Provide neatly typed circuit directories for panel power distribution systems to indicate loops or devices powered by the circuit and the fuse size.

- .6 For direct current wiring use black for positive and white for negative.
- .7 For thermistor wiring to motors use red and blue coloured insulated wire.

## 3. EXECUTION

## 3.1 Coordination With Other Divisions

- .1 Examine the Drawing and Specifications of all Divisions and become fully familiar with the Work. Before commencing Work, obtain a ruling from the Contract Administrator on any conflicting issues between Divisions. No compensation will be made for any costs arising from conflict not identified before Work has commenced.
- .2 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 Product Handling

- .1 Remove advertising labels from all Products that have such labels attached. Identification or CSA labels are not to be removed.
- .2 Remove dirt, rubbish, grease, etc. resulting from Work performed under this Section of the Contract from all surfaces.

# 3.3 Separation of Services

.1 Maintain separation between the electrical wiring system, piping, ductwork and the instrumentation cables so that each system is isolated (except at approved connections to such systems) to prevent galvanic corrosion. In particular, contact between dissimilar metals, such as copper and aluminum, in damp or wet locations is unacceptable.

## .2 Classifications of Circuits

.1 The circuit categorization shall of first priority follow Canadian Electrical Code (CEC) with respect to separation for electrical safety and the following shall apply with respect to electro-magnetic compatibility:

Very Noisy	High voltage circuits and their associated grounding			
	High current (>200A) LV circuits.			
	Harmonic-rich LV circuits.			
	DC circuits: un-suppressed or above 50V.			

Noigy	Low current class two (2) circuits.			
Noisy	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.			
Sellsitive	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 circuits 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

# 3.4 Wire and Cable

.1 Refer to Section 17124 – Instrumentation Cable.

# 3.5 **Equipment Connections**

.1 Prior to the connection of signal wiring to process control and instrumentation devices, check the device voltage rating and polarity for compatibility with the corresponding loop

and/or schematic diagram. Where device and circuit characteristics are found to be incompatible, the connections are not to be made. Report the condition immediately to the Contract Administrator.

- .2 All control wiring diagrams illustrate typical control circuits applicable to the type of equipment specified. Control circuits may vary with different Manufacturers 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.
- .3 Provide power disconnect terminals in marshalling panels for all devices and PLC inputs/outputs sourced from the panel. Provide local power disconnect switches for all 120VAC power instruments. Mount adjacent the instrument.

#### 3.6 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.

#### 3.7 Tagging Standards for Devices and Wiring

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

## 3.8 Testing of Instrumentation Loops

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

# 3.9 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 For each instrument supplied as part of an equipment skid, perform the following applicable calibration prior to instrument installation:
  - .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.
  - .4 Calibrate gas detectors using standard gas sample.
  - 5 Calibrate temperature instruments against a standard lab thermometer.

## 3.10 Test Forms

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

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INSTRUMENT TI	EST RE	PORT									
SYSTEM:  SERVICE:  LOCATION:				TAG NO.:							
MAKE:			MODE	MODEL:							
SERIAL NO.:			_								
ELEMENT:											
DESIGN SETTING/RANG						ON: _					
SIGNAL IN:						ENT:					
INSTRUMENT CONDITION											
PROJECT NO:											
		TE:	ST 1			TES	ST 2				
TEST METHOD			<b>31 1</b>			112	71 2				
	IN	PUT	OUT	OUTPUT		INPUT		OUTPUT			
PROCESS	INC.	DEC.	INC.	DEC.	INC.	DEC.	INC.	DEC.			
TEST POINT 1											
TEST POINT 2											
TEST POINT 3 TEST POINT 4											
TEST POINT 5											
COMMENTS				1		1					
GRAPHS											
TESTED BY:											
DATE:			_ DATE	DATE:							

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LOOP CHECK REPORT						(	CHECK	ED OU	ТОК
				П			NOT A	PPLIC/	ABLE
				_					
				Ц	FURT	HER A	CTION	REQU.	IRED
			INS	TRU	MENT	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: REA	DY F	OR S	ΓART	T-UP					
Date		_							
Insta	lled by	/:							
Chec	ked by	/:							

# 3.11 Installation and Performance Testing

- .1 Refer to the requirements of Division 1 for additional requirements.
- .2 Commissioning of the I&C system to include but not be limited to the following:
  - .1 Verify installation of components, wiring connections, and piping connections.
  - .2 Verify instrument calibration and provide written report.
  - .3 Assist I&C equipment installation Contractor's service personnel as required for complete system testing.
  - .4 Instruct plant personnel in correct method of operation of I&C equipment.
  - .5 Direct plant personnel at hand-over as to final adjustment of the system for correct operation of plant.
  - .6 Coordinate and cooperate with City staff and the Contract Administrator to commission the interface between the Plant supervisory control and data acquisition (SCADA) and the packaged PLC based control system.

# 3.12 Training

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

## 1. GENERAL

#### 1.1. References - General

.1 Equipment, Products and Execution must meet all requirements detailed in Section 17010.

## 2. PRODUCTS

## 2.1. General

- .1 Unless otherwise specified, provide outside finishes on all enclosures in American National Standards Institute (ANSI) 61 Grey as specified in Division 11.
- .2 The enclosures must be suitable for carrying the weight of the equipment mounted inside the panel and on the doors without any warpage.

## 2.2. Enclosures

- .1 Provide Electrical & Electronic Manufacturer's Association of Canada (EEMAC) type 12 gasketted enclosures in MCC rooms and control rooms.
- .2 All enclosures for mounting outside of Motor Control Centre (MCC) rooms and control rooms to be EEMAC Type 4, watertight except where otherwise specified.
- .3 Provide EEMAC 7/3R enclosures for equipment in and around classified areas such as sumps.
- .4 Enclosures for certain equipment in corrosive atmospheres to be EEMAC 4X approved for the classification (e.g. chemical cleaning).
- .5 Enclosures for mounting field control indicator lamps and switches in unclassified areas to be Allen Bradley model 800T-xTZ die cast enclosures.
- .6 Enclosures for mounting field control indicator lamps and switches in Class 1 areas to be Allen Bradley model 800H-xHHX7 cast aluminum enclosures.

#### 2.3. Panel Enclosures

- .1 Fabricate panel enclosures from 11 gauge steel panels complete with necessary stiffening to form a rigid free-standing lineup. The structures must be suitable for carrying the weight of the equipment mounted inside the panel and on the doors. Provide removable top and bottom cable entry plates.
- 2 Provide panels with front access only. Doors shall be key lockable and fitted with 3-point heavy duty latching assemblies. Provide a continuous piano hinge and a pneumatic hold open device on each door.

.3 Finish the interior of the enclosure with white paint. Provide a switched fluorescent light fixture and 120VAC duplex convenience receptacle inside the enclosure.

# 2.4. Marshaling and Control Panels

- .1 Supply, fabricate, checkout, layout, document and deliver to Site fully equipped and functional panels.
- .2 Supply all components contained on or within the panels fully wired under this Section of the Specification.
- .3 The selection of all accessories, materials and methods for fabrication not covered by this Specification, but which are necessary to complete the fabrication of the control panels, is the responsibility of the Contractor.
- .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 #16 AWG tinned stranded copper; insulation rated at 600 V.
  - .2 Wiring for power distribution shall be a minimum of #14 AWG tinned stranded copper; insulation rated at 600 V.
  - .3 Refer to Division 16 for cable routing requirements.
- 2 Tag each wire at both ends with a heat shrink sleeve that is machine printed. 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 wire ways such as Panduit. Size all wire ways so that the total cross sectional area of the insulated wire and cable does not exceed 40% of the cross sectional area of the wire way.
- .5 Provide a minimum clearance of 50 mm between wire ways 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 end device terminal number appended to it.
- .2 Identify every joint and/or terminal of the above wire run with the same identifier.
- .3 For example, pressure transmitter PT-O100A located in the field has a 2 PR-TPSH cable connected to it. The cable runs through a junction box to a marshaling panel. The wire identifiers for the pair of wires would be PT-O100A all the way to the marshaling 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 wiring terminates on the outboard side.
- .7 Two 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 type to isolate field wiring that is powered sourced from the panel.
- .9 Provide sufficient terminals so that not more that 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 color coded as follows:

.1	Red	=	positive 24Vdc
.2	Black	=	0Vdc common and analog signal plus
.3	White	=	analog signal common and VAC neutral
.4	Grey	=	120 VAC
.5	Green	=	ground
.6	Yellow	=	shield

.11 Provide nameplates for each device on or within the panels and enclosures. Nameplates shall be white lamacoid with black lettering, a minimum of 25mm x 75mm in size with up to three lines of 3mm lettering. Securely fasten nameplates in and situate them in a visible location.

# 2.6. Panel Grounding

- .1 Provide a ground system for the instrumentation circuits, isolated from the main power system ground to each marshaling panel.
- .2 Provide grounding lugs for each panel, suitable for termination of up to #2 AWG copper grounding conductor.
- .3 Provide in each marshaling panel an isolated grounding bus bar 6 x 25 x 600 mm, equipped with necessary lugs for accepting two #2 AWG grounding conductors.
- .4 Firmly bond all panel mounted devices on or within the panels to ground. Provide supplementary bonding conductors for back panels and doors. Attach a separate bonding conductor to all devices that are not firmly fastened to the panels with screws for such devices as case mounted instruments, meters, etc.

# 3. EXECUTION

## 3.1. References - General

.1 Refer To Section 17010, Part 3.

# 3.2. Mounting Heights

.1 Unless otherwise specified or a conflict exists, mount all panels, starters and disconnects 2000 mm to top of cover.

## 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 between all instruments and control panels that are located within a single packaged skid. Instrument cables between instruments and control panels that are not located within the same skid will be supplied and installed by others.

## 1.2. Related Work

.1 Refer to Division 16.

## 1.3. Standards

.1 All wire and cable shall be Canadian Standards Association (CSA) approved.

# 2. PRODUCTS

## 2.1. Twisted Pair Shielded Cables (TPSH)

- .1 TPSH shall be constructed as follows:
  - .1 Two (2) copper conductors, stranded, minimum #18 AWG, PVC insulated, twisted in nominal intervals of 50 mm.
  - .2 Insulated for 600V, 90°C.
  - .3 100% coverage aluminum foil or tape shield.
  - .4 Separate bare stranded copper drain wire, minimum #18 AWG.
  - .5 Overall flame retardant PVC jacket compliant with CSA-C22.2.
  - .6 The entire cable assembly to be suitable for pulling in conduit or laying in cable tray.
  - .7 Shaw Type 1751-CSA or Belden equivalent.
- .2 Where multi-conductor TPSH cables are called for, each pair shall be individually shielded, and continuous number coded. The cable assembly shall have an overall shield and overall flame retardant PVC jacket.

# **INSTRUMENTATION CABLE**

## 2.2. RTD and Multi Conductor Shielded Cable

- .1 RTD cables shall be CSA approved and shall be constructed as follows:
  - .1 Three (3) or more copper conductors, stranded, minimum #18 AWG.
  - .2 PVC insulated for 600V.
  - .3 100% coverage aluminum foil or tape shield.
  - .4 Separate bare stranded copper drain wire.
  - .5 Overall flame retardant PVC jacket to CAS-C22.2

## 2.3. Teck Cables

.1 As per Division 16.

## 2.4. Wire

.1 As per Division 16.

# 3. EXECUTION

## 3.1. Analog Signals

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

# 3.2. Digital Signals

.1 Use TPSH cable for all low level (24V and below) input and output signals.

#### 3.3. Instrument Power

.1 Use Teck cable or wire and conduit for power to instruments, for 120V signals other than those mentioned above and as otherwise indicated on the Drawings. Use stranded wire and cable to supply power to instruments.

# 3.4. Installation

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

# INSTRUMENTATION CABLE

- .2 Where non-armored instrumentation cables are installed in cable trays, provide barriers in the tray to separate instrumentation cables from power cables.
- .3 At each end of the run leave sufficient cable length for termination.
- .4 Do not make splices in any of the instrumentation cable runs.
- .5 Cable shields shall be terminated on insulated terminals and carried through to the extent of the cable.
- .6 Ground cable shields at one end only. Unless otherwise specified, ground the shields at the marshalling panel.
- .7 Protect all conductors against moisture during and after installation.

## 3.5. 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.

## 3.6. Testing

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

## 3.7. 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.

#### **POWER SUPPLIES**

#### 1. GENERAL

#### 1.1 References - General

.1 Refer to Section 17010.

#### 2. PRODUCTS

# 2.1 Power Supply and Conditioning Equipment

#### .1 General

- .1 Provide all DC power supplies as required for all instrument circuits. All circuits are to be powered from the marshalling panels. Power supplies to be Hammond, G.F.C. or approved equal, complete with an over-voltage protection module.
- .2 Provide redundant configurations for power supply equipment serving more than one instrument loop, so that failure of a single unit will not disable all or any shared part of the instrumentation and communication system. Provide diode isolation for redundant direct current supply units, and ground the negative terminal of the power supply.
- .3 Power supplies and transmitters feeding circuits that run in non-armored cable in cable tray shall meet the requirements for Class 2 circuits as defined under Section 16 of the CEC Part I.
- .4 Unless otherwise required, all DC power supplies to be rated 28VDC, adjustable plus or minus 5 percent, and set to provide 26.4 volts on the panel direct current bus. Size the power supply for two times the connected load, minimum size is 2 amps.

#### 2.2 Noise Suppression

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

# 2.3 UPS Power Supply

- .1 Two 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.
- 2 Control and operator interface system hardware including but not limited to PLC's, PLC I/O racks, PLC communication modules, Human Machine Interface (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.

# **POWER SUPPLIES**

- .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, Part 3.

# INSTRUMENT AIR SUPPLY AND TRANSMISSION

## 1. GENERAL

#### 1.1 References - General

.1 Equipment, Products and Execution must meet all requirements detailed in Section 17010.

#### 2. PRODUCTS

# 2.1 Pneumatic and Process Connections

.1 Pipe, fittings, valves, tubing, tube fittings, etc. required under this section of the Contract to be Swagelok or approved equal and rated for the service in which they are to be employed. Tubing and fittings are 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 Fischer 67FR air sets unless specified otherwise.
- .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.
- .2 Solenoid enclosures to be minimum Electrical & Electronic Manufacturer's Association of Canada (EEMAC) 4; corrosive areas require EEMAC 4X and hazardous areas require EEMAC Type 9. Refer to Division 16 for area classifications.
- .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 6mm; 4-way valve 10mm.

#### 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.

# 3.2 Tubing and Fitting Installation

- .1 Group instruments logically together. Orient instrument air and process connection isolation valves to provide consistent handle indication of normal open/closed status.
- .2 Final location of skid mounted instruments to provide sufficient clearance for access to all maintenance settings, to provide unobstructed viewing of instrument indicators and to permit instrument calibration and maintenance during normal operation of the Site.
- .3 Tubing installations shall slope down 20 mm per 2 meters of run to process connections.
- .4 Support tubing in channel or raceway if exposed or in close proximity to rotating equipment or high traffic areas. Otherwise, do not exceed 1 m between tubing supports.
- .5 All turns shall have a minimum bending radius of 50 mm.
- .6 Avoid non-terminal connections in tubing runs.
- .7 Use Teflon tape on all threaded fittings. Do not apply tape on the first two threads.
- .8 Tubing shall terminate at devices with fittings or 90° bends so as to allow removal of tubing without disturbing the device mounting.
- 9 Complete the final 300 mm (nominal) of air tubing to instruments or control valves installed in process equipment with flexible reinforced neoprene hose. Support the tubing at the hose connection. Locate the hose connection to facilitate unrestricted removal of the instrument or control valve and to minimize transmission of process equipment vibration into the tubing.

#### PROCESS TAPS AND PRIMARY ELEMENTS

## 1. GENERAL

#### 1.1 References - General

.1 Equipment, Products and Execution must meet all requirements detailed in Section 17010.

## 2. PRODUCTS

# 2.1 Process Taps

.1 Provide pressure gauge and thermowell taps in accordance with Division 11.

## 2.2 Primary Elements

- .1 Provide primary elements and transmitters as shown on the Piping and Instrumentation Diagrams (P&IDs) and specified in Division 11.
- .2 Provide written assurance that the instrument Manufacturer approves the selection for the primary element materials that are in contact with the specified process fluid and certifies that the materials are inert to the effects of the process fluid.
- .3 Provide drip pots for sensing elements measuring gas. Provide seamless, stainless steel drip pots consisting of a 50mm by 300mm 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.
- .4 Provide diaphragm seals for any fluid other than clean water or glycol.
- .5 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.
- .6 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)

#### TRANSMITTERS AND INDICATORS

#### 1. GENERAL

#### 1.1 References - General

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

#### 2. PRODUCTS

## 2.1 Transmitters and Indicators

- .1 Provide transmitters and indicators as shown on the Piping and Instrumentation Diagrams (P&IDs) and specified in Division 11.
- .2 Transmitters shall have adequate power output to drive all devices associated with the signal loop. Provide signal boosters as required to achieve adequate signal strength or to isolate the signal.
- .3 All transmitters to have local indication scaled in engineering units. 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 operations personnel.
- .4 Remote indicators provided by Crompton Instruments, Simpson or Newport are acceptable for use.
- .5 Where the 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.
- .6 Where available as an option, the transmitter shall be supplied with an isolated fault contact.
- .7 Standard of acceptance for instrumentation shall be as follows:
  - .1 Magnetic Flow Transmitters: Rosemount 8700 Series, ABB Magmaster, Fischer and Porter. Endress and Hauser.
  - .2 Thermal Mass Flow Transmitters: ABB, Brooks.
  - .3 Variable area Flow Transmitters: Omega, Kobold
  - .4 Pressure Transmitters: Rosemount Model 3051, ABB or Foxboro complete with stainless steel two (2) and three (3) valve manifolds as manufactured by Anderson Greenwood.
  - .5 Pressure Gauges: Ashcroft, H.O. Trerice, Budenberg.
  - .6 Ultrasonic Level Transmitters: Siemens Multiranger 100/200, Magnetrol, Endress & Hauser.

## TRANSMITTERS AND INDICATORS

- .7 Radar Level Transmitters: Endress & Hauser, Siemens, Magnetrol.
- .8 Magnetic Level Indication: Krohne, Magnetrol, K-Tek KM26.
- .9 Sludge Blanket Level: Partech, Siemens.
- .10 Temperature Transmitters (RTD): Rosemount, ABB, Foxboro.
- 11 pH Sensors: Rosemount, Endress and Hauser, ABB, Foxboro 870 Series.
- .12 Turbidity Sensors: Hach, Rosemount, Endress and Hauser.
- .13 Chlorine Residual Analyzers: Wallace & Tiernan, Rosemount, Endress and Hauser.
- .14 Dissolved Oxygen (DO) Sensors: GLI International, Royce Instruments, Capital Controls.
- .15 Ozone Analyzer: Crowcon.
- .16 Dew/Moisture Measurement: Veronics.
- .17 Particle Counter Analyzer: Hach.
- .18 Suspended Solids Analyzer: Hach.
- .19 Monochloramine Analyzer: Hach.
- .20 Power Meters: Power Measurement Limited (PML).
- .21 Gas Detection Systems: Draeger, MSA, Crowcon.

# 3. EXECUTION

# 3.1 References - General

.1 Refer to Section 17010.

## **POWERED ACTUATORS**

## 1. GENERAL

#### 1.1. Work Included

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

## 1.2. Related Work

.1 General Process Provisions:

Division 11

#### **1.3.** Submittals for Review

- .1 Provide Submittals in accordance with Division 1 and Section 17010.
- .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.

# 1.4. Submittals for Information Only

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

#### 1.5. Service Conditions

- .1 Provide electrical enclosures rated for wet and corrosive areas.
- .2 Control air to be instrument quality, oil free, supplied between 555 kPa minimum to 810 kPa maximum pressure.
- .3 Refer to the Instrument Specification Sheets in Section 17701 for process and design conditions.
- .4 Refer to Section 17010 for additional details.

#### **POWERED ACTUATORS**

## 1.6. Shipment

.1 Ship equipment in accordance with Division 1 and Section 17010.

# 1.7. Delivery

- .1 Deliver valves and actuators to Site use loading methods which do not damage casings or coatings.
- .2 Clearly tag all control valves and actuators, stating size, type, coatings and mating parts.

#### 1.8. Process Valve and Actuator Schedules

- .1 Refer to the Piping and Instrumentation Diagrams (P&IDs) and the instrument index for valve and actuator identification and for details. Power actuated devices which require automation, as shown on the P&IDs, have their actuators and all ancillary instrumentation specified under Division 17. The device material Specifications are found under Division 11.
- .2 Actuator abbreviations are described in part 2.2 of this Section.

## 2. PRODUCTS

## 2.1. General

- .1 Provide new material only.
- .2 Provide all actuator mounting hardware and accessories mounted on the device prior to shipment.
- .3 Provide actuators of National Electrical Manufacturers Association (NEMA) 4 construction, suitable for use in an industrial environment.
- .4 Provide device and actuator as a matched set from the same Manufacturer wherever possible.
- .5 Where available as an option, actuators shall be provided with Modbus/TCP communications capability.
- .6 Tag the control devices, accessories and actuators to indicate operating characteristics. Tag the actuator inlet and outlet ports for electric or pneumatic services. Electric actuators must be Canadian Standards Association (CSA) approved.
- .7 Refer to Section 17140 for air sets.
- .8 Refer to Section 17140 for solenoid valves

## 2.2. Actuator Types

- .1 Pneumatic Diaphragm Actuators General
  - .1 Provide diaphragm quarter turn and linear actuators capable of continuous duty over the full operating range.
  - .2 Unless specified otherwise, the actuators shall fail to the open position when the control function fails or when pressure is removed from the actuator diaphragm.
  - .3 Each actuator shall be capable of operating in any horizontal or vertical orientation.
  - .4 When manual actuation is specified, fit each actuator with a hand wheel mounted in line with the valve shaft, which will enable manual override control of the valve.
  - .5 House all internal components in a cast iron enclosure, drip-proof and corrosion-proof.
- .2 Pneumatic Diaphragm Quarter Turn Actuators, Modulating Type (PDQM)
  - .1 Diaphragm operators to be suitable for mounting on quarter turn valves intended for modulating service.
- .3 Pneumatic Diaphragm Linear Actuators, Modulating-Type (PDLM)
  - .1 Diaphragm operators to be suitable for mounting on sliding-stem valves and dampers requiring linear actuation intended for modulating service.
- .4 Pneumatic Diaphragm Quarter Turn Actuators, Open/Close-Type (PDQO)
  - .1 Diaphragm operators to be suitable for mounting on quarter turn valves intended for on/off service.
  - .2 Provide a solenoid valve, an air set and accessories as detailed on the Instrument Specification Sheets for each actuator.
  - .3 Provide two needle valves (snubbers) for each actuator. The needle valves control instrument air flows such that the actuator travels a full stroke within a time range adjustable from 1 to 30 seconds with separate adjustments for each direction of travel.
- .5 Pneumatic Piston Actuators General
  - .1 Provide piston actuators that are rated for continuous duty over the full operating range.
  - .2 Unless specified otherwise, the actuators will fail to the open position when the control function fails or when pressure is removed from the actuator diaphragm.
  - .3 When manual actuation is specified, fit each actuator with a hand wheel to enable manual override control of the valve.

- .4 Each actuator shall be capable of operating in any horizontal or vertical orientation.
- .5 House internal components in a drip-proof and corrosion proof cast iron enclosure.
- .6 Where valves are intended to fail open or closed, provide spring loaded actuators. Where they are intended to fail to last operating position, provide double acting actuators.
- .6 Pneumatic Piston Quarter Turn Actuator, Modulating Type (PPQM)
  - .1 Piston actuators to be suitable for mounting on quarter turn valves or dampers intended for modulating service.
- .7 Pneumatic Piston Quarter Turn Actuator, Open/Close Type (PPQO)
  - .1 Piston operators to be suitable for mounting on quarter turn valves or dampers intended for on/off service. Sector types are not permitted
  - .2 Provide actuator accessories such as limit switches and position switches as described in the Instrument Specification Sheets and in Section 17216.
  - .3 Provide two needle valves (snubbers) for each actuator. The needle valves control instrument air flows such that the actuator travels a full stroke within a time range of 1 to 30 seconds with separate adjustments for each direction.
- .8 Electro-Mechanical Actuators, General
  - .1 Unless noted otherwise, the actuator will fail to the last position when the control function or power fails.
  - .2 Unless otherwise specified, electric actuators to be 120 VAC, 1 phase, 60 Hz for service where required torque is less than 115 N-m and 600 VAC, 3 phase, 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.
  - .3 Approved electric actuator Manufacturers are Limitorque and Rotork.
- .9 Electric Quarter Turn Actuators, Open/Close Type (EMQO) and Modulating Type (EMQM)
  - .1 Provide electric operators suitable for mounting on quarter turn valves or dampers intended for on/off and modulating service.
  - .2 Provide each actuator with built-in motor overload protection.
  - .3 Fit each actuator with a hand wheel which will enable manual override control of the valve.
  - .4 Each actuator shall 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 a moisture and corrosion resistant Electrical & Electronic Manufacturer's Association of Canada (EEMAC) 4 enclosure. Internal components shall be permanently lubricated.
- .7 Motors will be rated at 20 percent intermittent duty cycle.
- .8 For remote indication provide the actuator with two 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 shall accept a 4-20 mA control signal for remote proportional control.
- .10 Electric Linear Actuators, Open/Close Type (EMLO) and Modulating Type (EMLM)
  - .1 Electric actuators for gates to be comprised of an electric motor and one or two gear boxes, depending on the gate design.
  - .2 Provide a sufficiently sized motor to seat and unseat gates and, if necessary, for control to traverse from full open to full closed position in small increments in response to control signals.
  - .3 The actuator will impart a travel speed of 2.5 m/hr to modulating gates and 18.0 m/h to open/close gates unless otherwise specified on the Instrument Specification Sheets. The actuator speed shall 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 reverse phase rotation.
  - .6 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.

- .7 House the internal components of actuators and related gear boxes in weather proof, corrosion proof metal enclosures. Electrical components shall be contained in EEMAC 6 enclosures. All electrical and mechanical components shall be capable of continuous operation in an ambient temperature range of -40°C to plus 40°C.
- .8 Provide a space heater for each actuator.
- .9 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 1:1 gearing ratio with respect to the main drive shaft for the hand wheel.
- .10 Fit removable safety guards over all moving drive train components between the actuator and each gear box.
- .11 Provide adjustable limit switches on each actuator to define the upper and lower limits of the stroke.
- .12 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.
- .13 Provide a controller enclosure to contain a motor contactor complete with overload protection. Provide line, load and external control terminal strips.
- .14 Fit each actuator with an electronic positioner to control gate elevation in response to a continuous 4-20 mA DC input signal.
- .15 Provide a local operating station with a Computer-Off-Hand switch and an Open-Close switch

### 2.3. Current to Pneumatic (I/P) Converters

- .1 Provide I/P converters where required, as indicated on the Drawings.
- .2 Supply all required hardware for mounting the I/P converter on the controlled device.
- .3 I/P converter shall be of EEMAC 4 construction.
- .4 I/P converter to operate with instrument quality, control air at an operating pressure range of 20 to 200 kPa.
- .5 Approved I/P converter Manufacturers are Omega and Moore.

### 2.4. Valve Positioners

- .1 Supply compatible positioners pre-mounted to each actuator. Do not mount the positioner upside down.
- .2 Each positioner shall service the entire operating range of the actuator. The equipment position shall be fed back to the positioner through a mechanical linkage.
- .3 Positioner shall operate with instrument quality, oil-free control air.
- .4 Provide three independent, interchangeable cams for each positioner linear function, square function, and square root function.
- .5 Mount a pressure gauge on the positioner to measure air output.

### 2.5. Position Switches and indicators

- .1 Actuator position switches shall include two (2) form C 2 amp contacts in an EEMAC 4 (minimum) rated enclosure.
- .2 Cams shall be fastened to a splined shaft and adjustable without set screws.
- .3 Provide a visual indicator with beacon type display showing red when the controlled device is open and green when the device is closed.
- .4 Supply all required hardware for mounting of the position monitor in accordance with the specified valve/actuator orientation.
- .5 Diaphragm actuated valves shall have external position monitor actuated through linkages.
- .6 Enclosures are to be suitable for the environment.

# 2.6. Manual Loading Station

- .1 Manual loading station shall consist of a manually adjustable loading regulator, changeover valve (manual/automatic), a gauge for manual signal pressure indication, a gauge for automatic signal pressure indication, an air set, and an air supply isolating valve.
- .2 Mount loading station on a galvanized plate attached to a floor stand. Locate station within 2 m of the controlled device.

# 2.7. Minimum monitoring and control signal requirements

- .1 Open Close actuators:
  - .1 Momentary Open Command (Remote dry contact).
  - .2 Momentary Close Command (Remote dry contact).

- .3 Open Status (Dry contact for remote indication).
- .4 Closed Status (Dry contact for remote indication).
- .5 Computer (Remote) Mode (Dry contact for remote indication).
- .6 Remote dry contacts will be rated 2 Amps at 120 VAC minimum.

## .2 Modulating actuators:

- .1 Input signal: 4-20 mA for position control from programmable logic controller (PLC).
- .2 Output signal: 4-20 mA to PLC for position monitoring.
- .3 Computer (Remote) Mode (Dry contact for remote indication).

## 3. EXECUTION

## 3.1. Field Testing and Commissioning

- .1 Provide performance and installation verification in accordance with Division 1 and Section 17010, Part 3.
- .2 Factory test each actuator assembly prior to shipment.

## 3.2. Training

.1 Provide training in accordance with Division 1.

### **SWITCHES AND RELAYS**

## 1. GENERAL

### 1.1 References - General

.1 Refer to Section 17010.

## 2. PRODUCTS

### 2.1 General

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

## 2.2 Indicators, Pushbuttons, and Selector Switches

- .1 All control indicator lamps, pushbutton switches and selector switches in unclassified or non-corrosive areas to be Allen Bradley 800T or 800E series items or Cutler Hammer 10250T series.
- 2 All control indicator lamps, pushbutton switches, and selector switches in classified or corrosive (includes outdoors) areas to be Allen Bradley 800H series items or Cutler Hammer E34 series.
- .3 Enclosures are specified under Section 17110 Enclosures.
- .4 All control indicator lamps shall be push-to-test type.

## 2.3 Relays

.1 The quality and type of relays shall be based on Omron types. Other acceptable Manufacturers are Idec and Potter & Brumfield.

### **SWITCHES AND RELAYS**

- .2 120 VAC relays to be Model LY 4PDT, plug-in, complete with test button, operation indicator, and surge suppressor.
- .3 24 VDC relays to be Model MY 2PDT, plug-in, complete with test button, 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 setting 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.

### 2.4 Process Switches

- .1 Standard of acceptance for instrumentation shall be as follows:
  - .1 Thermal Flow Switches: Ifm, Weber.
  - .2 Pressure Switches (Electronic): Ifm, United Electric.
  - .3 Pressure Switches (Conventional): Ashcroft, United Electric, Barksdale.
  - .4 Conductivity Level Switches: Endress & Hauser.
  - .5 Vibration Type Level Switches: Endress & Hauser.
  - .6 Float Switches: Flygt, Consolidated Electric, Warwick, Magnetrol.
  - .7 Capacitance Level Switches: Siemens, Endress & Hauser.
  - .8 Admittance Level Switches: Magnetrol, Bestobell.
  - .9 Temperature Switches: Ifm.

# **SWITCHES AND RELAYS**

# 3. EXECUTION

# 3.1 References – General

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

### SIGNAL CONDITIONING MODULES

## 1. GENERAL

## 1.1 References - General

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

## 2. PRODUCTS

## 2.1 Signal Conditioning Modules

- .1 Where required, provide signal conditioning modules that comply with the following requirements, unless otherwise specified:
  - .1 Analog signal inputs: 4-20 mA DC into 500 ohms.
  - .2 Analog signal outputs: 4-20 mA DC into 500 ohms.
  - .3 Discrete output contacts: SPDT rated 5A, 120 VAC.
  - .4 Arrange electronic trips so that output contact opens in case of loss of signal or loss of power supply.
  - .5 Modules to be rated for continuous operation in an ambient temperature of 0 to 80°C. Ambient temperature effect not to exceed plus or minus 0.01% per °C within that range.
  - .6 Span and zero adjustments to be made by front accessible multi-turn potentiometers or keypad.
  - .7 Provide electronic trip modules with L.E.D. indicators for relay status.
  - Modules to withstand 30 volts per meter radio frequency radiation between 200 and 500 MHz with not more than 0.25% calibration effect. Provide modules with traps on the terminals to shunt conducted radio frequency interference to ground.
  - .9 Galvanically isolate signal and power supply terminals from the case.
- .2 All modules specified in this Section to be the Product of a single Manufacturer.

# 2.2 Current to Pneumatic (I/P) Converters

.1 Refer to Section 17213 – Powered Actuators, Item 2.3.

# SIGNAL CONDITIONING MODULES

# 3. EXECUTION

# 3.1 References – General

.1 Refer to Section 17010 – Instrumentation and Control General Requirements, Part three (3).

### PANEL INSTRUMENTS

## 1. GENERAL

### 1.1 References - General

.1 Equipment, Products and Execution must meet all requirements detailed in Section 17010.

## 2. PRODUCTS

## 2.1 Electronic Panel Instruments

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

### 3. EXECUTION

## 3.1 References - General

.1 Refer to Section 17010.

### MISCELLANEOUS PANEL DEVICES

## 1. GENERAL

### 1.1 References - General

.1 Equipment, Products and Execution must meet all requirements detailed in Section 17010.

### 2. PRODUCTS

## 2.1 Miscellaneous Panel Devices

# .1 Pilot Lights

.1 Provide pilot lights of the 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 volts.
- .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 for nameplate Specification.

## 2.2 Signal Current Isolator

.1 Isolators shall be installed to provide galvanic isolation of milliamp transmission signals from transmitters with inadequately isolated output circuits.

### MISCELLANEOUS PANEL DEVICES

- .2 Isolator to be housed in a National Electrical Manufacturers Association (NEMA) 250, Type 4/7 conduit body and derive its operating power from the signal input circuit.
- .3 Input and output signals shall be 4-20 mA, with an error not exceeding 0.1 percent of span. Input resistance will not exceed 550 ohms with an output load of 250 ohms.
- .4 Approved Manufacturers are Moore Industries, Weidmuller or Phoenix.

## 2.3 Intrinsic Safety Barriers and Relays

- .1 Provide intrinsic safety barriers where required for two-wire transmitters of the active, isolating, loop powered type; MTL Type MT3042, Stahl 9005/01-252/100/00, 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.

## 2.4 Industrial Ethernet Switches

- .1 Install Ethernet Switches in all control panels housing programmable logic controllers (PLCs) that interface to the plant control and operator interface network. Connect to PLC's, 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 Institute of Electrical and Electronic Engineers (IEEE) 802.3, 802.3u, 802.3x, 802.1D.
- .3 Switches shall include a minimum of 5 10/100 Base T(x) RJ45 Ports and 2 multimode 100 Base FX Fiber ports.
- .4 Switches shall include one (1) relay output alarm contact rated for 1A@24VDC.
- .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.

## 2.5 Fiber Termination Panel

.1 Install a fiber termination panel suitable for the termination of two 12-strand multimode fiber optic cables in all control panels housing PLCs, PLC remote I/O racks, or Human Machine Interfaces (HMI) that interface to the plant control and operator interface network.

# MISCELLANEOUS PANEL DEVICES

# 3. EXECUTION

# 3.1 References - General

.1 Refer to Section 17010, Part 3.

### **GAS DETECTION SYSTEMS**

## 1. GENERAL

## 1.1 Description

- .1 This Section specifies the supply, installation, testing and commissioning of gas detection systems.
- .2 Use this Specification in conjunction with Section 17010.

## 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 Canadian Standards Association (CSA) C22.1.

# 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, 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.

## 2.2 Details

.1 The gas detection system will monitor for concentrations of Ozone.

### **GAS DETECTION SYSTEMS**

- .2 Provide sensors and calibrators as specified on the Instrumentation Specification Sheets in Section 17701.
- .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 Electrical & Electronic Manufacturer's Association of Canada (EEMAC) 4X.
- .4 Power gas monitors from separate breakers located in a UPS powered panel board in the electrical room.
- .5 Refer to the requirements of Section 17010 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, 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, 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.
  - .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 Commissioning & Start-up

## **GAS DETECTION SYSTEMS**

.1 Commissioning and start-up shall be performed in accordance with CSA Standard C22.2 No. 152 and the requirements of Section 17010, 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.

### PROGRAMMABLE LOGIC CONTROLLERS

## 1. GENERAL

## 1.1 References - General

.1 Equipment, Products and Execution must meet all requirements detailed in Section 17010.

### 1.2 Work Included

- .1 Design, supply, and installation of a programmable logic controller (PLC)-based control system that will control and monitor the system in accordance with the requirements defined in Division 11.
- .2 PLC's and Inputs/Outputs (I/O) shall be housed in a central control panel.
- .3 PLC's shall be programmed using the latest version of Schneider Electric's Unity Programming Software. The program shall be fully documented and programmed according to standards that will be provided by the Contract Administrator.
- .4 The final PLC configuration program shall be provided to the City on compact disk.
- .5 Start-up and commissioning assistance as required for the control system.

### 1.3 Related Work

1 General Process Provisions:

Division 11

## 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 PLC network shall be Modbus/TCP. Ethernet communication modules shall be provided in each PLC 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.

### PROGRAMMABLE LOGIC CONTROLLERS

- .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 uninterruptible power supply (UPS) system. Each new PLC panel assembly shall include Sola Hevi-Duty STV100K series incoming power transient 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 Section 11490, 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 commissioning of the control system.
- .2 Supply, Install, test, and commission the PLC Control Panel as specified in this Section and as shown on the Drawings.
- 3 Assist the Systems Integrator to establish communication with the PLC's. Test data exchange between the PLC's and the plant control network as defined in this Section and the process description.

# PROGRAMMABLE LOGIC CONTROLLERS

# 3. EXECUTION

# 3.1 References – General

.1 Refer to Section 17010, Part three (3).

## **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 reconfigure 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 programmable logic controller (PLC) control system to the plant control system.

### **OPERATOR INTERFACE REQUIREMENTS**

- .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 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 Piping and Instrumentation Diagrams (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, Part three (3).

## 3.2 Installation

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

# OPERATOR INTERFACE REQUIREMENTS

requirements for I/O, local control equipment details, and detailed system operation descriptions.

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