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DRAWING LIST

P001 PROCESS FLOW DIAGRAM
P101 PROCESS BASEMENT AND GROUND FLOOR REMOVALS AND UPGRADE PLANS
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PWGSC Ontario
Region Project
Number 450-2431

SPECIFICATION
TITLE SHEET

Section 00 00 00
Page 1
2017-05-02

PROJECT TITLE

JOYCEVILLE WATER TREATMENT PLANT GAC PUMP
REPLACEMENT AND MODIFICATIONS TO BACKWASH PIPING

PROJECT NUMBER

450-2431

PROJECT DATE

2017-05-02

PART 1 - GENERAL

1.1 SECTION
INCLUDES

- .1 Description of Work.
- .2 Contract Method.
- .3 Cost Breakdown
- .4 Work by others.
- .5 Work sequence.
- .6 Contractor use of premises.
- .7 Owner occupancy.

1.2 PRECEDENCE

- .1 For Federal Government projects, Division 01 Sections take precedence over technical specification sections in other Divisions of this Project Manual.

1.3 DESCRIPTION OF
WORK

- .1 This Project generally consists of the removal of four (4) submersible pumps and controls to be replaced by two (2)VFD controlled vertical well pumps to transfer treated water to the granular activated carbon(GAC)tanks. The GAC tanks are to be stripped down, re-coated, the media replace and the tank re-built. Additionally, a new backwash magnetic flow meter is to be installed with new process piping and valves.

1.4 WORK COVERED BY
CONTRACT DOCUMENTS

- .1 Work of this Contract comprises all process mechanical and electrical work require for a fully function refurbishment of the GAC tanks, new GAC pumps and new magnetic flow meter installation.

1.5 CONTRACT METHOD

- .1 Construct work under lump sum contract.
- .2 Relations and responsibilities between Contractor and subcontractors and suppliers assigned by Owner are as defined in Conditions of Contract. Assigned Subcontractors must, in addition:
 - .1 Furnish to Contractor, bonds covering faithful performance of subcontracted work and payment of obligations thereunder when Contractor is required to furnish such bonds to Departmental Representative.
 - .2 Purchase and maintain liability insurance to protect Contractor from claims for not less than limits of liability which Contractor is required to provide

to Departmental Representative.

1.6 COST BREAKDOWN

- .1 Within 48 hours of notification of acceptance of bid furnish a cost breakdown by Section aggregating contract price.
- .2 Show separately cost of equipment purchased exempt from Ontario Retail Sales Tax under your Ontario Sales Tax licence number.
- .3 Within 48 hours of acceptance of bid submit a list of subcontractors.

1.7 WORK BY OTHERS

- .1 The Contractor shall for the purpose of the Ontario Occupational Health and Safety Act and Regulations for Construction Projects, and for the duration of the Work of the Contract:
 - .1 Assume the role of Constructor in accordance with the Authority Having Jurisdictions.
 - .2 SCADA integration to be provided by owner.

1.8 WORK SEQUENCE

- .1 Construct Work in stages to accommodate Owner's continued use of premises during construction.
- .2 Coordinate Progress Schedule.
- .3 Required stages:
 - .1 Isolate one GAC line.
 - .2 Refurbish GAC tank.
 - .3 Isolate one half GAC pumps and replace.
 - .4 Install new VFDs and wiring for mag meter.
 - .5 Install new mag meter and piping.
 - .6 Commission half system.
 - .7 Complete refurbishment and replacement of second half of system.
- .4 Maintain functional system throughout, coordinate length of shut-downs and installation with operations.

1.9 CONTRACTOR USE OF PREMISES

- .1 Contractor has restricted use of site until Substantial Performance.
- .2 Coordinate use of premises under direction of Owner.
- .3 Obtain and pay for use of additional storage or work areas needed for operations under this Contract.

1.10 OWNER
OCCUPANCY

- .1 Owner will occupy premises during entire construction period for execution of normal operations.
- .2 Cooperate with Owner in scheduling operations to minimize conflict and to facilitate Owner usage.

PART 2 - PRODUCTS

2.1 NOT USED

- .1 Not used.

PART 3 - EXECUTION

3.1 NOT USED

- .1 Not used.

PART 1 - GENERAL

1.1 USE OF SITE AND FACILITIES

- .1 Execute work with least possible interference or disturbance to normal use of premises. Make arrangements with Departmental Representative to facilitate work as stated.
- .2 Maintain existing services to building and provide for personnel and vehicle access.
- .3 Where security is reduced by work provide temporary means to maintain security.
- .4 Departmental Representative will assign sanitary facilities for use by Contractor's personnel. Keep facilities clean.
- .5 Closures: protect work temporarily until permanent enclosures are completed.

1.2 ALTERATIONS, ADDITIONS OR REPAIRS TO EXISTING BUILDING

- .1 Execute work with least possible interference or disturbance to normal use of premises. Arrange with Departmental Representative to facilitate execution of work.

1.3 EXISTING SERVICES

- .1 Notify, Departmental Representative utility companies of intended interruption of services and obtain required permission.
- .2 Where Work involves breaking into or connecting to existing services, give Departmental Representative 48 hours of notice for necessary interruption of mechanical or electrical service throughout course of work. Keep duration of interruptions minimum. Carry out interruptions after normal working hours of occupants, preferably on weekends.
- .3 Provide for personnel and vehicular traffic.
- .4 Construct barriers in accordance with Section 01 56 00.
- .5 When connecting to existing watermain, a maximum disruption time of 6 hours will be permitted.

1.4 SPECIAL
REQUIREMENTS

- .1 Submit schedule in accordance with Section 01 32 16.07 - Construction Progress Schedule - Bar (GANTT) Chart.
- .2 Ensure Contractor's personnel employed on site become familiar with and obey regulations including safety, fire, traffic and security regulations.
- .3 Keep within limits of work and avenues of ingress and egress.

PART 2 - PRODUCTS

2.1 NOT USED

- .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

- .1 Not Used.

PART 1 - GENERAL

1.1 SECTION
INCLUDES

- .1 Coordination Work with other contractors and work by Owner under administration of Departmental Representative.
- .2 Scheduled preconstruction, progress meetings.

1.2 RELATED
SECTIONS

- .1 Section 01 11 00 - Summary of Work.

1.3 DESCRIPTION

- .1 Coordination of progress schedules, submittals, use of site, temporary utilities, construction facilities, and construction Work, with progress of Work of other contractors, under instructions of Departmental Representative.

1.4 PROJECT
MEETINGS

- .1 Schedule and administer bi-weekly project meetings throughout progress of Work as determined by Departmental Representative.
- .2 Prepare agenda for meetings.
- .3 Distribute written notice of each meeting four days in advance of meeting date to Owner.
- .4 Physical space shall be provided for within the existing facility to accommodate meetings.
- .5 Preside at meetings.
- .6 Record minutes. Include significant proceedings and decisions. Identify action by parties.
- .7 Reproduce and distribute copies of minutes within three days after each meeting and transmit to meeting participants, affected parties not in attendance and Owner.

1.5 CONSTRUCTION
ORGANIZATION AND
START-UP

- .1 Within 15 days after award of Contract, request a meeting of parties in contract to discuss and resolve administrative procedures and responsibilities.
- .2 Senior representatives of the Owner, Contractor, major Subcontractors, field inspectors will be in attendance.

- .3 Establish time and location of meeting and notify parties concerned minimum 5 days before meeting.
- .4 Agenda to include following:
 - .1 Appointment of official representative of participants in Work.
 - .2 Schedule of Work, progress scheduling in accordance with Section 01 32 16.07.
 - .3 Schedule of submission of shop drawings, in accordance with Section 01 33 00.
 - .4 Requirements for temporary facilities, site sign, offices, storage sheds, utilities, fences in accordance with Section 01 51 00.
 - .5 Delivery schedule of specified equipment in accordance with Section 01 32 16.07.
 - .6 Site security in accordance with Section 01 52 00.
 - .7 Proposed changes, change orders, procedures, approvals required, mark-up percentages permitted, time extensions, overtime, and administrative requirements (GC).
 - .8 Record drawings in accordance with Section 01 78 00.
 - .9 Maintenance in accordance with Section 01 78 00.
 - .10 Commissioning in accordance with Section 01 91 00.
 - .11 Take-over procedures, acceptance, and warranties in accordance with Section 01 77 00 and 01 78 00.
 - .12 Monthly progress claims, administrative procedures, photographs, and holdbacks (GC).
 - .13 Appointment of inspection and testing agencies or firms in accordance with Section 01 45 00.
 - .14 Insurances and transcript of policies (GC).
- .5 Comply with Departmental Representative's allocation of mobilization areas of site; for field offices and sheds, for access, traffic, and parking facilities.
- .6 During construction coordinate use of site and facilities through Departmental Representative's procedures for intra-project communications: Submittals, reports and records, schedules, coordination of drawings, recommendations, and resolution of ambiguities and conflicts.
- .7 Comply with instructions of Departmental Representative for use of temporary utilities and construction facilities.
- .8 Coordinate field engineering and layout work with Departmental Representative.

1.6 ON-SITE
DOCUMENTS

- .1 Maintain at job site, one copy each of the following:
 - .1 Contract drawings.
 - .2 Specifications.
 - .3 Amendments.
 - .4 Reviewed shop drawings.
 - .5 Change orders.
 - .6 Other modifications to Contract.
 - .7 Field test reports.
 - .8 Copy of approved Work schedule.
 - .9 Manufacturers' installation and application instructions.
 - .10 Labour conditions and wage schedules.
 - .11 Material Safety Data Sheets.
 - .12 Labour and Material Bonds.
 - .13 All applicable Municipal Permits.

1.7 SCHEDULES

- .1 Submit preliminary construction progress schedule in accordance with Section 01 33 00 and Commissioning Schedule in accordance with Section 01 91 20 to Departmental Representative coordinated with Departmental Representative's project schedule.
- .2 After review, revise and resubmit schedule to comply with revised project schedule.
- .3 During progress of Work revise and resubmit as directed by Departmental Representative.

1.8 CONSTRUCTION
PROGRESS MEETINGS

- .1 During course of Work and 2 weeks prior to project completion, schedule progress meetings bi-weekly.
- .2 Schedule separate commissioning meetings in accordance with Section 01 91 20.
- .3 Contractor, major subcontractors involved in Work and Departmental Representative are to be in attendance.
- .4 Notify parties minimum 5 days prior to meetings.
- .5 Record minutes of meetings and circulate to attending parties and affected parties not in attendance within 3 days after meeting.
- .6 Agenda to include following:
 - .1 Review, approval of minutes of previous meeting.
 - .2 Review of Work progress since previous meeting.
 - .3 Field observations, problems, conflicts.
 - .4 Problems which impede construction schedule.
 - .5 Review of off-site fabrication delivery schedules.
 - .6 Corrective measures and procedures to regain projected schedule.
 - .7 Revision to construction schedule.
 - .8 Progress schedule, during succeeding work

period.

.9 Review submittal schedules: expedite as required.

.10 Maintenance of quality standards.

.11 Review proposed changes for affect on construction schedule and on completion date.

.12 Other business.

1.9 SUBMITTALS

- .1 Submit preliminary shop drawings, product data and samples in accordance with Section 01 33 00 and 01 91 20 for review for compliance with Contract Documents; for field dimensions and clearances, for relation to available space, and for relation to Work of other contracts. After review, revise and resubmit for transmittal to Departmental Representative.
- .2 Submit requests for payment for review, and for transmittal to Departmental Representative.
- .3 Submit requests for interpretation of Contract Documents, and obtain instructions through Departmental Representative.
- .4 Process substitutions through Departmental Representative.
- .5 Process change orders through Departmental Representative.
- .6 Deliver closeout submittals for review and preliminary inspections, for transmittal to Departmental Representative.

1.10 COORDINATION DRAWINGS

- .1 Provide information required by Departmental Representative for preparation of coordination drawings.
- .2 Review and approve revised drawings for submittal to Departmental Representative.

1.11 CLOSEOUT PROCEDURES

- .1 Notify Departmental Representative when Work is considered ready for Substantial Performance.
- .2 Accompany Departmental Representative on preliminary inspection to determine items listed for completion or correction.
- .3 Comply with Departmental Representative's instructions for correction of items of Work listed in executed certificate of Substantial Performance.
- .4 Notify Departmental Representative of instructions for completion of items of Work determined in Departmental

Representative's final inspection.

PART 2 - PRODUCTS

2.1 NOT USED .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED .1 Not Used.

PART 1 - GENERAL

1.1 DEFINITIONS

- .1 Activity: element of Work performed during course of Project. Activity normally has expected duration, and expected cost and expected resource requirements. Activities can be subdivided into tasks.
- .2 Bar Chart (GANTT Chart): graphic display of schedule-related information. In typical bar chart, activities or other Project elements are listed down left side of chart, dates are shown across top, and activity durations are shown as date-placed horizontal bars. Generally Bar Chart should be derived from commercially available computerized project management system.
- .3 Baseline: original approved plan (for project, work package, or activity), plus or minus approved scope changes.
- .4 Construction Work Week: Monday to Friday, inclusive, will provide five day work week and define schedule calendar working days as part of Bar (GANTT) Chart submission.
- .5 Duration: number of work periods (not including holidays or other nonworking periods) required to complete activity or other project element. Usually expressed as workdays or workweeks.
- .6 Master Plan: summary-level schedule that identifies major activities and key milestones.
- .7 Milestone: significant event in project, usually completion of major deliverable.
- .8 Project Schedule: planned dates for performing activities and the planned dates for meeting milestones. Dynamic, detailed record of tasks or activities that must be accomplished to satisfy Project objectives. Monitoring and control process involves using Project Schedule in executing and controlling activities and is used as basis for decision making throughout project life cycle.
- .9 Project Planning, Monitoring and Control System: overall system operated by Departmental Representative to enable monitoring of project work in relation to established milestones.

1.2 REQUIREMENTS

- .1 Ensure Master Plan and Detail Schedules are practical and remain within specified Contract duration.
- .2 Plan to complete Work in accordance with prescribed milestones and time frame.
- .3 Limit activity durations to maximum of approximately 10 working days, to allow for progress reporting.
- .4 Ensure that it is understood that Award of Contract or time of beginning, rate of progress, Certificate of Substantial Performance and Certificate of Completion as defined times of completion are of essence of this contract.

1.3 SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00.
- .2 Submit to Departmental Representative within 5 working days of Award of Contract Bar (GANTT) Chart as Master Plan for planning, monitoring and reporting of project progress.
- .3 Submit Project Schedule to Departmental Representative within 5 working days of receipt of acceptance of Master Plan.

1.4 PROJECT MILESTONES

- .1 **Certificate of Substantial Performance: Thursday, November 30, 2017 for completion of all works including reinstatement.**

1.5 MASTER PLAN

- .1 Structure schedule to allow orderly planning, organizing and execution of Work as Bar Chart (GANTT).
- .2 Departmental Representative will review and return revised schedules within 5 working days.
- .3 Revise impractical schedule and resubmit within 5 working days.
- .4 Accepted revised schedule will become Master Plan and be used as baseline for updates.

1.6 PROJECT SCHEDULE

- .1 Develop detailed Project Schedule derived from Master Plan.
- .2 Ensure detailed Project Schedule includes as minimum milestone and activity types as follows:

- .1 Award.
- .2 Shop Drawings, Samples.
- .3 Permits.
- .4 Mobilization.
- .5 Electrical.
- .6 Piping.
- .7 Controls.
- .8 Testing and Commissioning.

1.7 PROJECT
SCHEDULE REPORTING

- .1 Update Project Schedule on weekly basis reflecting activity changes and completions, as well as activities in progress.
- .2 Include as part of Project Schedule, narrative report identifying Work status to date, comparing current progress to baseline, presenting current forecasts, defining problem areas, anticipated delays and impact with possible mitigation.

1.8 PROJECT
MEETINGS

- .1 Discuss Project Schedule at regular site meetings specified in Section 01 31 19, identify activities that are behind schedule and provide measures to regain slippage. Activities considered behind schedule are those with projected start or completion dates later than current approved dates shown on baseline schedule.
- .2 Weather related delays with their remedial measures will be discussed and negotiated.

PART 2 - PRODUCTS

2.1 NOT USED

- .1 Not used.

PART 3 - EXECUTION

3.1 NOT USED

- .1 Not used.

PART 1 - GENERAL

1.1 ADMINISTRATIVE

- .1 Submit to Departmental Representative submittals listed for review. Submit promptly and in orderly sequence to not cause delay in Work. Failure to submit in ample time is not considered sufficient reason for extension of Contract Time and no claim for extension by reason of such default will be allowed.
- .2 Do not proceed with Work affected by submittal until review is complete.
- .3 Present shop drawings, product data, samples and mock-ups in SI Metric units.
- .4 Where items or information is not produced in SI Metric units converted values are acceptable.
- .5 Review submittals prior to submission to Departmental Representative. This review represents that necessary requirements have been determined and verified, or will be, and that each submittal has been checked and co-ordinated with requirements of Work and Contract Documents. Submittals not stamped, signed, dated and identified as to specific project will be returned without being examined and considered rejected.
- .6 Notify Departmental Representative, in writing at time of submission, identifying deviations from requirements of Contract Documents stating reasons for deviations.
- .7 Verify field measurements and affected adjacent Work are co-ordinated.
- .8 Contractor's responsibility for errors and omissions in submission is not relieved by Departmental Representative's review of submittals.
- .9 Contractor's responsibility for deviations in submission from requirements of Contract Documents is not relieved by Departmental Representative review.
- .10 Keep one reviewed copy of each submission on site.
- .11 Submit number of hard copies specified for each type and format of submittal and also submit in electronic format as pdf files. Forward pdf files on CD or through email.

1.2 SHOP DRAWINGS
AND PRODUCT DATA

- .1 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by Contractor to illustrate details of a portion of Work.
- .2 Where technical sections specify that shop drawings bear stamp of registered Professional Engineer. Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario of Canada.
- .3 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been co-ordinated, regardless of Section under which adjacent items will be supplied and installed. Indicate cross references to design drawings and specifications.
- .4 Allow 5 working days for Departmental Representative's review of each submission.
- .6 Adjustments made on shop drawings by Departmental Representative are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Departmental Representative prior to proceeding with Work.
- .7 Make changes in shop drawings as Departmental Representative may require, consistent with Contract Documents. When resubmitting, notify Departmental Representative in writing of revisions other than those requested.
- .8 Accompany submissions with 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 data and sample.
 - .5 Other pertinent data.
- .9 Submissions shall include:
 - .1 Date and revision dates.
 - .2 Project title and number.
 - .3 Name and address of:
 - .1 Subcontractor.
 - .2 Supplier.
 - .3 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 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 Relationship to adjacent work.
- .11 Equipment identification tag.

- .10 After Departmental Representative's review, distribute copies.
- .11 Submit three hard copies and one electronic copy of shop drawings for each requirement requested in specification Sections and as Departmental Representative may reasonably request.
- .12 Submit three hard copies and one electronic copy of product data sheets or brochures for requirements requested in specification Sections and as requested by Departmental Representative where shop drawings will not be prepared due to standardized manufacture of product.
- .13 Submit three hard copies and one electronic copy of test reports for requirements requested in specification Sections and as requested by Departmental Representative.
 - .1 Report signed by authorized official of testing laboratory that material, product or system identical to material, product or system to be provided has been tested in accord with specified requirements.
 - .2 Testing must have been within 3 years of date of contract award for project.
- .14 Submit three hard copies and one electronic copy of certificates for requirements requested in specification Sections and as requested by Departmental Representative.
 - .1 Statements printed on manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that product, system or material meets specification requirements.
 - .2 Certificates must be dated after award of project contract complete with project name.
- .15 Submit three hard copies and one electronic copy of manufacturers instructions for requirements requested in specification Sections and as requested by

Departmental Representative.

.1 Pre-printed material describing installation of product, system or material, including special notices and Material Safety Data Sheets concerning impedances, hazards and safety precautions.

.16 Submit three hard copies and one electronic copy of Manufacturer's Field Reports for requirements requested in specification Sections and as requested by Departmental Representative.

.17 Documentation of the testing and verification actions taken by manufacturer's representative to confirm compliance with manufacturer's standards or instructions.

.18 Submit three hard copies and one electronic copy of Operation and Maintenance Data for requirements requested in specification Sections and as requested by Departmental Representative.

.19 Delete information not applicable to project.

.20 Supplement standard information to provide details applicable to project.

.21 If upon review by Departmental Representative, no errors or omissions are discovered or if only minor corrections are made, copies will be returned and fabrication and installation of Work may proceed. If shop drawings are rejected, noted copy will be returned and resubmission of corrected shop drawings, through same procedure indicated above, must be performed before fabrication and installation of Work may proceed.

.22 The review of shop drawings by Public Works and Government Services Canada (PWGSC) is for sole purpose of ascertaining conformance with general concept.

.1 This review shall not mean that PWGSC approves detail design inherent in shop drawings, responsibility for which shall remain with Contractor submitting same, and such review shall not relieve Contractor of responsibility for errors or omissions in shop drawings or of responsibility for meeting requirements of construction and Contract Documents.

.2 Without restricting generality of foregoing, Contractor is responsible for dimensions to be confirmed and correlated at job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for co-ordination of Work of sub-trades.

1.3 SAMPLES

- .1 Submit for review samples in duplicate as requested in respective specification Sections. Label samples with origin and intended use.
- .2 Deliver samples prepaid to Departmental Representative's business address.
- .3 Notify Departmental Representative in writing, at time of submission of deviations in samples from requirements of Contract Documents.
- .4 Where colour, pattern or texture is criterion, submit full range of samples.
- .5 Adjustments made on samples by Departmental Representative are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Departmental Representative prior to proceeding with Work.
- .6 Make changes in samples which Departmental Representative may require, consistent with Contract Documents.
- .7 Reviewed and accepted samples will become standard of workmanship and material against which installed Work will be verified.

1.4 MOCK-UPS

- .1 Erect mock-ups in accordance with Section 01 45 00.

1.5 PHOTOGRAPHIC DOCUMENTATION

- .1 Submit electronic colour digital photography in jpg format, fine resolution monthly with progress statement and as directed by Departmental Representative.
- .2 Project identification: name and number of project and date of exposure indicated.
- .3 Number of viewpoints:
 - .1 Viewpoints and their location as determined by Departmental Representative.
- .4 Frequency of photographic documentation: monthly and at completion of: demolition/removals, areas and supports installed prior to equipment install, installed equipment prior to commissioning and final product, and as directed by Departmental Representative.

1.6 CERTIFICATES AND TRANSCRIPTS

- .1 Immediately after award of Contract, submit Workers' Safety and Insurance Board Experience Report.

1.7 FEES, PERMITS
AND CERTIFICATES

- .2 Submit transcription of insurance immediately after award of Contract.
- .3 Security Clearance requirements for all workers on the job site.
- .1 Provide authorities having jurisdiction with information requested.
- .2 Pay fees and obtain certificates and permits required.
- .3 Furnish certificates and permits.
- .4 Submit acceptable certificate stating that suspended ceiling systems provide adequate support for electrical fixtures, as required by current bulletin of Electrical Inspection Department of Ontario Hydro.

PART 2 - PRODUCTS

2.1 NOT USED

- .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

- .1 Not Used.

-
- 1 PURPOSE .1 To ensure that both the construction project and the institutional operations may proceed without undue disruption or hindrance.
- 2 DEFINITIONS .1 "Contraband" means:
.1 An intoxicant.
.2 A weapon or a component thereof, ammunition for a weapon, and anything that is designed to kill, injure or disable a person or that is altered so as to be capable of killing, injuring or disabling a person, when possessed without prior authorization.
.3 An explosive or a bomb or a component thereof.
.4 Currency over any applicable prescribed limit, when possessed by an inmate without prior authorization.
.5 Any item not described in paragraphs 2.1.1 to 2.1.4 that could jeopardize the security of a Penitentiary or the safety of persons, when that item is possessed without prior authorization.
- .2 "Commercial Vehicle" means any motor vehicle used for the shipment of material, equipment and tools required for the construction project.
- .3 "CSC" means Correctional Service Canada.
- .4 "Director" means Director, Warden or Superintendent of the Institution as applicable.
- .5 "Construction Employees" means persons working for the General Contractor, the sub-contractors, equipment operators, material suppliers, testing and inspection companies and regulatory agencies.
- .6 "Departmental Representative" means the project manager from Public Works and Government Services Canada.
- .7 "Perimeter" means the fenced or walled area of the Institution that restrains the movement of the inmates.
- .8 "Construction Limits" means the area as shown on the contract drawings that the Contractor will be allowed to work". This area may or may not be isolated from the security area of the Institution.
- 3 PRELIMINARY PROCEEDINGS .1 Prior to the commencement of work, the Contractor shall meet with the Director or his representative to:
.1 Discuss the nature and extent of all activities involved in the Project.
.2 Establish mutually acceptable security procedures in accordance with this instruction and the institution's particular requirements.

- .2 Contractor shall:
 - .1 Ensure that all Construction Employees are aware of the security requirements.
 - .2 Ensure that a copy of the security requirements is always prominently on display at the job site.
 - .3 Co-operate with institutional personnel in ensuring that security requirements are observed by all Construction Employees.

4 CONSTRUCTION
EMPLOYEES

- .1 Submit to the Director a list of the names with date of birth of all Construction Employees on the construction site and a security clearance form for each employee.
- .2 Allow two (2) weeks for processing of security clearances. Employees will not be admitted to the Institution without a valid security clearance in place and a recent picture identification such as a provincial driver's license. Security clearances obtained from other CSC Institutions are not valid at this Institution.
- .3 The Director may require that facial photographs may be taken of Construction Employees and these photographs may be displayed at appropriate locations in the Institution or in an electronic database for identification purposes. The Director may require that these photographs be displayed prominently on the Construction Employees clothing while employees are in the Institution.
- .4 Entry to Institutional Property will be refused to any person there may be reason to believe may be a security risk.
- .5 Any person employed on the construction site will be subject to immediate removal from Institutional Property if they:
 - .1 Appear to be under the influence of alcohol, drugs or narcotics.
 - .2 Behave in an unusual or disorderly manner.
 - .3 Are in possession of contraband.

5 VEHICLES

- .1 All unattended vehicles on CSC property shall have windows closed; doors and trunks shall be locked and keys removed. The keys shall be securely in the possession of the owner or an employee of the company that owns the vehicle.
- .2 The Director may limit at any time the number and type of vehicles allowed within the Institution.
- .3 Drivers of delivery vehicles for material required by

the project will not require security clearances but must remain with their vehicle the entire time that the vehicle is in the Institution. The Director may require that these vehicles be escorted by Institutional Staff or Commissionaires while in the Institution.

- .4 If the Director permits trailers to be left inside the secure perimeter of the Institution, these trailer doors will be locked at all times. All windows will be securely locked when left unoccupied.

6 PARKING

- .1 Parking area(s) to be used by Construction Employees will be designated by the Director. Parking in other locations will be prohibited and vehicles may be subject to removal.

7 SHIPMENTS

- .1 All shipments of project material, equipment and tools shall be addressed in the Contractor's name to avoid confusion with the Institution's own shipments. The Contractor must have his/her own employees on site to receive any deliveries or shipments. CSC staff will NOT accept receipt of deliveries or shipments of any material equipment or tools.

8 TELEPHONES

- .1 The installation of telephones, Facimile machines and computers with Internet connections requires the prior approval of the Director.
- .2 The Director will ensure that approved telephones, facimile machine and computers with internet connections are located where they are not accessible to inmates. All computers will have an approved password protection that will stop an internet connection to unauthorized personnel.
- .3 Wireless cellular and digital telephones are not permitted within the Institution unless approved by the Director. If wireless cellular telephones are permitted, the user will not permit their use by any inmate.
- .4 The Director may approve but limit the use of two way radios.

9 WORK HOURS

- .1 Work hours within the Institution are: Monday to Friday 07:30 hrs. to 16:30 hrs.
- .2 Work will not be permitted during weekends and statutory holidays without the permission of the Director. A minimum of seven days advance notice will

be required to obtain the required permission.

10 OVERTIME WORK

- .1 No overtime work will be allowed without permission of the Director. Give a minimum forty-eight (48) hours advance notice when overtime work on the construction project is necessary and approved. If overtime work is required because of an emergency such the completion of a concrete pour or work to make the construction safe and secure, the Contractor shall advise the Director as soon as this condition is known and follow the directions given by the Director. Costs to the Crown for such events may be attributed to the Contractor.
- .2 When overtime work, weekend statutory holiday work is required and approved by the Director, extra staff members may be posted by the Director or his designate, to maintain the security surveillance. The Departmental Representative may post extra staff for inspection of construction activities. The actual cost of this extra staff may be subject to reclamation by the Crown.

11 TOOLS AND
EQUIPMENT

- .1 Maintain a complete list of all tools and equipment to be used during the construction project. Make this inventory available for inspection when required.
- .2 Throughout the construction project maintain up-to-date the list of tools and equipment specified above.
- .3 Keep all tools and equipment under constant supervision, particularly power-driven and cartridge-driven tools, cartridges, files, saw blades, rod saws, wire, rope, ladders and any sort of jacking device.
- .4 Store all tools and equipment in approved secure locations.
- .5 Lock all tool boxes when not in use. Keys to remain in the possession of the employees of the contractor.
- .6 All missing or lost tools or equipment shall be reported immediately to the Director.
- .7 The Director will ensure that the security staff members carry out checks of the Contractor's tools and equipment against the list provided by the Contractor. These checks may be carried out at the following intervals:
 - .1 At the beginning and conclusion of every construction project.
 - .2 Weekly, when the construction project extends longer than a one week period.

- .8 Certain tools/equipment such as cartridges and hacksaw blades are highly controlled items. The Contractor will be given at the beginning of the day, a quantity that will permit one day's work. Used blades/cartridges will be returned to the Director's representative at the end of each day.
- .9 If propane or natural gas is used for heating the construction, the Institution may require that an employee supervise the construction site during non-working hours.

12 PRESCRIPTION
DRUGS

- .1 Employees of the Contractor who are required to take prescription drugs during the workday shall obtain approval of the Director to bring a one day supply only into the Institution.

13 CONTRABAND

- .1 Weapons, ammunition, explosives, alcoholic beverages, drugs and narcotics are prohibited on Institutional Property.
- .2 Discovery of Contraband on the construction site and the identification of the person(s) responsible for the Contraband shall be reported immediately to the Director.
- .3 Contractors shall be vigilant with both their staff and the staff of their sub-contractors and suppliers that the discovery of Contraband may result in cancellation of the security clearance of the affected employee. Serious infractions may result in the removal of the company from the Institution for the duration of the construction.
- .4 Presence of arms and ammunition in vehicles of Contractors, sub-contractors and suppliers or employees of these will result in the immediate cancellation of security clearances for the driver of the vehicle.

14 SEARCHES

- .1 All vehicles and persons entering Institutional property may be subject to search.
- .2 When the Director suspects, on reasonable grounds, that an employee of the Contractor is in possession of Contraband, he may order that person to be searched.
- .3 All employees entering the Institution may be subject to screening of personal effects for traces of Contraband drug residue.

15 ACCESS TO AND
REMOVAL FROM
INSTITUTION
PROPERTY

- .1 Construction personnel and commercial vehicles will not be admitted to the Institution after normal working hours, unless approved by the Director.

16 MOVEMENT OF
VEHICLES

- .1 Escorted commercial vehicles will be allowed to enter or leave the Institution through the vehicle access gate during the following hours:
 - .1 07:30 hrs. to 16:30 hrs.
- .2 Construction vehicles shall not leave the Institution until an inmate count is completed.
- .3 The Contractor shall advise the Director twenty four (24) hours in advance to the arrival on the site of heavy equipment such as concrete trucks, cranes, etc.
- .4 Vehicles being loaded with soil or other debris, or any vehicle considered impossible to search, must be under continuous supervision by CSC Staff or Commissionaires working under the authority of the Director.
- .5 Commercial Vehicles will only be allowed access to Institutional Property when their contents are certified by the Contractor or his/her representative as being strictly necessary to the execution of the construction project.
- .6 Vehicles shall be refused access to Institutional Property if, in the opinion of the Director, they contain any article which may jeopardize the security of the Institution.
- .7 Private vehicles of Construction Employees will not be allowed within the security wall or fence of medium or maximum security Institutions without the permission of the Director.
- .8 With prior approval of the Director, a vehicle may be used in the morning and evening to transport a group of employees to the work site. This vehicle will not remain within the Institution the remainder of the day.
- .9 With the approval of the Director, certain equipment may be permitted to remain on the construction site overnight or over the weekend. This equipment must be securely locked, with the battery removed. The Director may require that the equipment be secured with a chain and padlock to another solid object.

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- 17 MOVEMENT OF CONSTRUCTION EMPLOYEES ON INSTITUTIONAL PROPERTY
- .1 Subject to the requirements of good security, the Director will permit the Contractor and his employees as much freedom of action and movement as is possible.
 - .2 However, notwithstanding paragraph above, the Director may:
 - .1 Prohibit or restrict access to any part of the Institution.
 - .2 Require that in certain areas of the Institution, either during the entire construction project or at certain intervals, Construction Employees only be allowed access when accompanied by a member of the CSC security staff.
 - .3 During the lunch and coffee breaks, all employees will remain within the construction site. Employees are not permitted to eat in the officer's lounge and dining room.
- 18 SURVEILLANCE AND INSPECTION
- .1 Construction activities and all related movement of personnel and vehicles will be subject to surveillance and inspection by CSC security staff members to ensure that established security requirements are met.
 - .2 CSC staff members will ensure that an understanding of the need to carry out surveillance and inspections, as specified above, is established among Construction Employees and maintained throughout the construction project.
- 19 STOPPAGE OF WORK
- .1 The Director may request at any time that the Contractor, his employees, sub-contractors and their employees not enter or leave the work site immediately due to a security situation occurring within the Institution. The Contractor's site supervisor shall note the name of the staff member making the request and the time of the request and obey the order as quickly as possible.
 - .2 The Contractor shall advise the Departmental Representative within 24 hours of this delay to the progress of the work.
- 20 CONTACT WITH INMATES
- .1 Unless specifically authorized, it is forbidden to come into contact with inmates, to talk with them, to receive objects from them or to give them objects. Any employee doing any of the above will be removed from the site and his/her security clearance revoked.

.2 It is forbidden to take pictures of inmates, of CSC staff members or of any part of the Institution other than those required as part of this Contract.

21 COMPLETION OF
CONSTRUCTION
PROJECT

.1 Upon completion of the construction project or, when applicable, the takeover of a facility, the Contractor shall remove all remaining construction material, tools and equipment that are not specified to remain in the Institution as part of the construction contract.

PART 1 - GENERAL

1.1 REFERENCES

- .1 Canadian Standards Association (CSA): Canada
 - .1 CSA S350-M1980(R2003), Code of Practice for Safety in Demolition of Structures.
- .2 National Building Code 2010 (NBC):
 - .1 NBC 2010, Division B, Part 8 Safety Measures at Construction and Demolition Sites.
- .3 National Fire Code 2010 (NFC):
 - .1 NFC 2010, Division B, Part 5 Hazardous Processes and Operations, subsection 5.6.1.3 Fire Safety Plan.
- .4 Province of Ontario:
 - .1 Occupational Health and Safety Act Revised Statutes of Ontario 1990, Chapter O.1 as amended, and Regulations for Construction Projects, O. Reg. 213/91 as amended.
 - .2 O. Reg. 490/09, Designated Substances.
 - .3 Workplace Safety and Insurance Act, 1997.
 - .4 Municipal statutes and authorities.
- .5 Treasury Board of Canada Secretariat (TBS):
 - .1 Treasury Board, Fire Protection Standard April 1, 2010 www.tbs-sct.gc.ca/pol/doc-eng.aspx?id=17316§ion=text.
- .6 Fire Commissioner of Canada (FCC):
 - .1 FC-301 Standard for Construction Operations, June 1982.
 - .2 FC-302 Standard for Welding and Cutting, June 1982.

Labour Program
Fire Protection Engineering Services
4900 Yonge Street 8th Floor
North York, Ontario M2N 6A8

and copies may be obtained from:

Human Resources and Social Development Canada
Labour Program
Fire Protection Engineering Services
Ottawa, Ontario K1A 0J2

1.2 SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00.
- .2 Submit site-specific Health and Safety Plan: Within 7 days after date of Notice to Proceed and prior to commencement of Work. Health and Safety Plan must include:

- .1 Results of site specific safety hazard assessment.
- .2 Results of safety and health risk or hazard analysis for site tasks and operations.
- .3 Measures and controls to be implemented to address identified safety hazards and risks.
- .4 Provide a Fire Safety Plan, specific to the work location, in accordance with NBC, Division B, Article 8.1.1.3 prior to commencement of work. The plan shall be coordinated with, and integrated into, the existing Building, Facility, Tenant's Emergency Procedures and Evacuation Plan in place at the site. Departmental Representative will provide Building, Facility, Tenant's Emergency Procedures and Evacuation Plan. Deliver two copies of the Fire Safety Plan to the Departmental Representative not later than 14 days before commencing work.
- .5 Contractor's and Sub-contractors' Safety Communication Plan.
- .6 Contingency and Emergency Response Plan addressing standard operating procedures specific to the project site to be implemented during emergency situations. Coordinate plan with existing Building, Facility, Tenant's Emergency Response requirements and procedures provided by Departmental Representative.
- .3 Departmental Representative will review Contractor's site-specific Health and Safety Plan and provide comments to Contractor within 3 days after receipt of plan. Revise plan as appropriate and resubmit plan to Departmental Representative within 3 days after receipt of comments from Departmental Representative.
- .4 Departmental Representative's review of Contractor's final Health and Safety plan should not be construed as approval and does not reduce the Contractor's overall responsibility for construction Health and Safety.
- .5 Submit names of personnel and alternates responsible for site safety and health.
- .6 Submit records of Contractor's Health and Safety meetings when requested.
- .7 Submit 2 copies of Contractor's authorized representative's work site health and safety inspection reports to Departmental Representative, weekly.
- .8 Submit copies of orders, directions or reports issued by health and safety inspectors of the authorities having jurisdiction.
- .9 Submit copies of incident and accident reports.

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- .10 Submit Material Safety Data Sheets (MSDS).
 - .11 Submit Workplace Safety and Insurance Board (WSIB)-
Experience Rating Report.
- 1.3 FILING OF NOTICE
- .1 File Notice of Project with Provincial authorities prior to commencement of Work.
- 1.4 WORK PERMIT
- .1 Obtain building permits related to project prior to commencement of Work.
 - .2 Obtain Hot Work Permit from Chief Plant Maintenance.
- 1.5 SAFETY ASSESSMENT
- .1 Perform site specific safety hazard assessment related to project.
- 1.6 MEETINGS
- .1 Schedule and administer Health and Safety meeting with Departmental Representative prior to commencement of Work.
- 1.7 REGULATORY REQUIREMENTS
- .1 Comply with the Acts and regulations of the Province of Ontario.
 - .2 Comply with specified standards and regulations to ensure safe operations at site.
- 1.8 PROJECT/SITE CONDITIONS
- .1 Work at site may involve contact with:
 - .1 Silica in concrete, concrete block.
 - .2 Benzene in fuel oil, paints and adhesives.
 - .3 Guano in attic on roof parapet/cap flashing and on roof.
 - .4 PCBs in ballasts.
 - .5 Mould on duct lining, gypsum board, concrete block, foundation wall, basement wall.
 - .6 Arsenic and acrylonitrile in paints and adhesives.
 - .7 Vinyl chloride in pipes, conduits and interior finishes.
 - .2 Confined spaces in maintenance holes, valve chambers and underground tanks.
- 1.9 GENERAL REQUIREMENTS
- .1 Develop written site-specific Health and Safety Plan based on hazard assessment prior to beginning site Work and continue to implement, maintain, and enforce plan until final demobilization from site. Health and Safety Plan must address project specifications.

- .2 Departmental Representative may respond in writing, where deficiencies or concerns are noted and may request re-submission with correction of deficiencies or concerns either accepting or requesting improvements.
- .3 Relief from or substitution for any portion or provision of minimum Health and Safety standards specified herein or reviewed site-specific Health and Safety Plan shall be submitted to Departmental Representative in writing.

1.10 COMPLIANCE REQUIREMENTS

- .1 Comply with Ontario Occupational Health and Safety Act, R.S.O. 1990 Chapter 0.1, as amended.

1.11 RESPONSIBILITY

- .1 Be responsible for health and safety of persons on site, safety of property on site and for protection of persons adjacent to site and environment to extent that they may be affected by conduct of Work.
- .2 Comply with and enforce compliance by employees with safety requirements of Contract Documents, applicable federal, provincial, territorial and local statutes, regulations, and ordinances, and with site-specific Health and Safety Plan.
- .3 Where applicable the Contractor shall be designated "Constructor", as defined by Occupational Health and Safety Act for the Province of Ontario.

1.12 UNFORSEEN HAZARDS

- .1 Should any unforeseen or peculiar safety-related factor, hazard, or condition become evident during performance of Work, immediately stop work and advise Departmental Representative verbally and in writing.
- .2 Follow procedures in place for Employees Right to Refuse Work as specified in the Occupational Health and Safety Act for the Province of Ontario.

1.13 HEALTH AND SAFETY CO-ORDINATOR

- .1 Employ and assign to Work, competent and authorized representative as Health and Safety Co-ordinator. Health and Safety Co-ordinator must:
 - .1 Have working knowledge of occupational safety and health regulations.
 - .2 Be responsible for completing Contractor's Health and Safety Training Sessions and ensuring that personnel not successfully completing required training are not permitted to enter site to perform Work.
 - .3 Be responsible for implementing, enforcing daily

and monitoring site-specific Contractor's Health and Safety Plan.

.4 Be on site during execution of Work and report directly to and be under direction of site supervisor.

1.14 POSTING OF DOCUMENTS

- .1 Ensure applicable items, articles, notices and orders are posted in conspicuous location on site in accordance with Acts and Regulations of Province of Ontario, and in consultation with Departmental Representative.
- .1 Contractor's Safety Policy.
 - .2 Constructor's Name.
 - .3 Notice of Project.
 - .4 Name, trade, and employer of Health and Safety Representative or Joint Health and Safety Committee members (if applicable).
 - .5 Ministry of Labour Orders and reports.
 - .6 Occupational Health and Safety Act and Regulations for Construction Projects for Province of Ontario.
 - .7 Address and phone number of nearest Ministry of Labour office.
 - .8 Material Safety Data Sheets.
 - .9 Written Emergency Response Plan.
 - .10 Site Specific Safety Plan.
 - .11 Valid certificate of first aider on duty.
 - .12 WSIB "In Case of Injury At Work" poster.
 - .13 Location of toilet and cleanup facilities.

1.15 CORRECTION OF NON-COMPLIANCE

- .1 Immediately address health and safety non-compliance issues identified by authority having jurisdiction or by Departmental Representative.
- .2 Provide Departmental Representative with written report of action taken to correct non-compliance of health and safety issues identified.
- .3 Departmental Representative may stop Work if non-compliance of health and safety regulations is not corrected.

1.16 BLASTING

- .1 Blasting or other use of explosives is not permitted without prior receipt of written instruction by Departmental Representative.
- .2 Do blasting operations in accordance with Section 31 23 16.26.

1.17 POWDER ACTUATED DEVICES

- .1 Use powder actuated devices only after receipt of written permission from Departmental Representative.

- 1.18 WORK STOPPAGE
- .1 Give precedence to safety and health of public and site personnel and protection of environment over cost and schedule considerations for Work.
 - .2 Assign responsibility and obligation to Health and Safety Coordinator to stop or start Work when, at Health and Safety Coordinator's discretion, it is necessary or advisable for reasons of health or safety. Departmental Representative may also stop Work for health and safety considerations.

PART 2 - PRODUCTS

- 2.1 NOT USED
- .1 Not used.

PART 3 - EXECUTION

- 3.1 NOT USED
- .1 Not used.

PART 1 - GENERAL

1.1 DEFINITIONS

- .1 Environmental Pollution and Damage: presence of chemical, physical, biological elements or agents which adversely affect human health and welfare; unfavourably alter ecological balances of importance to human life; affect other species of importance to humankind; or degrade environment aesthetically, culturally and/or historically.
- .2 Environmental Protection: prevention/control of pollution and habitat or environment disruption during construction. Control of environmental pollution and damage requires consideration of land, water, and air; biological and cultural resources; and includes management of visual aesthetics; noise; solid, chemical, gaseous, and liquid waste; radiant energy and radioactive material as well as other pollutants.

1.2 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00.
- .2 Prior to commencing construction activities or delivery of materials to site, submit Environmental Protection Plan for review and approval by Departmental Representative. Environmental Protection Plan is to present comprehensive overview of known or potential environmental issues which must be addressed during construction.
- .3 Address topics at level of detail commensurate with environmental issue and required construction tasks.
- .4 Environmental protection plan: include:
 - .1 Names of persons responsible for ensuring adherence to Environmental Protection Plan.
 - .2 Names and qualifications of persons responsible for manifesting hazardous waste to be removed from site.
 - .3 Names and qualifications of persons responsible for training site personnel.
 - .4 Descriptions of environmental protection personnel training program.
 - .5 Erosion and sediment control plan which identifies type and location of erosion and sediment controls to be provided including monitoring and reporting requirements to assure that control measures are in compliance with EPA-R-06-004 or requirements of authorities having jurisdiction, whichever is more stringent.
 - .6 Drawings showing locations of proposed temporary excavations or embankments for haul roads, stream crossings, material storage areas, structures,

sanitary facilities, and stockpiles of excess or spoil materials including methods to control runoff and to contain materials on site.

.7 Traffic control plans including measures to reduce erosion of temporary roadbeds by construction traffic, especially during wet weather. Plans include measures to minimize amount of mud transported onto paved public roads by vehicles or runoff.

.8 Work area plan showing proposed activity in each portion of area and identifying areas of limited use or non-use. Plan to include measures for marking limits of use areas including methods for protection of features to be preserved within authorized work areas.

.9 Spill Control Plan: including procedures, instructions, and reports to be used in event of unforeseen spill of regulated substance.

.10 Non-Hazardous solid waste disposal plan identifying methods and locations for solid waste disposal including clearing debris.

.11 Air pollution control plan detailing provisions to assure that dust, debris, materials, and trash, do not become air borne and travel off project site.

.12 Contaminant prevention plan that: identifies potentially hazardous substances to be used on job site; identifies intended actions to prevent introduction of such materials into air, water, or ground; and details provisions for compliance with Federal, Provincial, and Municipal laws and regulations for storage, handling and disposal of these materials.

.13 Waste water management plan that identifies methods and procedures for management and/or discharge of waste waters which are directly derived from construction activities, such as concrete curing water, clean-up water, dewatering of ground water, disinfection water, hydrostatic test water, and water used in flushing of lines.

.14 Historical, archaeological, cultural resources biological resources and wetlands plan that defines procedures for identifying and protecting historical, archaeological, cultural resources, biological resources and wetlands.

.15 Pesticide treatment plan: to be included and updated, as required.

.16 Halocarbon Control Plan: submit documentation specified in PWGSC Ontario Region Halocarbon Information Sheet dated March 2010 including a signed, completed copy of the information sheet.

1.3 FIRES

.1 Fires and burning of rubbish on site not permitted.

1.4 DISPOSAL OF WASTES

.1 Do not bury rubbish and waste materials on site.

- .2 Do not dispose of waste or volatile materials, such as mineral spirits, oil or paint thinner into waterways, storm or sanitary sewers.

1.5 DRAINAGE

- .1 Provide erosion and sediment control plan that identifies type and location of erosion and sediment controls to be provided. Plan: include monitoring and reporting requirements to assure that control measures are in compliance with erosion and sediment control plan, Federal, Provincial, and Municipal laws and regulations.
- .2 Storm Water Pollution Prevention Plan (SWPPP) to be substituted for erosion and sedimentations control plan.
- .3 Provide temporary drainage and pumping as necessary to keep excavations and site free from water.
- .4 Do not pump water containing suspended materials into waterways, sewer or drainage systems.
- .5 Control disposal or runoff of water containing suspended materials or other harmful substances in accordance with local authority requirements.

1.6 SITE CLEARING AND PLANT PROTECTION

- .1 Protect trees and plants on site and adjacent properties where indicated.
- .2 Wrap in burlap, trees and shrubs adjacent to construction work, storage areas and trucking lanes, and encase with protective wood framework from grade level to height of 2m.
- .3 Protect roots of designated trees to dripline during excavation and site grading to prevent disturbance or damage. Avoid unnecessary traffic, dumping and storage of materials over root zones.
- .4 Minimize stripping of topsoil and vegetation.
- .5 Restrict tree removal to areas indicated or designated by Departmental Representative.

1.7 WORK ADJACENT TO WATERWAYS

- .1 Do not operate construction equipment in waterways.
- .2 Do not use waterway beds for borrow material without Departmental Representative's approval.
- .3 Do not dump excavated fill, waste material or debris in waterways.

- .4 Design and construct temporary crossings to minimize erosion to waterways.
- .5 Do not skid logs or construction materials across waterways.

1.8 POLLUTION
CONTROL

- .1 Maintain temporary erosion and pollution control features installed under this contract.
- .2 Control emissions from equipment and plant to local authorities' emission requirements.
- .3 Prevent sandblasting and other extraneous materials from contaminating air and waterways beyond application area, by providing temporary enclosures.
- .4 Cover or wet down dry materials and rubbish to prevent blowing dust and debris. Provide dust control for temporary roads.
- .5 Spills of deleterious substances:
 - .1 Immediately contain, limit spread and clean up in accordance with provincial regulatory requirements.
 - .2 Report immediately to Ontario Spills Action Centre: 1-800-268-6060.
 - .3 Further information on dangerous goods emergency cleanup and precautions including a list of companies performing this work can be obtained from the Transport Canada 24-hour number (613) 996-6666 collect.

1.9 HALOCARBONS

- .1 Comply with Federal Halocarbon Regulations 2003 under the Canadian Environmental Protection Act 1999, EPAM and PWGSC Ontario Region Halocarbon Information Sheet dated March 2010.

1.10 HISTORICAL/
ARCHAEOLOGICAL
CONTROL

- .1 Provide historical, archaeological, cultural resources biological resources and wetlands plan that defines procedures for identifying and protecting historical, archaeological, cultural resources, biological resources and wetlands known to be on project site: and/or identifies procedures to be followed if historical archaeological, cultural resources, biological resources and wetlands not previously known to be onsite or in area are discovered during construction.
- .2 Plan: include methods to assure protection of known or discovered resources and identify lines of communication between Contractor personnel and Departmental Representative.

1.11 NOTIFICATION

- .1 Departmental Representative will notify Contractor in writing of observed noncompliance with Federal, Provincial or Municipal environmental laws or regulations, permits, and other elements of Contractor's Environmental Protection plan.
- .2 Contractor: after receipt of such notice, inform Departmental Representative of proposed corrective action and take such action for approval by Departmental Representative.
- .3 Departmental Representative will issue stop order of work until satisfactory corrective action has been taken.
- .4 No time extensions granted or equitable adjustments allowed to Contractor for such suspensions.

PART 2 - PRODUCTS

2.1 NOT USED

- .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

- .1 Not Used.

PART 1 - GENERAL

1.1 REFERENCES AND
CODES

- .1 Perform Work in accordance with National Building Code of Canada (NBC) 2010, National Fire Code of Canada (NFC) 2010 and Ontario Building Code (OBC) 2006, including all amendments up to bid closing date and other codes of provincial or local application provided that in case of conflict or discrepancy, more stringent requirements apply.
- .2 Meet or exceed requirements of:
 - .1 Contract documents.
 - .2 Specified standards, codes and referenced documents.

1.2 HAZARDOUS
MATERIAL DISCOVERY

- .1 Stop work immediately and notify Departmental Representative if materials which may contain designated substances or PCB's, other than those identified in Section 01 35 43 are discovered in course of work.

1.3 STATISTICAL
INFORMATION

- .1 Provide statistical information to Departmental Representative:
 - .1 Within ten working days after March 31 and September 30 occurring between commencement of work and final completion
 - .2 Within ten working days after final completion.
- .2 Include in statistical information:
 - .1 Statement of total person days of labour used on site in performance of contract, including labour provided under sub-contracts.
 - .2 Estimate of total value in dollars of material delivered to site and installed, including material provided and installed under sub-contracts.
- .3 This information is required by Government of Canada solely to provide statistics that will aid in assessing socio-economic benefits of this project.

1.4 TAXES

- .1 Pay applicable Federal, Provincial and Municipal taxes.

PART 2 - PRODUCTS

2.1 NOT USED .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED .1 Not Used.

PART 1 - GENERAL

1.1 SECTION
INCLUDES

- .1 Inspection and testing, administrative and enforcement requirements.
- .2 Tests and mix designs.
- .3 Mock-ups.
- .4 Mill tests.
- .5 Equipment and system adjust and balance.

1.2 RELATED
SECTIONS

- .1 Section 01 91 20 - Project Commissioning.

1.3 INSPECTION

- .1 Allow Departmental Representative access to Work. If part of Work is in preparation at locations other than Place of Work, allow access to such Work whenever it is in progress.
- .2 Give timely notice requesting inspection if Work is designated for special tests, inspections or approvals by Departmental Representative instructions, or law of Place of Work.
- .3 If Contractor covers or permits to be covered Work that has been designated for special tests, inspections or approvals before such is made, uncover such Work, have inspections or tests satisfactorily completed and make good such Work.
- .4 Departmental Representative may order any part of Work to be examined if Work is suspected to be not in accordance with Contract Documents. If, upon examination such work is found not in accordance with Contract Documents, correct such Work and pay cost of examination and correction. If such Work is found in accordance with Contract Documents, Departmental Representative shall pay cost of examination and replacement.

1.4 INDEPENDENT
INSPECTION AGENCIES

- .1 Independent Inspection/Testing Agencies will be engaged by Departmental Representative for purpose of inspecting and/or testing portions of Work, above and beyond those required of the Contractor. Cost of such services will be borne by Departmental Representative.
- .2 Provide equipment required for executing inspection

and testing by appointed agencies.

- .3 Employment of inspection/testing agencies does not relax responsibility to perform Work in accordance with Contract Documents.
- .4 If defects are revealed during inspection and/or testing, appointed agency will request additional inspection and/or testing to ascertain full degree of defect. Correct defect and irregularities as advised by Departmental Representative at no cost to Departmental Representative. Pay costs for retesting and reinspection.

1.5 ACCESS TO WORK

- .1 Allow inspection/testing agencies access to Work, off site manufacturing and fabrication plants.
- .2 Co-operate to provide reasonable facilities for such access.

1.6 PROCEDURES

- .1 Notify appropriate agency and Departmental Representative in advance of requirement for tests, in order that attendance arrangements can be made.
- .2 Submit samples and/or materials required for testing, as specifically requested in specifications. Submit with reasonable promptness and in an orderly sequence so as not to cause delay in Work.
- .3 Provide labour and facilities to obtain and handle samples and materials on site. Provide sufficient space to store and cure test samples.

1.7 REJECTED WORK

- .1 Remove defective Work, whether result of poor workmanship, use of defective products or damage and whether incorporated in Work or not, which has been rejected by Departmental Representative as failing to conform to Contract Documents. Replace or re-execute in accordance with Contract Documents.
- .2 Make good other Contractor's work damaged by such removals or replacements promptly.
- .3 If in opinion of Departmental Representative it is not expedient to correct defective Work or Work not performed in accordance with Contract Documents, Departmental Representative may deduct from Contract Amount difference in value between Work performed and that called for by Contract Documents, amount of which shall be determined by Departmental Representative.

1.8 REPORTS

- .1 Submit 4 copies of inspection and test reports to Departmental Representative.
- .2 Provide copies to Subcontractor of work being inspected or tested, manufacturer or fabricator of material being inspected or tested.

1.9 TESTS AND MIX DESIGNS

- .1 Furnish test results and mix designs as may be requested.
- .2 The cost of tests and mix designs beyond those called for in Contract Documents or beyond those required by law of Place of Work shall be appraised by Departmental Representative and may be authorized as recoverable.

1.10 MOCK-UPS

- .1 Prepare mock-ups for Work specifically requested in specifications. Include for Work of all Sections required to provide mock-ups.
- .2 Construct in all locations acceptable to Departmental Representative.
- .3 Prepare mock-ups for Departmental Representative's review with reasonable promptness and in an orderly sequence, so as not to cause any delay in Work.
- .4 Failure to prepare mock-ups in ample time is not considered sufficient reason for an extension of Contract Time and no claim for extension by reason of such default will be allowed.
- .5 If requested, Departmental Representative will assist in preparing a schedule fixing dates for preparation.
- .6 Specification section identifies whether mock-up may remain as part of Work or if it is to be removed and when.

1.11 MILL TESTS

- .1 Submit mill test certificates as requested required of specification Sections.

1.12 EQUIPMENT AND SYSTEMS

- .1 Submit testing, adjusting and balancing reports for mechanical, electrical and building equipment systems.
- .2 Submit Commissioning Documentation in accordance with Section 01 91 20.
- .3 Refer to Section mechanical and electrical for definitive requirements.

PART 2 - PRODUCTS

2.1 NOT USED .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED .1 Not Used.

PART 1 - GENERAL

- 1.1 SECTION INCLUDES .1 Temporary utilities.
- 1.2 REFERENCES .1 U.S. Environmental Protection Agency (EPA) / Office of Water
.1 EPA 833-R-06-004, May 2007, Developing Your Stormwater Pollution Prevention Plan - A Guide for Construction Sites.
- 1.3 SUBMITTALS .1 Provide submittals in accordance with Section 01 33 00.
- 1.4 INSTALLATION AND REMOVAL .1 Provide temporary utilities controls in order to execute work expeditiously.
.2 Remove from site all such work after use.
- 1.5 DEWATERING .1 Provide temporary drainage and pumping facilities to keep excavations and site free from standing water.
- 1.6 WATER SUPPLY .1 Departmental Representative will provide continuous supply of potable water for construction use.
.2 Arrange for connection with appropriate utility company and pay all costs for installation, maintenance and removal.
.3 Departmental Representative will pay for utility charges at prevailing rates.
- 1.7 TEMPORARY HEATING AND VENTILATION .1 Provide temporary heating required during construction period, including attendance, maintenance and fuel.
.2 Construction heaters used inside building must be vented to outside or be non-flameless type. Solid fuel salamanders are not permitted.
.3 Provide temporary heat and ventilation in enclosed areas as required to:
.1 Facilitate progress of Work.
.2 Protect Work and products against dampness and cold.
.3 Prevent moisture condensation on surfaces.
.4 Provide ambient temperatures and humidity levels for storage, installation and curing of materials.

- .5 Provide adequate ventilation to meet health regulations for safe working environment.
- .4 Maintain temperatures of minimum 10°C in areas where construction is in progress.
- .5 Ventilating:
 - .1 Prevent accumulations of dust, fumes, mists, vapours or gases in areas occupied during construction.
 - .2 Provide local exhaust ventilation to prevent harmful accumulation of hazardous substances into atmosphere of occupied areas.
 - .3 Dispose of exhaust materials in manner that will not result in harmful exposure to persons.
 - .4 Ventilate storage spaces containing hazardous or volatile materials.
 - .5 Ventilate temporary sanitary facilities.
 - .6 Continue operation of ventilation and exhaust system for time after cessation of work process to assure removal of harmful contaminants.
- .6 Permanent heating system of building, may be used when available. Be responsible for damage to heating system if use is permitted.
- .7 On completion of Work for which permanent heating system is used, replace filters, and clean entire unit.
- .8 Ensure Date of Substantial Performance and Warranties for heating system do not commence until entire system is in as near original condition as possible and is certified by Departmental Representative.
- .9 Departmental Representative will pay utility charges when temporary heat source is existing building equipment.
- .10 Maintain strict supervision of operation of temporary heating and ventilating equipment to:
 - .1 Conform with applicable codes and standards.
 - .2 Enforce safe practices.
 - .3 Prevent abuse of services.
 - .4 Prevent damage to finishes.
 - .5 Vent direct-fired combustion units to outside.
- .11 Be responsible for damage to Work due to failure in providing adequate heat and protection during construction.

1.8 TEMPORARY POWER
AND LIGHT

- .1 Provide and pay for temporary power during construction for temporary lighting and operating of power tools.
- .2 Arrange for connection with appropriate utility company. Pay all costs for installation, maintenance

and removal.

- .3 Temporary power for electric cranes and other equipment requiring in excess of above is responsibility of Contractor.
- .4 Provide and maintain temporary lighting throughout project. Ensure level of illumination on all floors and stairs is not less than 162 lx.
- .5 Electrical power and lighting systems installed under this Contract may be used for construction requirements only with prior approval of Departmental Representative provided that guarantees are not affected. Make good damage to electrical system caused by use under this Contract. Replace lamps which have been used for more than 3 months.

1.9 FIRE
PROTECTION

- .1 Provide and maintain temporary fire protection equipment during performance of Work required by insurance companies having jurisdiction and governing codes, regulations and bylaws.
- .2 Burning rubbish and construction waste materials is not permitted on site.

PART 2 - PRODUCTS

2.1 NOT USED

- .1 Not Used.

PART 3 - EXECUTION

3.1 TEMPORARY
EROSION AND
SEDIMENTATION
CONTROL

- .1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction.
- .2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

PART 1 - GENERAL

1.1 SECTION
INCLUDES

- .1 Construction aids.
- .2 Office and sheds.
- .3 Parking.
- .4 Project identification.

1.2 REFERENCES

- .1 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.189-2000, Exterior Alkyd Primer for Wood.
 - .2 CAN/CGSB-1.59-97, Alkyd Exterior Gloss Enamel.
- .2 Canadian Standards Association (CSA International)
 - .1 CSA-A23.1-09/A23.2-09, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
 - .2 CSA-0121-08, Douglas Fir Plywood.
 - .3 CSA Z797-09, Code of practice for Access Scaffold.
 - .4 CAN/CSA-Z321-96(R2006), Signs and Symbols for the Occupational Environment, withdrawn but still available from CSA, CCOHS and Techstreet.
- .3 U.S. Environmental Protection Agency (EPA)/ Office of Water
 - .1 EPA 833-R-06-004, May 2007, Developing Your Stormwater Pollution Prevention Plan - A Guide for Construction Sites.

1.3 SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00.

1.4 INSTALLATION
AND REMOVAL

- .1 Prepare site plan indicating proposed location and dimensions of area to be fenced and used by Contractor, number of trailers to be used, avenues of ingress/egress to fenced area and details of fence installation.
- .2 Identify areas which have to be gravelled to prevent tracking of mud.
- .3 Indicate use of supplemental or other staging area.
- .4 Provide construction facilities in order to execute work expeditiously.

.5 Remove from site all such work after use.

1.5 SCAFFOLDING

.1 Scaffolding in accordance with CSA Z797.

.2 Provide and maintain scaffolding, ramps, ladders and temporary stairs.

1.6 HOISTING

.1 Provide, operate and maintain hoists/cranes required for moving of workers, materials and equipment. Make financial arrangements with Subcontractors for use thereof.

.2 Hoists/cranes shall be operated by qualified operator.

1.7 SITE STORAGE/LOADING

.1 Confine work and operations of employees to areas defined by Contract Documents. Do not unreasonably encumber premises with products.

.2 Do not load or permit to load any part of Work with a weight or force that will endanger the Work.

1.8 CONSTRUCTION PARKING

.1 Parking will be permitted on site provided it does not disrupt performance of Work.

.2 Provide and maintain adequate access to project site.

.3 Build and maintain temporary roads where indicated or directed by Departmental Representative and provide snow removal during period of Work.

.4 If authorized to use existing roads for access to project site, maintain such roads for duration of Contract and make good damage resulting from Contractors' use of roads.

.5 Clean construction runways and taxi areas where used by Contractor's equipment.

.6 Refer to Section 01 35 13 for additional construction parking requirements.

1.9 SECURITY

.1 Pay for responsible security personnel to guard site and contents of site after working hours and during holidays.

1.10 OFFICES

.1 Provide office heated to 22°C, lighted 750 lx and ventilated, of sufficient size to accommodate site meetings and furnished with drawing laydown table.

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- .2 Provide a clearly marked and fully stocked first-aid case in a readily available location.
- .3 Subcontractors may provide their own offices as necessary. Direct location of these offices.
- 1.11 EQUIPMENT,
TOOL AND MATERIALS
STORAGE
- .1 Provide and maintain, in a clean and orderly condition, lockable weatherproof sheds for storage of tools, equipment and materials.
- .2 Locate materials not required to be stored in weatherproof sheds on site in a manner to cause least interference with work activities.
- 1.12 SANITARY
FACILITIES
- .1 Provide sanitary facilities for work force in accordance with governing regulations and ordinances.
- .2 Post notices and take such precautions as required by local health authorities. Keep area and premises in sanitary condition.
- .3 When permanent water and drain connections are completed, provide temporary water closets and urinals complete with temporary enclosures, inside building. Permanent facilities may be used on approval of Departmental Representative.
- 1.13 CONSTRUCTION
SIGNAGE
- .1 Provide and erect, within three weeks of signing Contract, a project sign in a location designated by Departmental Representative.
- .2 No other signs or advertisements, other than warning signs, are permitted on site.
- .3 Signs and notices for safety and instruction shall be in both official languages. Graphic symbols shall conform to CAN/CSA-Z321.
- .4 Maintain approved signs and notices in good condition for duration of project, and dispose of offsite on completion of project or earlier if directed by Departmental Representative.
- 1.14 PROTECTION AND
MAINTENANCE OF
TRAFFIC
- .1 Provide access and temporary relocated roads as necessary to maintain traffic.
- .2 Maintain and protect traffic on affected roads during construction period except as otherwise specifically directed by Departmental Representative.

- .3 Provide measures for protection and diversion of traffic, including provision of watch-persons and flag-persons, erection of barricades, placing of lights around and in front of equipment and work, and erection and maintenance of adequate warning, danger, and direction signs
- .4 Protect travelling public from damage to person and property.
- .5 Contractor's traffic on roads selected for hauling material to and from site to interfere as little as possible with public traffic.
- .6 Verify adequacy of existing roads and allowable load limit on these roads. Contractor: responsible for repair of damage to roads caused by construction operations.
- .7 Construct access and haul roads necessary.
- .8 Haul roads: constructed with suitable grades and widths; sharp curves, blind corners, and dangerous cross traffic shall be avoided.
- .9 Provide necessary lighting, signs, barricades, and distinctive markings for safe movement of traffic.
- .10 Dust control: adequate to ensure safe operation at all times.
- .11 Location, grade, width, and alignment of construction and hauling roads: subject to approval by Departmental Representative.
- .12 Lighting: to assure full and clear visibility for full width of haul road and work areas during night work operations.
- .13 Provide snow removal during period of Work.
- .14 Remove, upon completion of work, haul roads designated by Departmental Representative.

1.16 CLEAN-UP

- .1 Remove construction debris, waste materials, packaging material from work site daily.
- .2 Clean dirt or mud tracked onto paved or surfaced roadways.
- .3 Store materials resulting from demolition activities that are salvageable.

- .4 Stack stored new or salvaged material.

PART 2 - PRODUCTS

2.1 NOT USED

- .1 Not Used.

PART 3 - EXECUTION

3.1 TEMPORARY
EROSION AND
SEDIMENTATION
CONTROL

- .1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction, sediment and erosion control plan, specific to site, that complies with EPA 833-R-06-004 or requirements of authorities having jurisdiction, whichever is more stringent.
- .2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

PART 1 - GENERAL

1.1 SECTION
INCLUDES

- .1 Barriers.
- .2 Environmental Controls.
- .3 Traffic Controls.
- .4 Fire Routes.

1.2 REFERENCES

- .1 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB-1.189-2000, Exterior Alkyd Primer for Wood.
 - .2 CAN/CGSB-1.59-97, Alkyd Exterior Gloss Enamel.
- .2 Canadian Standards Association (CSA):
 - .1 CSA-O121-08, Douglas Fir Plywood.

1.3 INSTALLATION
AND REMOVAL

- .1 Provide temporary controls in order to execute Work expeditiously.
- .2 Remove from site all such work after use.

1.4 GUARD RAILS AND
BARRICADES

- .1 Provide secure, rigid guard rails and barricades around deep excavations, open shafts, open stair wells, open edges of floors and roofs.
- .2 Provide as required by governing authorities.

1.5 WEATHER
ENCLOSURES

- .1 Provide weather tight closures to unfinished door and window openings, tops of shafts and other openings in floors and roofs.
- .2 Close off floor areas where walls are not finished; seal off other openings; enclose building interior work for temporary heat.
- .3 Design enclosures to withstand wind pressure and snow loading.

1.6 DUST TIGHT
SCREENS

- .1 Provide dust tight screens or partitions to localize dust generating activities, and for protection of workers, finished areas of Work and public.
- .2 Maintain and relocate protection until such work is complete.

1.7 ACCESS TO SITE .1 Provide and maintain access roads, sidewalk crossings, ramps and construction runways as may be required for access to Work.

1.8 PUBLIC TRAFFIC FLOW .1 Provide and maintain competent signal flag operators, traffic signals, barricades and flares, lights, or lanterns as required to perform Work and protect the public.

1.9 FIRE ROUTES .1 Maintain access to property including overhead clearances for use by emergency response vehicles.

1.10 PROTECTION FOR OFF-SITE AND PUBLIC PROPERTY .1 Protect surrounding private and public property from damage during performance of Work.
.2 Be responsible for damage incurred.

1.11 PROTECTION OF BUILDING FINISHES .1 Provide protection for finished and partially finished building finishes and equipment during performance of Work.
.2 Provide necessary screens, covers, and hoardings.
.3 Confirm with Departmental Representative locations and installation schedule 3 days prior to installation.
.4 Be responsible for damage incurred due to lack of or improper protection.

PART 2 - PRODUCTS

2.1 NOT USED .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED .1 Not Used.

PART 1 - GENERAL

1.1 SECTION
INCLUDES

- .1 Product quality, availability, storage, handling, protection, and transportation.
- .2 Manufacturer's instructions.
- .3 Quality of Work, coordination and fastenings.
- .4 Existing facilities.

1.2 REFERENCES

- .1 Within text of specifications, reference may be made to reference standards.
- .2 Conform to these standards, in whole or in part as specifically requested in specifications.
- .3 If there is question as to whether any product or system is in conformance with applicable standards, Departmental Representative reserves right to have such products or systems tested to prove or disprove conformance.
- .4 The cost for such testing will be born by Owner in event of conformance with Contract Documents or by Contractor in event of non-conformance.
- .5 Conform to latest date of issue of referenced standards in effect on date of submission of Bids, except where specific date or issue is specifically noted.
- .6 OPSS Ontario Provincial Standard Specifications and OPSD Ontario Provincial Standard Drawings quoted in these specifications are available online at <http://www.raqsa.mto.gov.on.ca/techpubs/ops.nsf/OPSHomepage>.

1.3 QUALITY

- .1 Products, materials, equipment and articles (referred to as products throughout specifications) incorporated in Work shall be new, not damaged or defective, and of best quality (compatible with specifications) for purpose intended. If requested, furnish evidence as to type, source and quality of Products provided.
- .2 Defective products, whenever identified prior to completion of Work, will be rejected, regardless of previous inspections. Inspection does not relieve responsibility, but is precaution against oversight or error. Remove and replace defective products at own expense and be responsible for delays and expenses

caused by rejection.

- .3 Should any dispute arise as to quality or fitness of products, decision rests strictly with Departmental Representative based upon requirements of Contract Documents.
- .4 Unless otherwise indicated in specifications, maintain uniformity of manufacture for any particular or like item throughout building.
- .5 Permanent labels, trademarks and nameplates on products are not acceptable in prominent locations, except where required for operating instructions, or when located in mechanical or electrical rooms.

1.4 AVAILABILITY

- .1 Immediately upon signing Contract, review product delivery requirements and anticipate foreseeable supply delays for any items. If delays in supply of products are foreseeable, notify Departmental Representative of such, in order that substitutions or other remedial action may be authorized in ample time to prevent delay in performance of Work.
- .2 In event of failure to notify Departmental Representative at commencement of Work and should it subsequently appear that Work may be delayed for such reason, Departmental Representative reserves right to substitute more readily available products of similar character, at no increase in Contract Price or Contract Time.

1.5 METRIC SIZED MATERIALS

- .1 SI metric units of measurement are used exclusively on the drawings and in the specifications for this project.
- .2 The Contractor is required to provide metric products in the sizes called for in the Contract Documents except where a valid claim can be made that a particular product is not available on the Canadian market.
- .3 Claims for exemptions from use of metric sized products shall be in writing and fully substantiated with supportive documentation. Promptly submit application to Departmental Representative for consideration and ruling. Non-metric sized products may not be used unless Contractor's application has been approved in writing by the Departmental Representative.
- .4 Difficulties caused by the Contractor's lack of planning and effort to obtain modular metric sized products which are available on the Canadian market will not be considered sufficient reasons for claiming that they cannot be provided.

1.6 STORAGE,
HANDLING AND
PROTECTION

- .5 Claims for additional costs due to provision of specified modular metric sized products will not be considered.
- .1 Handle and store products in manner to prevent damage, adulteration, deterioration and soiling and in accordance with manufacturer's instructions when applicable.
- .2 Store packaged or bundled products in original and undamaged condition with manufacturer's seal and labels intact. Do not remove from packaging or bundling until required in Work.
- .3 Store products subject to damage from weather in weatherproof enclosures.
- .4 Store cementitious products clear of earth or concrete floors, and away from walls.
- .5 Keep sand, when used for grout or mortar materials, clean and dry. Store sand on wooden platforms and cover with waterproof tarpaulins during inclement weather.
- .6 Store sheet materials, lumber and like on flat, solid supports and keep clear of ground. Slope to shed moisture.
- .7 Store and mix paints in heated and ventilated room. Remove oily rags and other combustible debris from site daily. Take every precaution necessary to prevent spontaneous combustion.
- .8 Remove and replace damaged products at own expense and to satisfaction of Departmental Representative.
- .9 Touch-up damaged factory finished surfaces to Departmental Representative's satisfaction. Use touch-up materials to match original. Do not paint over name plates.

1.7 TRANSPORTATION

- .1 Pay costs of transportation of products required in performance of Work.
- .2 Transportation cost of products supplied by Owner will be paid for by Owner. Unload, handle and store such products.

1.8 MANUFACTURER'S
INSTRUCTIONS

- .1 Unless otherwise indicated in specifications, install or erect products in accordance with manufacturer's

instructions. Do not rely on labels or enclosures provided with products. Obtain written instructions directly from manufacturers.

- .2 Notify Departmental Representative in writing, of conflicts between specifications and manufacturer's instructions, so that Departmental Representative may establish course of action.
- .3 Improper installation or erection of products, due to failure in complying with these requirements, authorizes Departmental Representative to require removal and re-installation at no increase in Contract Price or Contract Time.

1.9 QUALITY OF WORK

- .1 Ensure Quality of Work is of highest standard, executed by workers experienced and skilled in respective duties for which they are employed. Immediately notify Departmental Representative if required Work is such as to make it impractical to produce required results.
- .2 Do not employ anyone unskilled in their required duties. Departmental Representative reserves right to require dismissal from site, workers deemed incompetent or careless.
- .3 Decisions as to standard or fitness of Quality of Work in cases of dispute rest solely with Departmental Representative, whose decision is final.

1.10 CO-ORDINATION

- .1 Ensure cooperation of workers in laying out Work. Maintain efficient and continuous supervision.
- .2 Be responsible for coordination and placement of openings, sleeves and accessories.

1.11 CONCEALMENT

- .1 In finished areas, conceal pipes, ducts and wiring in floors, walls and ceilings, except where indicated otherwise.
- .2 Before installation, inform Departmental Representative if there is interference. Install as directed by Departmental Representative.

1.12 REMEDIAL WORK

- .1 Perform remedial work required to repair or replace parts or portions of Work identified as defective or unacceptable. Coordinate adjacent affected Work as required.

	.2	Perform remedial work by specialists familiar with materials affected. Perform in a manner to neither damage nor put at risk any portion of Work.
<u>1.13 LOCATION OF FIXTURES</u>	.1	Consider location of fixtures, outlets, and mechanical and electrical items indicated as approximate.
	.2	Inform Departmental Representative of conflicting installation. Install as directed.
<u>1.14 FASTENINGS</u>	.1	Provide metal fastenings and accessories in same texture, colour and finish as adjacent materials, unless indicated otherwise.
	.2	Prevent electrolytic action between dissimilar metals and materials.
	.3	Use non-corrosive hot dip galvanized steel fasteners and anchors for securing exterior work, unless stainless steel or other material is specifically requested in affected specification Section.
	.4	Space anchors within individual load limit or shear capacity and ensure they provide positive permanent anchorage. Wood, or any other organic material plugs are not acceptable.
	.5	Keep exposed fastenings to a minimum, space evenly and install neatly.
	.6	Fastenings which cause spalling or cracking of material to which anchorage is made are not acceptable.
<u>1.15 FASTENINGS - EQUIPMENT</u>	.1	Use fastenings of standard commercial sizes and patterns with material and finish suitable for service.
	.2	Use heavy hexagon heads, semi-finished unless otherwise specified. Use No.304 stainless steel for exterior areas.
	.3	Bolts may not project more than one diameter beyond nuts.
	.4	Use plain type washers on equipment, sheet metal and soft gasket lock type washers where vibrations occur. Use resilient washers with stainless steel.
<u>1.16 PROTECTION OF WORK IN PROGRESS</u>	.1	Prevent overloading of any part of building. Do not cut, drill or sleeve any load bearing structural member, unless specifically indicated without written

approval of Departmental Representative.

1.17 EXISTING
UTILITIES

- .1 When breaking into or connecting to existing services or utilities, execute Work at times directed by local governing authorities, with minimum of disturbance to Work, and/or building occupants and pedestrian and vehicular traffic.
- .2 Protect, relocate or maintain existing active services. When services are encountered, cap off in manner approved by authority having jurisdiction. Stake and record location of capped service.

PART 2 - PRODUCTS

2.1 NOT USED

- .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

- .1 Not Used.

PART 1 - GENERAL

1.1 SECTION
INCLUDES

- .1 Field engineering survey services to measure and stake site.
- .2 Survey services to establish and confirm inverts for Work.
- .3 Recording of subsurface conditions found.

1.2 REFERENCES

- .1 Owner's identification of existing survey control points and property limits.

1.3 QUALIFICATIONS
OF SURVEYOR

- .1 Qualified registered land surveyor, licensed to practice in Place of Work, acceptable to Departmental Representative.

1.4 SURVEY
REFERENCE POINTS

- .1 Existing base horizontal and vertical control points are designated on drawings.
- .2 Locate, confirm and protect control points prior to starting site work. Preserve permanent reference points during construction.
- .3 Make no changes or relocations without prior written notice to Departmental Representative.
- .4 Report to Departmental Representative when reference point is lost or destroyed, or requires relocation because of necessary changes in grades or locations.
- .5 Require surveyor to replace control points in accordance with original survey control.

1.5 SURVEY
REQUIREMENTS

- .1 Establish two permanent bench marks on site, referenced to established bench marks by survey control points. Record locations, with horizontal and vertical data in Project Record Documents.
- .2 Establish lines and levels, locate and lay out, by instrumentation.
- .3 Stake for grading, fill and topsoil placement and landscaping features.
- .4 Stake slopes and berms.
- .5 Establish pipe invert elevations.
- .6 Stake batter boards for foundations.

- .7 Establish foundation column locations and floor elevations.
- .8 Establish lines and levels for mechanical and electrical work.

1.6 EXISTING
SERVICES

- .1 Before commencing work, establish location and extent of service lines in area of Work and notify Departmental Representative of findings.
- .2 Remove abandoned service lines within 2 m of structures. Cap or otherwise seal lines at cut-off points as directed by Departmental Representative.

1.7 LOCATION OF
EQUIPMENT AND
FIXTURES

- .1 Location of equipment, fixtures and outlets indicated or specified are to be considered as approximate.
- .2 Locate equipment, fixtures and distribution systems to provide minimum interference and maximum usable space and in accordance with manufacturer's recommendations for safety, access and maintenance.
- .3 Inform Departmental Representative of impending installation and obtain approval for actual location.
- .4 Submit field drawings to indicate relative position of various services and equipment when required by Departmental Representative.

1.8 RECORDS

- .1 Maintain a complete, accurate log of control and survey work as it progresses.
- .2 On completion of foundations and major site improvements, prepare a certified survey showing dimensions, locations, angles and elevations of Work.
- .3 Record locations of maintained, re-routed and abandoned service lines.

1.9 SUBMITTALS

- .1 Submit name and address of Surveyor to Departmental Representative.
- .2 On request of Departmental Representative, submit documentation to verify accuracy of field engineering work.
- .3 Submit certificate signed by surveyor certifying those elevations and locations of completed Work that conform and do not conform with Contract Documents.

1.10 SUBSURFACE
CONDITIONS

- .1 Promptly notify Departmental Representative in writing if subsurface conditions at Place of Work differ materially from those indicated in Contract Documents, or a reasonable assumption of probable conditions based thereon.
- .2 After prompt investigation, should Departmental Representative determine that conditions do differ materially, instructions will be issued for changes in Work as provided in Changes and Change Orders.

PART 2 - PRODUCTS

2.1 NOT USED

- .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

- .1 Not Used.

PART 1 - GENERAL

1.1 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00.
- .2 Submit written request in advance of cutting or alteration which affects:
 - .1 Structural integrity of elements of project.
 - .2 Integrity of weather-exposed or moisture-resistant elements.
 - .3 Efficiency, maintenance, or safety of operational elements.
 - .4 Visual qualities of sight-exposed elements.
 - .5 Work of Owner or separate contractor.
- .3 Include in request:
 - .1 Identification of project.
 - .2 Location and description of affected Work.
 - .3 Statement on necessity for cutting or alteration.
 - .4 Description of proposed Work, and products to be used.
 - .5 Alternatives to cutting and patching.
 - .6 Effect on Work of Owner or separate contractor.
 - .7 Written permission of affected separate contractor.
 - .8 Date and time work will be executed.

1.2 MATERIALS

- .1 Required for original installation.
- .2 Change in Materials: Submit request for substitution in accordance with Section 01 33 00.

1.3 PREPARATION

- .1 Inspect existing conditions, including elements subject to damage or movement during cutting and patching.
- .2 After uncovering, inspect conditions affecting performance of Work.
- .3 Beginning of cutting or patching means acceptance of existing conditions.
- .4 Provide supports to assure structural integrity of surroundings; provide devices and methods to protect other portions of project from damage.
- .5 Provide protection from elements for areas which are to be exposed by uncovering work; maintain excavations free of water.

1.4 EXECUTION

- .1 Execute cutting, fitting, and patching including excavation and fill, to complete Work.
- .2 Fit several parts together, to integrate with other Work.
- .3 Uncover Work to install ill-timed Work.
- .4 Remove and replace defective and non-conforming Work.
- .5 Remove samples of installed Work for testing.
- .6 Provide openings in non-structural elements of Work for penetrations of mechanical and electrical Work.
- .7 Execute Work by methods to avoid damage to other Work, and which will provide proper surfaces to receive patching and finishing.
- .8 Employ original installer to perform cutting and patching for weather-exposed and moisture-resistant elements, and sight-exposed surfaces.
- .9 Cut rigid materials using masonry saw or core drill. Pneumatic or impact tools not allowed on masonry work without prior approval.
- .10 Restore work with new products in accordance with requirements of Contract Documents.
- .11 Submit proposed materials, finishes and installation method for patching to Departmental Representative for approval, prior to patching.
- .12 Refinish surfaces to match adjacent finishes: Refinish continuous surfaces to nearest intersection. Refinish assemblies by refinishing entire unit.
- .13 Fit Work watertight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
- .14 At penetration of fire rated wall, ceiling, or floor construction, completely seal voids with firestopping material in accordance with Section 07 84 00, full thickness of the construction element.
- .15 Conceal pipes, ducts and wiring in floor, wall and ceiling construction of finished areas except where indicated otherwise.

1.5 WASTE
MANAGEMENT AND
DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 NOT USED .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED .1 Not Used.

PART 1 - GENERAL

1.1 SECTION
INCLUDES

- .1 Progressive cleaning.
- .2 Final cleaning.

1.2 PROJECT
CLEANLINESS

- .1 Maintain Work in tidy condition, free from accumulation of waste products and debris, other than that caused by Owner or other Contractors.
- .2 Remove waste materials from site at regularly scheduled times or dispose of as directed by Departmental Representative. Do not burn waste materials on site.
- .3 Clear snow and ice from access to building and bank/pile snow in designated areas only.
- .4 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
- .5 Provide on-site containers for collection of waste materials and debris.
- .6 Provide and use clearly marked separate bins for recycling. Refer to Section 01 74 20.
- .7 Remove waste material and debris from site and deposit in waste container at end of each working day.
- .8 Dispose of waste materials and debris off site.
- .9 Clean interior areas prior to start of finish work, and maintain areas free of dust and other contaminants during finishing operations.
- .10 Store volatile waste in covered metal containers, and remove from premises at end of each working day.
- .11 Provide adequate ventilation during use of volatile or noxious substances. Use of building ventilation systems is not permitted for this purpose.
- .12 Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.
- .13 Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on wet, newly painted surfaces nor contaminate building systems.

1.3 FINAL CLEANING

- .1 When Work is Substantially Performed, remove surplus products, tools, construction machinery and equipment not required for performance of remaining Work.
- .2 Remove waste products and debris other than that caused by others, and leave Work clean and suitable for occupancy.
- .3 Prior to final review, remove surplus products, tools, construction machinery and equipment.
- .4 Remove waste products and debris other than that caused by Owner or other Contractors.
- .5 Remove waste materials from site at regularly scheduled times or dispose of as directed by Departmental Representative. Do not burn waste materials on site.
- .6 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
- .7 Clean and polish glass, mirrors, hardware, wall tile, stainless steel, chrome, porcelain enamel, baked enamel, plastic laminate, and mechanical and electrical fixtures. Replace broken, scratched or disfigured glass.
- .8 Remove stains, spots, marks and dirt from decorative work, electrical and mechanical fixtures, furniture fitments, walls, and floors.
- .9 Clean lighting reflectors, lenses, and other lighting surfaces.
- .10 HEPA vacuum clean and dust building interiors, behind grilles, louvres and screens.
- .11 Wax, seal, shampoo or prepare floor finishes, as recommended by manufacturer.
- .12 Inspect finishes, fitments and equipment and ensure specified workmanship and operation.
- .13 Broom clean and wash exterior walks, steps and surfaces; rake clean other surfaces of grounds.
- .14 Remove dirt and other disfiguration from exterior surfaces.
- .15 Clean and sweep roofs, gutters, areaways, and sunken wells.
- .16 Sweep and wash clean paved areas.

- .17 Clean equipment and fixtures to a sanitary condition; clean or replace filters of mechanical equipment.
- .18 Clean roofs, downspouts, and drainage systems.
- .19 Remove debris and surplus materials from crawl areas and other accessible concealed spaces.
- .20 Remove snow and ice from access to building.

PART 2 - PRODUCTS

2.1 NOT USED

- .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

- .1 Not Used.

PART 1 - GENERAL

1.1 CONSTRUCTION &
DEMOLITION WASTE

- .1 Carefully deconstruct and source separate materials/equipment and divert, from D&C waste destined for landfill to maximum extent possible. Target for this project is 60% diversion from landfill. Reuse, recycle, compost, anaerobic digest or sell material for reuse except where indicated otherwise. On site sales are not permitted.
- .2 Source separate waste and maintain waste audits in accordance with the Environmental Protection Act, Ontario Regulation 102/94 and Ontario Regulation 103/94.
 - .1 Provide facilities for collection, handling and storage of source separated wastes.
 - .2 Source separate the following waste:
 - .1 Brick and portland cement concrete.
 - .2 Corrugated cardboard.
 - .3 Wood, not including painted or treated wood or laminated wood.
 - .4 Gypsum board, unpainted.
 - .5 Steel.
 - .6 Items indicated in Section 02 42 93, Deconstruction and Waste Products Workplan Summary.
- .3 Submit a waste reduction workplan indicating the materials and quantities of material that will be recycled and diverted from landfill.
 - .1 Indicate how material being removed from the site will be reused, recycled, composted or anaerobically digested using Section 02 42 93, Deconstruction and Waste Products Workplan Summary.
- .4 Submit proof that all waste is being disposed of at a licensed land fill site or waste transfer site. A copy of the disposal/waste transfer site's license and a letter verifying that said landfill site will accept the waste must be supplied to Departmental Representative prior to removal of waste from the demolition site.

1.2 WASTE
PROCESSING SITES

- .1 Province of: Ontario.
 - .1 Ministry of Environment and Energy, 135 St. Clair Avenue West, Toronto, ON, M4V 1P5.
 - .2 Telephone: 800-565-4923 or 416-323-4321.
 - .3 Fax: 416-323-4682.
- .2 Recycling Council of Ontario: 215 Spadina Avenue, #225, Toronto, ON, M5T 2C7.
 - .1 Telephone: 416-657-2797
 - .2 Fax: 416-960-8053

.3 Email: rco@rco.on.ca.
.4 Internet: <http://www.rco.on.ca/>.

PART 2 - PRODUCTS

2.1 NOT USED .1 Not Used.

PART 3 - EXECUTION

3.1 CANADIAN GOVERNMENTAL DEPARTMENTS CHIEF RESPONSIBILITY FOR THE ENVIRONMENT .1 Government Chief Responsibility for the Environment.
Province Address General Fax Inquiries

Ontario	Ministry of Environment and Energy	(416) 323-4321 (800) 565-4923	(416) 323-4682
	135 St Clair Avenue West		
	Toronto, ON M4V 1P5		
	Environment Canada	(416) 734-4494	
	Toronto, ON		

PART 1 - GENERAL

1.1 INSPECTION AND
DECLARATION

- .1 Contractor's Inspection: Contractor and all Subcontractors shall conduct an inspection of Work, identify deficiencies and defects, and repair as required to conform to Contract Documents.
 - .1 Notify Departmental Representative in writing of satisfactory completion of Contractor's Inspection and that corrections have been made.
 - .2 Request Departmental Representative's Inspection.
- .2 Departmental Representative's Inspection: Departmental Representative and Contractor will perform inspection of Work to identify obvious defects or deficiencies. Contractor to correct Work accordingly.
- .3 Completion: submit written certificate that following have been performed:
 - .1 Work has been completed and inspected for compliance with Contract Documents.
 - .2 Defects have been corrected and deficiencies have been completed.
 - .3 Equipment and systems have been tested, adjusted and balanced and are fully operational.
 - .4 Certificates required by Fire Commissioner and Utility companies have been submitted.
 - .5 Operation of systems have been demonstrated to Owner's personnel.
 - .6 Work is complete and ready for final inspection.
- .4 Final Inspection: when items noted above are completed, request final inspection of Work by Departmental Representative and Contractor. If Work is deemed incomplete by Departmental Representative, complete outstanding items and request reinspection.

1.2 CLEANING

- .1 In accordance with Section 01 74 11.
- .2 Remove waste and surplus materials, rubbish and construction facilities from the site in accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 NOT USED

- .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED .1 Not Used.

PART 1 - GENERAL

1.1 SECTION
INCLUDES

- .1 As-built, samples, and specifications.
- .2 Equipment and systems.
- .3 Product data, materials and finishes, and related information.
- .4 Operation and maintenance data.
- .5 Spare parts, special tools and maintenance materials.
- .6 Warranties and bonds.
- .7 Final site survey.

1.2 SUBMISSION

- .1 Prepare instructions and data using personnel experienced in maintenance and operation of described products.
- .2 Copy will be returned after final inspection, with Departmental Representative's comments.
- .3 Revise content of documents as required prior to final submittal.
- .4 Two weeks prior to Substantial Performance of the Work, submit to the Departmental Representative, four final copies of maintenance manuals and commissioning documentation in English.
- .5 Ensure spare parts, maintenance materials and special tools provided are new, undamaged or defective, and of same quality and manufacture as products provided in Work.
- .6 If requested, furnish evidence as to type, source and quality of products provided.
- .7 Defective products will be rejected, regardless of previous inspections. Replace products at own expense.
- .8 Pay costs of transportation.

1.3 FORMAT

- .1 Organize data in the form of an instructional manual.
- .2 Binders: vinyl, hard covered, 3 'D' ring, loose leaf 219 x 279 mm with spine and face pockets.

- .3 When multiple binders are used, correlate data into related consistent groupings. Identify contents of each binder on spine.
- .4 Cover: Identify each binder with type or printed title 'Project Record Documents'; list title of project and identify subject matter of contents.
- .5 Arrange content by systems, under Section numbers and sequence of Table of Contents.
- .6 Provide tabbed fly leaf for each separate product and system, with typed description of product and major component parts of equipment.
- .7 Text: Manufacturer's printed data, or typewritten data.
- .8 Drawings: provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.
- .9 Provide 1:1 scaled CAD files in dwg format on CD or USB drive.

1.4 CONTENTS - EACH
VOLUME

- .1 Table of Contents: provide title of project; date of submission; names, addresses, and telephone numbers of Contractor with name of responsible parties; schedule of products and systems, indexed to content of volume.
- .2 For each product or system:
 - .1 list names, addresses and telephone numbers of subcontractors and suppliers, including local source of supplies and replacement parts.
- .3 Product Data: mark each sheet to clearly identify specific products and component parts, and data applicable to installation; delete inapplicable information.
- .4 Drawings: supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.
- .5 Typewritten Text: as required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions specified in Section 01 45 00.
- .6 Training: Refer to Section 01 79 00.

1.5 AS-BUILTS AND
SAMPLES

- .1 Maintain at the site for Departmental Representative one record copy of:
 - .1 Contract Drawings.
 - .2 Specifications.
 - .3 Amendments.
 - .4 Change Orders and other modifications to the Contract.
 - .5 Reviewed shop drawings, product data, and samples.
 - .6 Field test records.
 - .7 Inspection certificates.
 - .8 Manufacturer's certificates.
- .2 Store record documents and samples in field office apart from documents used for construction. Provide files, racks, and secure storage.
- .3 Label record documents and file in accordance with Section number listings in List of Contents of this Project Manual. Label each document "PROJECT RECORD" in neat, large, printed letters.
- .4 Maintain record documents in clean, dry and legible condition. Do not use record documents for construction purposes.
- .5 Keep record documents and samples available for inspection by Departmental Representative.
- .6 Turn one set, paper copy and electronic copy, of AS-BUILT drawings and specifications over to Departmental Representative on completion of work.
- .7 If project is completed without significant deviations from Contract drawings and specifications submit to Departmental Representative one set of drawings and specifications marked "AS-BUILT".

1.6 RECORDING
ACTUAL SITE
CONDITIONS

- .1 Record information on set of black line opaque drawings, provided by Departmental Representative.
- .2 Provide felt tip marking pens, maintaining separate colours for each major system, for recording information.
- .3 Record information concurrently with construction progress. Do not conceal Work until required information is recorded.
- .4 Contract Drawings and shop drawings: legibly mark each item to record actual construction, including:
 - .1 Measured depths of elements of foundation in relation to finish first floor datum.
 - .2 Measured horizontal and vertical locations of underground utilities and appurtenances, referenced

to permanent surface improvements.

.3 Measured locations of internal utilities and appurtenances, referenced to visible and accessible features of construction.

.4 Field changes of dimension and detail.

.5 Changes made by change orders.

.6 Details not on original Contract Drawings.

.7 References to related shop drawings and modifications.

.5 Specifications: legibly mark each item to record actual construction, including:

.1 Manufacturer, trade name, and catalogue number of each product actually installed, particularly optional items and substitute items.

.2 Changes made by Amendments and change orders.

.6 Other Documents: maintain manufacturer's certifications, inspection certifications, field test records, required by individual specifications sections.

1.7 FINAL SURVEY

.1 Submit final site survey certificate in accordance with Section 01 71 00, certifying that elevations and locations of completed Work are in conformance, or non-conformance with Contract Documents.

1.8 EQUIPMENT AND SYSTEMS

.1 Each Item of Equipment and Each System: include description of unit or system, and component parts. Give function, normal operation characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.

.2 Panel board circuit directories: provide electrical service characteristics, controls, and communications.

.3 Include installed colour coded wiring diagrams.

.4 Operating Procedures: include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.

.5 Maintenance Requirements: include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.

.6 Provide servicing and lubrication schedule, and list of lubricants required.

- .7 Include manufacturer's printed operation and maintenance instructions.
- .8 Include sequence of operation by controls manufacturer.
- .9 Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- .10 Provide installed control diagrams by controls manufacturer.
- .11 Provide Contractor's coordination drawings, with installed colour coded piping diagrams.
- .12 Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
- .13 Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- .14 Include test and balancing reports as specified in Section 01 45 00 and 01 91 20.
- .15 Additional requirements: As specified in individual specification sections.

1.9 MATERIALS AND FINISHES

- .1 Building Products, Applied Materials, and Finishes: include product data, with catalogue number, size, composition, and colour and texture designations.
- .2 Instructions for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- .3 Moisture-protection and Weather-exposed Products: include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- .4 Additional Requirements: as specified in individual specifications sections.

1.10 SPARE PARTS

- .1 Provide spare parts, in quantities specified in individual specification sections.
- .2 Provide items of same manufacture and quality as items in Work.

- .3 Deliver to location as directed; place and store.
- .4 Receive and catalogue all items. Submit inventory listing to Departmental Representative. Include approved listings in Maintenance Manual.
- .5 Obtain receipt for delivered products and submit prior to final payment.

1.11 MAINTENANCE
MATERIALS

- .1 Provide maintenance and extra materials, in quantities specified in individual specification sections.
- .2 Provide items of same manufacture and quality as items in Work.
- .3 Deliver to location as directed; place and store.
- .4 Receive and catalogue all items. Submit inventory listing to Departmental Representative. Include approved listings in Maintenance Manual.
- .5 Obtain receipt for delivered products and submit prior to final payment.

1.12 SPECIAL TOOLS

- .1 Provide special tools, in quantities specified in individual specification section.
- .2 Provide items with tags identifying their associated function and equipment.
- .3 Deliver to location as directed; place and store.
- .4 Receive and catalogue all items. Submit inventory listing to Departmental Representative. Include approved listings in Maintenance Manual.

1.13 STORAGE,
HANDLING AND
PROTECTION

- .1 Store spare parts, maintenance materials, and special tools in manner to prevent damage or deterioration.
- .2 Store in original and undamaged condition with manufacturer's seal and labels intact.
- .3 Store components subject to damage from weather in weatherproof enclosures.
- .4 Store paints and freezable materials in a heated and ventilated room.
- .5 Remove and replace damaged products at own expense and to satisfaction of Departmental Representative.

1.14 WARRANTIES AND
BONDS

- .1 Separate each warranty or bond with index tab sheets keyed to Table of Contents listing.
- .2 List subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.
- .3 Obtain warranties and bonds, executed in duplicate by subcontractors, suppliers, and manufacturers, within ten days after completion of the applicable item of work.
- .4 Except for items put into use with Owner's permission, leave date of beginning of time of warranty until the Date of Certificate of Substantial Performance is determined.
- .5 Verify that documents are in proper form, contain full information, and are notarized.
- .6 Co-execute submittals when required.
- .7 Retain warranties and bonds until time specified for submittal.

PART 2 - PRODUCTS

2.1 NOT USED

- .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

- .1 Not Used.

PART 1 - GENERAL

1.1 SECTION
INCLUDES

- .1 Procedures for demonstration and instruction of equipment and systems to Owner's O&M personnel.
- .2 O&M personnel includes property facility manager, building operators, maintenance staff, security staff and technical specialists, as applicable.

1.2 RELATED
SECTIONS

- .1 Section 23 08 00 - Mechanical Commissioning.

1.3 DESCRIPTION

- .1 Demonstrate scheduled operation and maintenance of equipment and systems to Departmental Representative's personnel two weeks prior to date of substantial performance.
- .2 Departmental Representative will provide list of personnel to receive instructions, and will coordinate their attendance at agreed-upon times.

1.4 QUALITY CONTROL

- .1 When specified in individual Sections, require manufacturer to provide authorized representative to demonstrate operation of equipment and systems, instruct Owner's personnel, and provide written report that demonstration and instructions have been completed.
- .2 Submit training schedule of time and date for demonstration and training of each item of equipment and each system in accordance with the training plan four weeks prior to designated dates, for Departmental Representative's approval.
- .3 Submit reports within one week after completion of demonstration, that demonstration and instructions have been satisfactorily completed.
- .4 Report shall give time and date of each demonstration and training, with list of persons present.

1.5 CONDITIONS FOR
DEMONSTRATIONS

- .1 Equipment has been inspected and put into operation in accordance with relevant equipment specification sections.
- .2 Testing, adjusting, and balancing has been performed in accordance with Section 01 91 20 and equipment and systems are fully operational.

- .3 Provide copies of completed operation and maintenance manuals for use in demonstrations and instructions.

1.6 PREPARATION

- .1 Verify that conditions for demonstration and instructions comply with requirements.
- .2 Verify that designated O&M personnel are present.

1.7 DEMONSTRATION
AND INSTRUCTIONS

- .1 Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, and maintenance of each item of equipment at agreed upon times, at the designated location.
- .2 Instruct personnel in all phases of operation and maintenance using operation and maintenance manuals as the basis of instruction.
- .3 Review contents of manual in detail to explain all aspects of operation and maintenance.
- .4 Prepare and insert additional data in operations and maintenance manuals when the need for additional data becomes apparent during instructions.

PART 2 - PRODUCTS

2.1 NOT USED

- .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

- .1 Not Used.

PART 1 - GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 General requirements relating to commissioning of project's components and systems, specifying general requirements to PV of components, equipment, sub-systems, systems, and integrated systems.
- .2 Acronyms:
 - .1 AFD - Alternate Forms of Delivery, service provider.
 - .2 BMM - Building Management Manual.
 - .3 Cx - Commissioning.
 - .4 EMCS - Energy Monitoring and Control Systems.
 - .5 O&M - Operation and Maintenance.
 - .6 PI - Product Information.
 - .7 PV - Performance Verification.
 - .8 TAB - Testing, Adjusting and Balancing.

1.2 GENERAL

- .1 Cx is a planned program of tests, procedures and checks carried out systematically on systems and integrated systems of the finished Project. Cx is performed after systems and integrated systems are completely installed, functional and Contractor's Performance Verification responsibilities have been completed and approved. Objectives:
 - .1 Verify installed equipment, systems and integrated systems operate in accordance with contract documents and design criteria and intent.
 - .2 Ensure appropriate documentation is compiled into the BMM.
 - .3 Effectively train O&M staff.
- .2 Contractor assists in Cx process, operating equipment and systems, troubleshooting and making adjustments as required.
 - .1 Systems to be operated at full capacity under various modes to determine if they function correctly and consistently at peak efficiency. Systems to be interactively with each other as intended in accordance with Contract Documents and design criteria.
 - .2 During these checks, adjustments to be made to enhance performance to meet environmental or user requirements.
- .3 Design Criteria: as per client's requirements or determined by designer. To meet Project functional and operational requirements.

1.3 COMMISSIONING
OVERVIEW

- .1 Section 01 91 31.
- .2 For Cx responsibilities refer to Section 01 91 31.
- .3 Cx to be a line item of Contractor's cost breakdown.
- .4 Cx activities supplement field quality and testing procedures described in relevant technical sections.
- .5 Cx is conducted in concert with activities performed during stage of project delivery. Cx identifies issues in Planning and Design stages which are addressed during Construction and Cx stages to ensure the built facility is constructed and proven to operate satisfactorily under weather, environmental and occupancy conditions to meet functional and operational requirements. Cx activities includes transfer of critical knowledge to facility operational personnel.
- .6 Departmental Representative will issue Certificate of Substantial Performance when:
 - .1 Completed Cx documentation has been received, reviewed for suitability and approved by Departmental Representative.
 - .2 Equipment, components and systems have been commissioned.
 - .3 O&M training has been completed.

1.4 NON-CONFORMANCE
TO PERFORMANCE
VERIFICATION
REQUIREMENTS

- .1 Should equipment, system components, and associated controls be incorrectly installed or malfunction during Cx, correct deficiencies, re-verify equipment and components within the unfunctional system, including related systems as deemed required by Departmental Representative, to ensure effective performance.
- .2 Costs for corrective work, additional tests, inspections, to determine acceptability and proper performance of such items to be borne by Contractor. Above costs to be in form of progress payment reductions or hold-back assessments.

1.5 PRE-CX REVIEW

- .1 Before Construction:
 - .1 Review contract documents, confirm by writing to Departmental Representative.
 - .1 Adequacy of provisions for Cx.
 - .2 Aspects of design and installation pertinent to success of Cx.
- .2 During Construction:
 - .1 Co-ordinate provision, location and installation of provisions for Cx.

- .3 Before start of Cx:
 - .1 Have completed Cx Plan up-to-date.
 - .2 Ensure installation of related components, equipment, sub-systems, systems is complete.
 - .3 Fully understand Cx requirements and procedures.
 - .4 Have Cx documentation shelf-ready.
 - .5 Understand completely design criteria and intent and special features.
 - .6 Submit complete start-up documentation to Departmental Representative.
 - .7 Have Cx schedules up-to-date.
 - .8 Ensure systems have been cleaned thoroughly.
 - .9 Complete TAB procedures on systems, submit TAB reports to Departmental Representative for review and approval.
 - .10 Ensure "As-Built" system schematics are available.
- .4 Inform Departmental Representative in writing of discrepancies and deficiencies on finished works.

1.6 CONFLICTS

- .1 Report conflicts between requirements of this section and other sections to Departmental Representative before start-up and obtain clarification.
- .2 Failure to report conflict and obtain clarification will result in application of most stringent requirement.

1.7 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00.
 - .1 Submit no later than 4 weeks after award of Contract:
 - .1 Name of Contractor's Cx agent.
 - .2 Draft Cx documentation.
 - .3 Preliminary Cx schedule.
 - .2 Request in writing to Departmental Representative for changes to submittals and obtain written approval at least 8 weeks prior to start of Cx.
 - .3 Submit proposed Cx procedures to Departmental Representative where not specified and obtain written approval at least 8 weeks prior to start of Cx.
 - .4 Provide additional documentation relating to Cx process required by Departmental Representative.

1.8 COMMISSIONING DOCUMENTATION

- .1 Refer to Section 01 91 33.
- .2 Departmental Representative to review and approve Cx documentation.
- .3 Provide completed and approved Cx documentation to

Departmental Representative.

1.9 COMMISSIONING
SCHEDULE

- .1 Provide detailed Cx schedule as part of construction schedule in accordance with Section 01 32 16.07.
- .2 Provide adequate time for Cx activities prescribed in technical sections and commissioning sections including:
 - .1 Approval of Cx reports.
 - .2 Verification of reported results.
 - .3 Repairs, retesting, re-commissioning, re-verification.
 - .4 Training.

1.10 COMMISSIONING
MEETINGS

- .1 Convene Cx meetings following project meetings: Section 01 32 16.07 and as specified herein.
- .2 Purpose: to resolve issues, monitor progress, identify deficiencies, relating to Cx.
- .3 Continue Cx meetings on regular basis until commissioning deliverables have been addressed.
- .4 At 60% construction completion stage. Section 01 32 16.07. Departmental Representative to call a separate Cx scope meeting to review progress, discuss schedule of equipment start-up activities and prepare for Cx. Issues at meeting to include:
 - .1 Review duties and responsibilities of Contractor and subcontractors, addressing delays and potential problems.
 - .2 Determine the degree of involvement of trades and manufacturer's representatives in the commissioning process.
- .5 Thereafter Cx meetings to be held until project completion and as required during equipment start-up and functional testing period.
- .6 Meeting will be chaired by Cx Agent, who will record and distribute minutes.
- .7 Ensure subcontractors and relevant manufacturer representatives are present at 80% and subsequent Cx meetings and as required.

1.11 STARTING AND
TESTING

- .1 Contractor assumes liabilities and costs for inspections. Including disassembly and re-assembly after approval, starting, testing and adjusting, including supply of testing equipment.

1.12 WITNESSING OF
STARTING AND
TESTING

- .1 Provide 14 days notice prior to commencement.
- .2 Departmental Representative to witness of start-up and testing.
- .3 Contractor's Cx Agent to be present at tests performed and documented by sub-trades, suppliers and equipment manufacturers.

1.13 MANUFACTURER'S
INVOLVEMENT

- .1 Factory testing: manufacturer to:
 - .1 Coordinate time and location of testing.
 - .2 Provide testing documentation for approval by Departmental Representative.
 - .3 Arrange for Departmental Representative to witness tests.
 - .4 Obtain written approval of test results and documentation from Departmental Representative before delivery to site.
- .2 Obtain manufacturers installation, start-up and operations instructions prior to start-up of components, equipment and systems and review with Departmental Representative.
 - .1 Compare completed installation with manufacturer's published data, record discrepancies, and review with manufacturer.
 - .2 Modify procedures detrimental to equipment performance and review same with manufacturer before start-up.
- .3 Integrity of warranties:
 - .1 Use manufacturer's trained start-up personnel where specified elsewhere in other divisions or required to maintain integrity of warranty.
 - .2 Verify with manufacturer that testing as specified will not void warranties.
- .4 Qualifications of manufacturer's personnel:
 - .1 Experienced in design, installation and operation of equipment and systems.
 - .2 Ability to interpret test results accurately.
 - .3 To report results in clear, concise, logical manner.

1.14 PROCEDURES

- .1 Verify that equipment and systems are complete, clean, and operating in normal and safe manner prior to conducting start-up, testing and Cx.
- .2 Conduct start-up and testing in following distinct phases:
 - .1 Included in delivery and installation:
 - .1 Verification of conformity to specification, approved shop drawings and

- completion of PI report forms.
 - .2 Visual inspection of quality of installation.
 - .2 Start-up: follow accepted start-up procedures.
 - .3 Operational testing: document equipment performance.
 - .4 System PV: include repetition of tests after correcting deficiencies.
 - .5 Post-substantial performance verification: to include fine-tuning.
- .3 Correct deficiencies and obtain approval from Departmental Representative after distinct phases have been completed and before commencing next phase.
 - .4 Document require tests on approved PV forms.
 - .5 Failure to follow accepted start-up procedures will result in re-evaluation of equipment by an independent testing agency selected by Departmental Representative. If results reveal that equipment start-up was not in accordance with requirements, and resulted in damage to equipment, implement following:
 - .1 Minor equipment/systems: implement corrective measures approved by Departmental Representative.
 - .2 Major equipment/systems: if evaluation report concludes that damage is minor, implement corrective measures approved by Departmental Representative.
 - .3 If evaluation report concludes that major damage has occurred, Departmental Representative shall reject equipment.
 - .1 Rejected equipment to be remove from site and replace with new.
 - .2 Subject new equipment/systems to specified start-up procedures.

1.15 START-UP DOCUMENTATION

- .1 Assemble start-up documentation and submit to Departmental Representative for approval before commencement of commissioning.
- .2 Start-up documentation to include:
 - .1 Factory and on-site test certificates for specified equipment.
 - .2 Pre-start-up inspection reports.
 - .3 Signed installation/start-up check lists.
 - .4 Start-up reports,
 - .5 Step-by-step description of complete start-up procedures, to permit Departmental Representative to repeat start-up at any time.

1.16 OPERATION AND MAINTENANCE OF

- .1 After start-up, operate and maintain equipment and systems as directed by equipment/system manufacturer.

EQUIPMENT AND
SYSTEMS

- .2 With assistance of manufacturer develop written maintenance program and submit Departmental Representative for approval before implementation.
- .3 Operate and maintain systems for length of time required for commissioning to be completed.
- .4 After completion of commissioning, operate and maintain systems until issuance of certificate of interim acceptance.

1.17 TEST RESULTS

- .1 If start-up, testing and/or PV produce unacceptable results, repair, replace or repeat specified starting and/or PV procedures until acceptable results are achieved.
- .2 Provide manpower and materials, assume costs for re-commissioning.

1.18 START OF
COMMISSIONING

- .1 Notify Departmental Representative at least 21 days prior to start of Cx.
- .2 Start Cx after elements of building affecting start-up and performance verification of systems have been completed.

1.19 INSTRUMENTS /
EQUIPMENT

- .1 Submit to Departmental Representative for review and approval:
 - .1 Complete list of instruments proposed to be used.
 - .2 Listed data including, serial number, current calibration certificate, calibration date, calibration expiry date and calibration accuracy.
- .2 Provide the following equipment as required:
 - .1 2-way radios.
 - .2 Ladders.
 - .3 Equipment as required to complete work.

1.20 COMMISSIONING
PERFORMANCE
VERIFICATION

- .1 Carry out Cx:
 - .1 Under accepted simulated operating conditions, over entire operating range, in all modes.
 - .2 On independent systems and interacting systems.
- .2 Cx procedures to be repeatable and reported results are to be verifiable.
- .3 Follow equipment manufacturer's operating instructions.
- .4 EMCS trending to be available as supporting

documentation for performance verification.

1.21 WITNESSING
COMMISSIONING

- .1 Departmental Representative to witness activities and verify results.

1.22 AUTHORITIES
HAVING JURISDICTION

- .1 Where specified start-up, testing or commissioning procedures duplicate verification requirements of authority having jurisdiction, arrange for authority to witness procedures so as to avoid duplication of tests and to facilitate expedient acceptance of facility.
- .2 Obtain certificates of approval, acceptance and compliance with rules and regulation of authority having jurisdiction.
- .3 Provide copies to Departmental Representative within 5 days of test and with Cx report.

1.23 EXTRAPOLATION
OF RESULTS

- .1 Where Cx of weather, occupancy, or seasonal-sensitive equipment or systems cannot be conducted under near-rated or near-design conditions, extrapolate part-load results to design conditions when approved by Departmental Representative in accordance with equipment manufacturer's instructions, using manufacturer's data, with manufacturer's assistance and using approved formulae.

1.24 EXTENT OF
VERIFICATION

- .1 Laboratory areas:
 - .1 Provide manpower and instrumentation to verify up to 100% of reported results.
- .2 Elsewhere:
 - .1 Provide manpower and instrumentation to verify up to 30% of reported results, unless specified otherwise in other sections.
- .3 Number and location to be at discretion of Departmental Representative.
- .4 Conduct tests repeated during verification under same conditions as original tests, using same test equipment, instrumentation.
- .5 Review and repeat commissioning of systems if inconsistencies found in more than [20]% of reported results.
- .6 Perform additional commissioning until results are acceptable to Departmental Representative.

1.26 REPEAT
VERIFICATIONS

- .1 Assume costs incurred by Departmental Representative for third and subsequent verifications where:
 - .1 Verification of reported results fail to receive Departmental Representative's approval.
 - .2 Repetition of second verification again fails to receive approval.
 - .3 Departmental Representative deems Contractor's request for second verification was premature.

1.27 SUNDRY CHECKS
AND ADJUSTMENTS

- .1 Make adjustments and changes which become apparent as Cx proceeds.
- .2 Perform static and operational checks as applicable and as required.

1.28 DEFICIENCIES,
FAULTS, DEFECTS

- .1 Correct deficiencies found during start-up and Cx to satisfaction of Departmental Representative.
- .2 Report problems, faults or defects affecting Cx to Departmental Representative in writing. Stop Cx until problems are rectified. Proceed with written approval from Departmental Representative.

1.29 COMPLETION OF
COMMISSIONING

- .1 Upon completion of Cx leave systems in normal operating mode.
- .2 Except for warranty and seasonal verification activities specified in Cx specifications, complete Cx prior to issuance of Interim Certificate of Completion.
- .3 Cx to be considered complete when contract Cx deliverables have been submitted and accepted by Departmental Representative.

1.30 ACTIVITIES
UPON COMPLETION OF
COMMISSIONING

- .1 When changes are made to baseline components or system settings established during Cx process, provide updated Cx form for affected item.

1.31 TRAINING

- .1 In accordance with Section 01 91 41.

1.32 MAINTENANCE
MATERIALS, SPARE
PARTS, SPECIAL
TOOLS

- .1 Supply, deliver, and document maintenance materials, spare parts, and special tools as specified in contract.

1.33 OCCUPANCY

- .1 Cooperate fully with Departmental Representative during stages of acceptance and occupancy of facility.

1.34 INSTALLED
INSTRUMENTATION

- .1 Use instruments installed under Contract for TAB and PV if:
 - .1 Accuracy complies with these specifications.
 - .2 Calibration certificates have been deposited with Departmental Representative.
- .2 Calibrated EMCS sensors may be used to obtain performance data provided that sensor calibration has been completed and accepted.

1.35 PERFORMANCE
VERIFICATION
TOLERANCES

- .1 Application tolerances:
 - .1 Specified range of acceptable deviations of measured values from specified values or specified design criteria. Except for special areas, to be within +/-51% of specified values.
- .2 Instrument accuracy tolerances:
 - .1 To be of higher order of magnitude than equipment or system being tested.
- .3 Measurement tolerances during verification:
 - .1 Unless otherwise specified actual values to be within +/-1% of recorded values.

1.36 OWNER'S
PERFORMANCE TESTING

- .1 Performance testing of equipment or system by Departmental Representative will not relieve Contractor from compliance with specified start-up and testing procedures.

PART 2 - PRODUCTS

2.1 NOT USED

- .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

- .1 Not Used.

PART 1 - GENERAL

1.1 SPECIAL
WARNING

- .1 This project requires a special enhanced commissioning. The General Contractor must read and fully understand the special requirements specified in this Section prior to bidding this project.
- .2 One of the commissioning requirements is that the General Contractor must engage a qualified independent System Commissioning Administrator (SCA) to coordinate and organize all Pre-Commissioning Testing, Commissioning Testing, and O&M Training. The SCA must complete the Contractor's Commissioning Documentation as specified in this Section.
- .3 A total of 4% of the construction price will be held back by PWGSC for unfinished commissioning work.

1.2 RELATED
SECTIONS

- .1 Section 01 91 13: General Commissioning Requirements

1.3 GENERAL

- .1 The "Commissioning" for this project is defined as a planned program of activities which enhance quality management and information transfer that extends throughout all stages of project delivery.
- .2 The commissioning activities shall include the standard activities and the enhanced activities which are traditionally not provided by the design and construction industry and which are defined in this document.

1.4 REFERENCE
STANDARDS

- .1 The most stringent requirements of the following commissioning standards and guidelines shall apply:
 - .1 Associated Air Balance Council (AABC): National Standards for Field Measurements and Instrumentation, Total Systems Balance, Air Distribution - Hydronics Systems, 2002.
 - .2 ASHRAE Guideline 1.1-2007, the HVAC Commissioning Process.
 - .3 ASHRAE Guideline 4-2008, Preparation of Operating and Maintenance Documentation for Building System.
 - .4 NEBB Procedural Standards for Building Systems Commissioning (1999).
 - .5 NETA Standard for Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems 2009.

1.5 ROLES AND
RESPONSIBILITIES

- .1 The key members of the commissioning team include the Contractor, the Departmental Representative, and the PWGSC Commissioning Manager (or its representative).
 - .1 It is the Contractor's responsibility to engage a qualified independent System Commissioning Administrator (SCA) to represent the Contractor including the Sub-Contractors. The SCA shall be responsible for carrying out the Contractor's commissioning activities under the direction of the Departmental Representative.
 - .2 The PWGSC Commissioning Manager (or its representative) will be assisted by the Departmental Representative and other project team members for overview of the commissioning activities on behalf of the PWGSC Project Manager. The PWGSC Commissioning Manager is the Commissioning Authority for this project.
- .2 The Contractor is responsible for the following standard commissioning activities and enhanced commissioning activities during project construction, commissioning and operation phases.
 - .1 Construction Phase:
 - .1 Engage a qualified independent System Commissioning Administrator as single point of contact for all matters relating to commissioning (enhanced activity).
 - .2 Conduct separate commissioning meetings and prepare minutes of meeting.
 - .3 Submit shop drawings (standard activity).
 - .4 Conduct equipment installation and startup tests, and submit test reports (standard activity).
 - .5 Perform TAB and submit TAB report (standard activity).
 - .6 Conduct System Startup Verification Testing and complete Startup Checklists and PI Report forms (enhanced activity).
 - .2 Commissioning Phase:
 - .1 Conduct separate commissioning meetings and prepare minutes of meeting.
 - .2 Conduct Functional Performance Testing and complete PV Report forms (enhanced activity).
 - .3 Demonstrate system operation (standard activity).
 - .4 Submit Maintenance Manuals (formerly called O&M Manuals) (standard activity).
 - .5 Submit "As-Built" drawings and specifications (standard activity).
 - .6 Conduct O&M training (standard activity).
 - .3 Operation Phase:
 - .1 Conduct separate commissioning meetings and prepare minutes of meeting.
 - .2 Conduct deferred Functional Performance

- Testing and complete PV Report forms (enhanced activity).
- .3 Provide fine-tuning (standard activity).
 - .4 Provide specified inspection and maintenance services during warranty period (standard activity).
- .3 The Departmental Representative will carry out the following commissioning activities related to the Contractor:
- .1 Prepare Startup Checklists, PI and PV Report Forms and Functional Performance Test Forms (enhanced activity).
 - .2 Prepare Standard Operation Procedures (SOP) Manual (formerly called Systems Manual) (enhanced activity).
 - .3 Review and approve shop drawings (standard activity).
 - .4 Review and inspect installation, and prepare construction deficiencies report (standard activity).
 - .5 Review and approve TAB report (standard activity).
 - .6 Direct and approve System Startup Verification Testing (enhanced activity).
 - .7 Direct and approve Functional Performance Testing (enhanced activity).
 - .8 Review and approve Maintenance Manuals (standard activity).
 - .9 Review and approve "As-Built" drawings and specifications (standard activity).
 - .10 Update Standard Operating Procedures (SOP) Manual (enhanced activity).
 - .11 Review O&M training (standard activity).
 - .12 Prepare commissioning report (enhanced activity).
 - .13 Witness post-acceptance commissioning testing (enhanced activity).
 - .14 Direct and approve post-acceptance fine-tuning and review warranty services (standard activity).
 - .15 Update commissioning report (enhanced activity).
- .4 The PWGSC Commissioning Manager (or its representative) will carry out the following commissioning activities related to the Contractor and the Departmental Representative:
- .1 Review and approve the qualifications of the System Commissioning Administrator (SCA) submitted by the Contractor.
 - .2 Review and approve Startup Checklists, PI and PV Report Forms prepared by the Departmental Representative.
 - .3 Witness System Startup Verification Testing conducted by the Contractor and review test reports.
 - .4 Witness Functional Performance Testing conducted by the Contractor and review test reports.

- .5 Review and approve O&M training conducted by the Contractor.
- .6 Review commissioning documentation submitted by the Contractor and Departmental Representative.
- .7 Review and approved commissioning report prepared by the Departmental Representative.
- .8 Witness the post-acceptance commissioning testing conducted by the Contractor and review test reports.
- .9 Review and approve updated commissioning report prepared by the Departmental Representative.

1.6 QUALIFICATIONS
OF SYSTEM
COMMISSIONING
ADMINISTRATOR (SCA)

- .1 The System Commissioning Administrator: a qualified independent System Commissioning Administrator (SCA) for scheduling, coordination and supervision of Contractor's commissioning activities during construction, acceptance, and post-acceptance stages. The System Commissioning Administrator shall provide Contractor's Commissioning Documentation.
- .2 Unless approved by the PWGSC Commissioning Manager, the System Commissioning Administrator shall be a NEBB qualified SCA in building systems commissioning. The Contractor shall hire and submit the name of SCA with documentation confirming qualifications within 15 working days of award of contract.

1.7 SCHEDULING

- .1 Within 45 working days of contract award, the Contractor shall submit bar chart commissioning schedules indicating anticipated date of start, duration, and date of completion for the following key activities:
 - .1 Commissioning meetings.
 - .2 Shop drawings.
 - .3 Pre-startup installation inspections and tests.
 - .4 System and Equipment Startup and Verification.
 - .5 TAB.
 - .6 Functional Performance Test.
 - .7 Maintenance Manuals.
 - .8 "As-Built" drawings and specifications.
 - .9 O&M Training.
 - .10 O&M Training report.
- .2 Bar chart commissioning schedule shall be prepared for each component, equipment, sub-system, system and integrated system to be commissioned as listed under paragraph 1.11.
- .3 The Commissioning shall be carried out to meet the approved project schedule.

1.8 CONTRACTOR'S
COMMISSIONING
DOCUMENTATION

- .1 The Contractor's Commissioning Documentation shall include the following:
 - .1 Commissioning Schedule.
 - .2 Minutes of Commissioning meetings.
 - .3 Shop drawings and product data.
 - .4 Installation inspection and test reports.
 - .5 TAB reports.
 - .6 Startup Checklists.
 - .7 Product Information (PI) Report forms.
 - .8 Performance Verification (PV) Report forms.
 - .9 "As-Built" drawings and specifications.
 - .10 Maintenance Manuals.
 - .11 O&M Training Schedule
 - .12 O&M Training Report.

1.9 PRE-
COMMISSIONING
TESTING - STARTUPS

- .1 Requirements of Pre-commissioning Verification: a full range of checks and tests to determine that all components, equipment, systems, and interfaces between systems (eg., emergency, fire, and life safety) operate in accordance with contact documents. This includes all operating modes, interlocks, control responses, and specific responses to abnormal or emergency conditions. Verification of the proper operation of the control system also includes verifying the interface of the control system with the TAB criteria and the response of EMCS controllers and sensors. Also, the Departmental Representative shall select, at random, 10 percent of the reported TAB and EMCS data for verification, and a failure of selected items shall result in the rejection of the final TAB report or the report of system startup and testing.
- .2 The Startup Checklists and PI Report forms shall be completed by the Contractor and verified by the Departmental Representative.

1.10 COMMISSIONING
TESTING

- .1 Commissioning Testing shall include System Operation Demonstration and Functional Performance Testing of all systems to be commissioned. Test each system independently and then in unison with integrated systems.
- .2 Requirements of Functional Performance Testing (FPT): FPT shall determine if the systems are providing the required services in accordance with the finalized design intent. If FPT cannot be completed due to seasonal reasons, lack of occupancy, deficiencies beyond the scope of the mechanical work, or any other reason, this shall be noted along with an indication of when tests will be rescheduled. If any identified performance deficiencies need to be corrected, the tests shall be repeated after corrective work is carried out, and this process shall continue until acceptable performance is achieved.

- .3 The PV Report forms shall be completed by the Contractor and verified by the Departmental Representative.

1.11 EXTENT OF COMMISSIONING

- .1 Systems to be commissioned with the comprehensive commissioning to include:
 - ~~.1 Air Systems.~~
 - ~~.2 Exhaust Systems.~~
 - ~~.3 Building Automation Systems including EMCS.~~
 - ~~.4 Interface portion of the associated electrical and other building systems.~~
 - ~~.5 Power Distribution Systems.~~
 - ~~.6 Lighting Systems.~~
 - ~~.7 Fire and domestic water pumps.~~
 - .8 Process piping system, instrumentation and controls.

1.12 O&M TRAINING

- .1 The Contractor shall provide qualified training instructors to conduct O&M training.
- .2 Four weeks prior to commencement of O&M training, the Contractor shall submit training schedule with course outline, agenda and a copy of training manual in accordance with the training plan for review by the Departmental Representative and the PWGSC Commissioning Manager.
- .3 Training shall include familiarization sessions, hands-on instruction, and classroom sessions.
- .4 Classroom training shall include: review of Maintenance Manuals, Standard Operating Procedures (SOP) Manual, System Operational Procedures for all modes of operation, acceptable tolerances for system adjustments and procedures for dealing with abnormal and emergency situations.

1.13 UNFINISHED COMMISSIONING WORK

- .1 Prior to the "Interim Certificate of Completion" a total of 4% of the construction price will be held back by PWGSC Project Manager until the acceptable Functional Performance Testing, O&M Training, and commissioning documentation have been completed.

1.14 COMMISSIONING REPORT AND POST-ACCEPTANCE COMMISSIONING

- .1 When the acceptable Functional Performance Testing, O&M Training, and commissioning documentation have been completed, the Departmental Representative shall prepare a commissioning report. The report will identify the completed functional performance tests, the deferred functional performance tests, construction deficiencies, design deficiencies, user's changes of requirement, and outstanding

commissioning issues. The report will provide review comments on test results, O&M training and commissioning documentation, and will recommend follow-up actions to be taken during post-acceptance commissioning.

- .2 The Project Manager will not issue the "Interim Certificate of Completion" until the commissioning report with a recommendation of acceptance is submitted by the PWGSC Commissioning Manager.

1.15 ADDITIONAL
COMMISSIONING
REQUIREMENTS

- .1 Refer to other specifications sections for additional commissioning requirements.

PART 2 - PRODUCTS

- .1 Not used.

PART 3 - EXECUTION

- .1 Not used.

PART 1 - GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Description of overall structure of Cx Plan and roles and responsibilities of Cx team.

1.2 REFERENCES

- .1 American Water Works Association (AWWA)
- .2 National Fire Protection Association (NFPA)
 - .1 NFPA 20-2010, Standard for the Installation of Stationary Fire Pumps for Fire Protection.
- .3 Public Works and Government Services Canada (PWGSC)
 - .1 PWGSC - Commissioning Guidelines CP.4 -3rd edition-03.
- .4 Underwriters' Laboratories of Canada (ULC)

1.3 GENERAL

- .1 Provide a fully functional facility:
 - .1 Systems, equipment and components meet user's functional requirements before date of acceptance, and operate consistently at peak efficiencies and within specified energy budgets under normal loads.
 - .2 Facility user and O&M personnel have been fully trained in aspects of installed systems.
 - .3 Optimized life cycle costs.
 - .4 Complete documentation relating to installed equipment and systems.
- .2 Term "Cx" in this section means "Commissioning".
- .3 Use this Cx Plan as master planning document for Cx:
 - .1 Outlines organization, scheduling, allocation of resources, documentation, pertaining to implementation of Cx.
 - .2 Communicates responsibilities of team members involved in Cx Scheduling, documentation requirements, and verification procedures.
 - .3 Sets out deliverables relating to O&M, process and administration of Cx.
 - .4 Describes process of verification of how built works meet design requirements.
 - .5 Produces a complete functional system prior to issuance of Certificate of Occupancy.
 - .6 Management tool that sets out scope, standards, roles and responsibilities, expectations, deliverables, and provides:
 - .1 Overview of Cx.
 - .2 General description of elements that make up Cx Plan.
 - .3 Process and methodology for successful Cx.

- .4 Acronyms:
 - .1 Cx - Commissioning.
 - .2 BMM - Building Management Manual.
 - .3 EMCS - Energy Monitoring and Control Systems.
 - .4 MSDS - Material Safety Data Sheets.
 - .5 PI - Product Information.
 - .6 PV - Performance Verification.
 - .7 TAB - Testing, Adjusting and Balancing.
 - .8 WHMIS - Workplace Hazardous Materials Information System.
- .5 Commissioning terms used in this Section:
 - .1 Bumping: short term start-up to prove ability to start and prove correct rotation.
 - .2 Deferred Cx - Cx activities delayed for reasons beyond Contractor's control due to lack of occupancy, weather conditions, need for heating/cooling loads.

1.4 DEVELOPMENT OF
100% CX PLAN

- .1 Cx Plan to be 100% completed within 8 weeks of award of contract to take into account:
 - .1 Approved shop drawings and product data.
 - .2 Approved changes to contract.
 - .3 Contractor's project schedule.
 - .4 Cx schedule.
 - .5 Contractor's, sub-contractor's, suppliers' requirements.
 - .6 Project construction team's and Cx team's requirements.
- .2 Submit completed Cx Plan to Departmental Representative and obtain written approval.

1.5 REFINEMENT OF
CX PLAN

- .1 During construction phase, revise, refine and update Cx Plan to include:
 - .1 Changes resulting from Client program modifications.
 - .2 Approved design and construction changes.
- .2 Revise, refine and update every 10 weeks during construction phase. At each revision, indicate revision number and date.
- .3 Submit each revised Cx Plan to Departmental Representative for review and obtain written approval.
- .4 Include testing parameters at full range of operating conditions and check responses of equipment and systems.

1.6 COMPOSITION,
ROLES AND
RESPONSIBILITIES OF
CX TEAM

- .1 Departmental Representative to maintain overall responsibility for project and is sole point of contact between members of commissioning team.

- .2 Project Manager will select Cx Team consisting of following members:
 - .1 PWGSC Design Quality Review Team: during construction, will conduct periodic site reviews to observe general progress.
 - .2 PWGSC Quality Assurance Commissioning Manager: ensures Cx activities are carried out to ensure delivery of a fully operational project including:
 - .1 Review of Cx documentation from operational perspective.
 - .2 Review for performance, reliability, durability of operation, accessibility, maintainability, operational efficiency under conditions of operation.
 - .3 Protection of health, safety and comfort of occupants and O&M personnel.
 - .4 Monitoring of Cx activities, training, development of Cx documentation.
 - .5 Work closely with members of Cx Team.
- .3 Departmental Representative is responsible for:
 - .1 Organizing Cx.
 - .2 Monitoring operations Cx activities.
 - .3 Witnessing, certifying accuracy of reported results.
 - .4 Witnessing and certifying TAB and other tests.
 - .5 Developing BMM.
 - .6 Ensuring implementation of final Cx Plan.
 - .7 Performing verification of performance of installed systems and equipment.
 - .8 Implementation of Training Plan.
- .4 Construction Team: contractor, sub-contractors, suppliers and support disciplines, is responsible for construction/installation in accordance with contract documents, including:
 - .1 Testing.
 - .2 TAB.
 - .3 Performance of Cx activities.
 - .4 Delivery of training and Cx documentation.
 - .5 Assigning one person as point of contact with Departmental Representative and PWGSC Cx Manager for administrative and coordination purposes.
- .5 Contractor's Cx agent implements specified Cx activities including:
 - .1 Demonstrations.
 - .2 Training.
 - .3 Testing.
 - .4 Preparation, submission of test reports.
- .6 Property Manager: represents lead role in Operation Phase and onwards and is responsible for:
 - .1 Receiving facility.
 - .2 Day-to-day operation and maintenance of facility.

1.7 CX PARTICIPANTS

- .1 Employ the following Cx participants to verify performance of equipment and systems:
 - .1 Installation contractor/subcontractor:
 - .1 Equipment and systems except as noted.
 - .2 Equipment manufacturer: equipment specified to be installed and started by manufacturer.
 - .1 To include performance verification.
 - .3 Specialist subcontractor: equipment and systems supplied and installed by specialist subcontractor.
 - .4 Client: responsible for intrusion and access security systems.
 - .5 Ensure that Cx participant:
 - .1 Could complete work within scheduled time frame.
 - .2 Available for emergency and troubleshooting service during first year of occupancy by user for adjustments and modifications outside responsibility of O&M personnel, including:
 - .1 Modify ventilation rates to meet changes in off-gassing.
 - .2 Changes to heating or cooling loads beyond scope of EMCS.
 - .3 Changes to EMCS control strategies beyond level of training provided to O&M personnel.
 - .4 Redistribution of electrical services.
 - .5 Modifications of fire alarm systems.
 - .6 Modifications to voice communications systems.
 - .6 Provide names of participants to Departmental Representative and details of instruments and procedures to be followed for Cx 1 month prior to starting date of Cx for review and approval.

1.8 EXTENT OF CX

- .1 Commission electrical systems and equipment:
 - .1 Other systems and equipment:
 - .1 Process and Instrumentation, communications, operation and controls.

1.9 DELIVERABLES
RELATING TO O&M
PERSPECTIVES

- .1 General requirements:
 - .1 Compile English documentation.
 - .2 Documentation to be computer-compatible format ready for inputting for data management.
- .2 Provide deliverables:
 - .1 Warranties.
 - .2 Project record documentation.
 - .3 Inventory of spare parts, special tools and maintenance materials.
 - .4 Maintenance Management System (MMS)

identification system used.
.5 WHMIS information.
.6 MSDS data sheets.
.7 Electrical Panel inventory containing detailed inventory of electrical circuitry for each panel board. Duplicate of inventory inside each panel.

1.10 DELIVERABLES
RELATING TO THE CX
PROCESS

- .1 General:
.1 Start-up, testing and Cx requirements, conditions for acceptance and specifications form part of relevant technical sections of these specifications.
- .2 Definitions:
.1 Cx as used in this section includes:
.1 Cx of components, equipment, systems, subsystems, and integrated systems.
.2 Factory inspections and performance verification tests.
- .3 Deliverables: provide:
.1 Cx Specifications.
.2 Startup, pre-Cx activities and documentation for systems, and equipment.
.3 Completed installation checklists (ICL).
.4 Completed product information (PI) report forms.
.5 Completed performance verification (PV) report forms.
.6 Results of Performance Verification Tests and Inspections.
.7 Description of Cx activities and documentation.
.8 Description of Cx of integrated systems and documentation.
.9 Tests of following witnessed by PWGSC Design Quality Review Team:
.10 Tests performed by Owner/User.
.11 Training Plans.
.12 Cx Reports.
.13 Prescribed activities during warranty period.
- .4 Departmental Representative and Departmental Representative to witness and certify tests and reports of results provided to Departmental Representative and Departmental Representative.
- .5 Departmental Representative and Departmental Representative to participate.

1.11 PRE-CX
ACTIVITIES AND
RELATED
DOCUMENTATION

- .1 Items listed in this Cx Plan include the following:
.1 Pre-Start-Up inspections: by Departmental Representative prior to permission to start up and rectification of deficiencies to Departmental Representative's satisfaction.
.2 Departmental Representative to use approved check lists.

- .3 Departmental Representative will monitor some of these pre-start-up inspections.
 - .4 Include completed documentation with Cx report.
 - .5 Conduct pre-start-up tests: conduct pressure, static, flushing, cleaning, and "bumping" during construction as specified in technical sections. To be witnessed and certified by Departmental Representative and does not form part of Cx specifications.
 - .6 Include completed documentation in Cx report.
- .2 Pre-Cx activities - MECHANICAL:
- .1 Plumbing systems:
 - .1 "Bump" each item of equipment in its "stand-alone" mode.
 - .2 Complete pre-start-up checks and complete relevant documentation.
 - .3 After equipment has been started, test related systems in conjunction with control systems on a system-by-system basis.
 - .2 HVAC equipment and systems:
 - .1 "Bump" each item of equipment in its "stand-alone" mode.
 - .2 At this time, complete pre-start-up checks and complete relevant documentation.
 - .3 After equipment has been started, test related systems in conjunction with control systems on a system-by-system basis.
 - .4 Perform TAB on systems. TAB reports to be approved by Departmental Representative.
 - .3 EMCS:
 - .1 EMCS trending to be available as supporting documentation for performance verification.
 - .2 Perform point-by-point testing in parallel with start-up.
 - .3 Carry out point-by-point verification.
 - .4 Demonstrate performance of systems, to be witnessed by Departmental Representative prior to start of 30 day Final Acceptance Test period.
 - .5 Perform final Cx and operational tests during demonstration period and 30 day test period.
 - .6 Only additional testing after foregoing have been successfully completed to be "Off-Season Tests".
 - ~~.4 Pre-Cx activities - LIFE SAFETY SYSTEMS~~
 - ~~.1 Include equipment and systems identified above.~~
 - ~~.2 Reports of test results to be witnessed and certified by Departmental Representative before verification.~~

- .5 Pre-Cx activities - ELECTRICAL:
 - .1 High voltage distribution systems over 750 V:
 - .1 Substation and switch gear.
 - .2 Low voltage distribution systems under 750 V:
 - .1 Requires independent testing agency to perform pre- energization and post-energization tests.
 - .3 Emergency power generation systems
 - .1 Transfer switches: test by simulating loss of power. Verify availability of power at equipment requiring same.
 - .2 Uninterruptible power systems: test under full and partial load conditions.
 - .4 Lighting systems:
 - .1 Emergency lighting systems:
 - .1 Tests to include verification of lighting levels and coverage, initially by disrupting normal power.
 - .5 Fire alarm systems: test after other safety and security systems are completed. Testing to include a complete verification in accordance with ULC requirements. Departmental Representative has witnessed and certified report, demonstrate devices and zones to Departmental Representative.
 - .6 Low voltage systems: these include:
 - .1 Communications, low voltage lighting control systems and data communications systems.
 - .7 Security, surveillance and intrusion alarm systems: to include verification by Departmental Representative.
 - .8 Lightning protection systems.

1.13 START-UP

- .1 Start up components, equipment and systems.
- .2 Equipment manufacturer, supplier, installing specialist sub-contractor, as appropriate, to start-up, under Contractor's direction, following equipment, systems:
 - .1 Service Water Pumps (GAC Pumps).
 - .2 Instrumentation
- .3 Departmental Representative to monitor some of these start-up activities.
 - .1 Rectify start-up deficiencies to satisfaction of Departmental Representative.
- .4 Performance Verification (PV):
 - .1 Approved Cx Agent to perform.
 - .1 Repeat when necessary until results are acceptable to Departmental Representative.
 - .2 Use procedures modified generic procedures to suit project requirements.
 - .3 Departmental Representative to witness and

certify reported results using approved PI and PV forms.

.4 Departmental Representative to approve completed PV reports and provide to Departmental Representative.

.5 Departmental Representative reserves right to verify up to 30% of reported results at random.

.6 Failure of randomly selected item shall result in rejection of PV report or report of system startup and testing.

1.14 CX ACTIVITIES
AND RELATED
DOCUMENTATION

.1 Perform Cx by specified Cx agency using procedures developed by Departmental Representative and approved by Departmental Representative.

.2 Departmental Representative to monitor Cx activities.

.3 Upon satisfactory completion, Cx agency performing tests to prepare Cx Report using approved PV forms.

.4 Departmental Representative to witness, certify reported results of, Cx activities and forward to Departmental Representative.

.5 Departmental Representative reserves right to verify a percentage of reported results at no cost to contract.

1.15 CX OF
INTEGRATED SYSTEMS
AND RELATED
DOCUMENTATION

.1 Cx to be performed by specified Cx specialist, using procedures developed by Departmental Representative and approved by Departmental Representative.

.2 Tests to be witnessed by Departmental Representative and documented on approved report forms.

.3 Upon satisfactory completion, Cx specialist to prepare Cx Report, to be certified by Departmental Representative and submitted to Departmental Representative for review.

.4 Departmental Representative reserves right to verify percentage of reported results.

.5 Integrated systems to include:

.1 Service pumps, Mag meter controllers and SCADA.

.2 GAC Tank refurbishment and process flow.

.6 Identification:

.1 In later stages of Cx, before hand-over and acceptance Departmental Representative and Cx Manager to co-operate to complete inventory data sheets and provide assistance to PWGSC in full implementation of MMS identification system of components, equipment, sub-systems, systems.

1.16 INSTALLATION
CHECK LISTS (ICL)

.1 Refer to Section 01 91 33.

1.17 PRODUCT
INFORMATION (PI)
REPORT FORMS

.1 Refer to Section 01 91 33.

1.18 PERFORMANCE
VERIFICATION (PV)
REPORT

.1 Refer to Section 01 91 33.

1.19 DELIVERABLES
RELATING TO
ADMINISTRATION OF
CX

.1 General:
.1 Because of risk assessment, complete Cx of occupancy, weather and seasonal-sensitive equipment and systems in these areas before building is occupied.

1.20 CX SCHEDULES

.1 Prepare detailed Cx Schedule and submit to Departmental Representative for review and approval same time as project Construction Schedule. Include:
.1 Milestones, testing, documentation, training and Cx activities of components, equipment, subsystems, systems and integrated systems, including:
.1 Design criteria, design intents.
.2 Pre-TAB review: 28 days after contract award, and before construction starts.
.3 Cx agents' credentials: 60 days before start of Cx.
.4 Cx procedures: 3 months after award of contract.
.5 Cx Report format: 3 months after contract award.
.6 Submission of list of instrumentation with relevant certificates: 21 days before start of Cx.
.7 Notification of intention to start TAB: 21 days before start of TAB.
.8 TAB: after successful start-up, correction of deficiencies and verification of normal and safe operation.
.9 Notification of intention to start Cx: 14 days before start of Cx.
.10 Notification of intention to start Cx of integrated systems: after Cx of related systems is completed 14 days before start of integrated

1.21 CX SCHEDULE
FOR MECHANICAL
SYSTEMS

- system Cx.
 - .12 Identification of deferred Cx.
 - .13 Implementation of training plans.
 - .14 Cx reports: immediately upon successful completion of Cx.
- .2 Detailed training schedule to demonstrate no conflicts with testing, completion of project and hand-over to Owner.
- .3 2 months in Cx schedule for verification of performance in all seasons and wear conditions.
- .2 After approval, incorporate Cx Schedule into Construction Schedule.
- .3 Departmental Representative, Contractor, Contractor's Cx agent, and Departmental Representative will monitor progress of Cx against this schedule.
- .1 Produce schedule of Cx activities in bar chart format to a scale that will ensure legibility. Bar chart to indicate:
 - .1 Sequences of testing equipment and systems, interrelationship between tests, duration of tests and training periods.
 - .2 Cx resources which will be committed to this project to ensure completion by prescribed dates.
 - .3 Training Plan.
 - .4 Cx Documentation Plan
- .2 Watermains and related site process water:
 - .1 Commission as soon as installation is complete, using procedures described in NSF and AWWA reference standards to provide protection for exterior envelope of new building during construction.
- .3 Plumbing systems:
 - .1 To be filled, pressure booster pumps "bumped" in a stand-alone mode and pre-start-up inspections completed. Then proceed with flushing, cleaning and disinfection processes.
 - .2 Test plumbing and piping systems in conjunction with related control systems.
- . 4 Final Cx activities:
 - .1 Upon completion of Cx to satisfaction of Departmental Representative lock control devices in their final positions, indelibly mark settings and include in TAB and PV Reports.

1.22 CX SCHEDULE
FOR ELECTRICAL
SYSTEMS

- .1 Systems to be tested as required by codes:
 - .1 Where testing is required as part of a regulatory process and where Cx procedures are developed and are appropriate to project, perform tests as required by such codes.

-
- .2 Departmental Representative to witness these tests as part of Quality Assurance role.
 - .2 Produce a schedule of Cx activities in a bar chart format to a scale that will ensure legibility. Bar chart to indicate:
 - .1 Sequences of testing equipment and systems, interrelationship between tests, duration of tests and training periods.
 - .2 Cx resources which will be committed to this project to ensure completion by prescribed dates.
 - .3 Training plan.
 - .4 Cx documentation plan.
 - .3 Main distribution system:
 - .1 Testing and Cx to be defined in construction specifications.
 - .2 Contractor to conduct "megger" tests of feeders.
 - .3 Cx to utilize services of an independent testing agency to perform a series of pre-energization and post-energization tests.
 - .4 Low voltage systems:
 - .1 These include existing PLC, pumps, instrumentation, VFDs and data communications systems.
 - .5 Cx requirements to be included in construction specifications.
- 1.23 CX REPORTS
- .1 Submit reports of tests, witnessed and certified by Departmental Representative to Departmental Representative who will verify reported results.
 - .2 Include completed and certified PV reports in properly formatted Cx Reports.
 - .3 Before reports are accepted, reported results to be subject to verification by Departmental Representative.
- 1.24 ACTIVITIES DURING WARRANTY PERIOD
- .1 Cx activities must be completed before issuance of Interim Certificate, it is anticipated that certain Cx activities may be necessary during Warranty Period, including:
 - .1 Fine tuning VFD parameters and SCADA controls.
- 1.25 TRAINING PLANS
- .1 Refer to Section 01 91 41.
- 1.26 FINAL SETTINGS
- .1 Upon completion of Cx to satisfaction of Departmental Representative lock control devices in their final positions, indelibly mark settings marked and include in Cx Reports.

PART 2 - PRODUCTS

2.1 NOT USED .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED .1 Not Used.

PART 1 - GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Commissioning forms to be completed for equipment, system and integrated system.

1.2
INSTALLATION/START-
UP CHECK LISTS

- .1 Include the following data:
 - .1 Product manufacturer's installation instructions and recommended checks.
 - .2 Special procedures as specified in relevant technical sections.
 - .3 Items considered good installation and engineering industry practices deemed appropriate for proper and efficient operation.
- .2 Equipment manufacturer's installation/start-up check lists are acceptable for use. As deemed necessary by Departmental Representative supplemental additional data lists will be required for specific project conditions.
- .3 Use check lists for equipment installation. Document check list verifying checks have been made, indicate deficiencies and corrective action taken.
- .4 Installer to sign check lists upon completion, certifying stated checks and inspections have been performed. Return completed check lists to Departmental Representative. Check lists will be required during Commissioning and will be included in Building Maintenance Manual (BMM) at completion of project.
- .5 Use of check lists will not be considered part of commissioning process but will be stringently used for equipment pre-start and start-up procedures.

1.3 PRODUCT
INFORMATION (PI)
REPORT FORMS

- .1 Product Information (PI) forms compiles gathered data on items of equipment produced by equipment manufacturer, includes nameplate information, parts list, operating instructions, maintenance guidelines and pertinent technical data and recommended checks that is necessary to prepare for start-up and functional testing and used during operation and maintenance of equipment. This documentation is included in the BMM at completion of work.
- .2 Prior to Performance Verification (PV) of systems complete items on PI forms related to systems and obtain Departmental Representative's approval.

1.4 PERFORMANCE
VERIFICATION (PV)
FORMS

- .1 PV forms to be used for checks, running dynamic tests and adjustments carried out on equipment and systems to ensure correct operation, efficiently and function independently and interactively with other systems as intended with project requirements.
- .2 PV report forms include those developed by Contractor records measured data and readings taken during functional testing and Performance Verification procedures.
- .3 Prior to PV of integrated system, complete PV forms of related systems and obtain Departmental Representative's approval.

1.5 SAMPLES OF
COMMISSIONING FORMS

- .1 Departmental Representative will develop and provide to Contractor required project-specific Commissioning forms in electronic format complete with specification data.
- .2 Revise items on Commissioning forms to suit project requirements.
- .3 Samples of Commissioning forms and a complete index of produced to date will be attached to this section.

1.6 CHANGES AND
DEVELOPMENT OF NEW
REPORT FORMS

- .1 When additional forms are required, but are not available from Departmental Representative develop appropriate verification forms and submit to Departmental Representative for approval prior to use.
 - .1 Additional commissioning forms to be in same format as provided by Departmental Representative.

1.7 COMMISSIONING
FORMS

- .1 Use Commissioning forms to verify installation and record performance when starting equipment and systems.
- .2 Strategy for Use:
 - .1 Departmental Representative provides Contractor project-specific Commissioning forms with Specification data included.
 - .2 Contractor will provide required shop drawings information and verify correct installation and operation of items indicated on these forms.
 - .3 Confirm operation as per design criteria and intent.
 - .4 Identify variances between design and operation and reasons for variances.
 - .5 Verify operation in specified normal and emergency modes and under specified load conditions.
 - .6 Record analytical and substantiating data.
 - .7 Verify reported results.

.8 Form to bear signatures of recording technician and reviewed and signed off by Departmental Representative.

.9 Submit immediately after tests are performed.

.10 Reported results in true measured SI unit values.

.11 Provide Departmental Representative with originals of completed forms.

.12 Maintain copy on site during start-up, testing and commissioning period.

.13 Forms to be both hard copy and electronic format with typed written results.

1.8 LANGUAGE

.1 To suit the language profile of the awarded contract.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not Used.

PART 1 - GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 This Section specifies roles and responsibilities of Commissioning Training.

1.2 TRAINEES

- .1 Trainees: personnel selected for operating and maintaining this facility. Includes Facility Manager, building operators, maintenance staff, security staff, and technical specialists as required.
- .2 Trainees will be available for training during later stages of construction for purposes of familiarization with systems.

1.3 INSTRUCTORS

- .1 Departmental Representative will provide:
 - .1 Descriptions of systems.
 - .2 Instruction on design philosophy, design criteria, and design intent.
- .2 Contractor and certified factory-trained manufacturers' personnel: to provide instruction on the following:
 - .1 Start-Up, operation, shut-down of equipment, components and systems.
 - .2 Control features, reasons for, results of, implications on associated systems of, adjustment of set points of control and safety devices.
 - .3 Instructions on servicing, maintenance and adjustment of systems, equipment and components.
- .3 Contractor and equipment manufacturer to provide instruction on:
 - .1 Start-up, operation, maintenance and shut-down of equipment they have certified installation, started up and carried out PV tests.

1.4 TRAINING
OBJECTIVES

- .1 Training to be detailed and duration to ensure:
 - .1 Safe, reliable, cost-effective, energy-efficient operation of systems in normal and emergency modes under all conditions.
 - .2 Effective on-going inspection, measurements of system performance.
 - .3 Proper preventive maintenance, diagnosis and trouble-shooting.
 - .4 Ability to update documentation.
 - .5 Ability to operate equipment and systems under emergency conditions until appropriate qualified assistance arrives.

1.5 TRAINING
MATERIALS

- .1 Instructors to be responsible for content and quality.
- .2 Training materials to include:
 - .1 "As-Built" Contract Documents.
 - .2 Operating Manual.
 - .3 Maintenance Manual.
 - .4 Management Manual.
 - .5 TAB and PV Reports.
- .3 Project Manager, Commissioning Manager and Property Manager will review training manuals.
- .4 Training materials to be in a format that permits future training procedures to same degree of detail.
- .5 Supplement training materials:
 - .1 Transparencies for overhead projectors.
 - .2 Multimedia presentations.
 - .3 Manufacturer's training videos.
 - .4 Equipment models.

1.6 SCHEDULING

- .1 Include in Commissioning Schedule time for training.
- .2 Deliver training during regular working hours, training sessions to be length as required.
- .3 Training to be completed prior to acceptance of facility.

1.7
RESPONSIBILITIES

- .1 Be responsible for:
 - .1 Implementation of training activities,
 - .2 Coordination among instructors,
 - .3 Quality of training, training materials,
- .2 Departmental Representative will evaluate training and materials.
- .3 Upon completion of training, provide written report, signed by Instructors, witnessed by Departmental Representative.

1.8 TRAINING
CONTENT

- .1 Training to include demonstrations by Instructors using the installed equipment and systems.
- .2 Content includes:
 - .1 Review of facility and occupancy profile.
 - .2 Functional requirements.
 - .3 System philosophy, limitations of systems and emergency procedures.
 - .4 Review of system layout, equipment, components and controls.

.5 Equipment and system start-up, operation, monitoring, servicing, maintenance and shut-down procedures.

.6 System operating sequences, including step-by-step directions for starting up, shut-down, operation of valves, dampers, switches, adjustment of control settings and emergency procedures.

.7 Maintenance and servicing.

.8 Trouble-shooting diagnosis.

.9 Inter-action among systems during integrated operation.

.10 Review of O&M documentation.

.3 Provide specialized training as specified in relevant Technical Sections of the construction specifications.

1.9 VIDEO-BASED TRAINING

.1 Manufacturer's videotapes/DVDs/Blu-ray to be used as training tool with Departmental Representative's review and written approval 3 months prior to commencement of scheduled training.

.2 On-Site training videos:

.1 Videotape or record training sessions for use during future training.

.2 To be performed after systems are fully commissioned.

.3 Organize into several short modules to permit incorporation of changes.

.3 Production methods to be high quality.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not Used.

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PART 1 - GENERAL

1.1 Related Work Specified Elsewhere .1 Section 05 50 00 - Metal Fabrication

- 1.2 Standards
- .1 Conform to CAN3-S157-05 Strength Design in Aluminum.
 - .2 Conform to CSA W59.2-M1991(C2008) Welded Aluminum Construction and CSA W47.2-M1987 (C2008) Certification of Companies for Fusion Welding of Aluminum.
 - .3 Conform to Occupational Health and Safety Act Section 89.

1.2 REFERENCES

- .1 Aluminum Association (AA)
 - .1 AA DAF 45-[03(R2009)], Designation System for Aluminum Finishes.
- .2 ASTM International
 - .1 ASTM A123/A123M-09, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - .2 ASTM A307-[07b], Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .3 ASTM A325-[09], Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
 - .4 ASTM A325M-[09], Standard Specification for Structural Bolts, Steel, Heat Treated, 830 MPa Minimum Tensile Strength [Metric].
 - .5 ASTM A490-[09], Standard Specification for Structural Bolts Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength.
 - .6 ASTM A490M-[09a], Standard Specification for High-Strength Steel Bolts, Classes 10.9 and 10.9.3 for Structural Steel Joints [Metric].
 - .7 ASTM B209M-[10], Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric].
 - .8 ASTM B210M-[05], Standard Specification

for Aluminum and Aluminum-Alloy Drawn Seamless Tubes [Metric].

.9 ASTM B211M-[03], Standard Specification for Aluminum and Aluminum Alloy Bar, Rod and Wire [Metric].

.10 ASTM F593-[02(2008)], Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.

- .3 American Welding Society (AWS)
 - .1 AWS-A5.10/A5.10M-[1999(R2007)], Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods.
- .4 Canada Green Building Council (CaGBC)
 - .1 LEED Canada For New Construction and Major Renovations 2009.
 - .2 LEED Canada For Core and Shell 2009.
 - .3 LEED Canada-CI Version 1.0-[2007], LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Guide For Commercial Interiors.
- .5 CSA International
 - .1 CAN/CSA-S157/S157.1-[05], Strength Design in Aluminum/Commentary on CAN/CSA-S157, Strength Design in Aluminum.
 - .2 CSA W47.2-[M1987(R2008)], Certification of Companies for Fusion Welding of Aluminum.
 - .3 CSA W59.2-[M1991(R2008)], Welded Aluminum Construction.
- .6 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .7 Master Painters Institute (MPI)
 - .1 MPI - EXT 5.5D, Bituminous Finish.

1.3 Quality Assurance

- .1 Welding shall only be undertaken by a company Certified by the Canadian Welding Bureau to the requirements of CSA Standard W47.2-M1987, Certification of Companies for the Fusion Welding of Aluminum.

1.4 Shop Drawings

- .1 Submit shop drawings in accordance with Section 01 33 00.
- .2 Indicate materials, thicknesses, weld symbols, reinforcement, details, accessories and grating panel layouts.
- .3 Manufacturer shall supply installation drawings and instructions.
- .4 All submitted drawings to bear signature of a Professional Engineer registered in the Province of Ontario for all fabricated designed assemblies, components and connections.

1.5 Design
Criteria

- .1 Design aluminum stair, balustrades and landing construction to Ontario Building Code vertical and horizontal live load requirements. Ladders and platforms to conform to latest Standards and Requirements of the Occupational Health and Safety Act.

PART 2 - PRODUCTS

2.1 Materials

- .1 Aluminum Extruded Shapes: to CSA HA.5-M1980, Alloys 6061-T6 or better.
- .2 Fasteners: to 304 stainless steel.
- .3 Aluminum tread plate: to CSA HA.5 M1980-Alloy 6061-T6.
- .4 Aluminum welding wire: Alcan 403.
- .5 Bituminous paint: to CAN/CGSB-1.108.

2.2 Fabrication

- .1 Fabricate square, true and accurate to required size, with joints closely fitted. Remove all burrs and sharp edges.
- .2 Provide 1.58 mm thick 80 durometer neoprene isolation pads for all aluminum in contact with concrete.

2.3 Access Hatches

- .1 Hatches to be stainless steel (316) complete

into Reservoir Tanks

with stainless steel hardware. For sizes and locations, refer to drawings.

- .2 Covers: fabricate with minimum 6.35mm stainless steel tread plate, reinforced with 6.35mm x 76mm s.s. (316) flat bar on underside to eliminate warpage, limit deflection to 1/150 of span. Design for a minimum live load of 9.6 kPa.
- .3 Angle frames: fabricate from extruded stainless steel (316), 102mm x102mm x 6.35mm HSS tube complete with welded 100 mm long strap cast anchors located at 250 mm on centre. Frame to be inset into concrete curb.
- .4 Equip access hatches with the following:
 - .1 Continuous formed Stainless Steel (316) hinge with 6.35mm tamperproof fasteners.
 - .2 90 deg. Stainless steel (316) Hold Open Arm with 6.35mm rod formed handle.
 - .3 Stainless steel flush lift handle.
 - .4 Black cord neoprene perimeter sealing gasket.
 - .5 Stainless steel (316) Slam Lock with Aluminum removable sealing plug and opening tool, flush s.s. handle and s.s. lock box.
 - .6 Stainless steel (316) Gas-spring assist cylinder with aluminum mounting brackets.
 - .7 38mm nominal pipe half-coupling with 38mm ABS adapter/elbow for perimeter drainage of hatch.
 - .8 provide lockable and removable key.

2.6 Isolation
Coating

- .1 Isolate aluminum from concrete, mortar or masonry and dissimilar metals with two coats of bituminous paint.

PART 3 - EXECUTION

3.1 Installation

- .1 Erect metalwork square, plumb, straight and true, accurately fitted, with tight joints and intersections.

.2 Provide suitable means of anchorage acceptable to the Engineer. All anchorages to be stainless steel.

3.2 Access Hatches
and Cover Plates

.1 Install access hatches as detailed and in accordance with reviewed show drawings.

.2 Adjust operable parts for correct function.

PART 1 - GENERAL

1.1 RELATED SECTIONS

- .1 Section 05 51 29 - Metal Stairs and Ladders
- .2 Section 09 91 23 - Interior Painting

1.2 REFERENCES

- .1 ASTM International
 - .1 ASTM A53/A53M-10, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
 - .2 ASTM A123/A123M-09, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - .3 ASTM A269-10, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
 - .4 ASTM A307-10, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
- .2 CSA International
 - .1 CSA G40.20-04(R2009)/G40.21-04(R2009), General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
 - .2 CSA S16-09, Design of Steel Structures.
 - .3 CSA W48-06, Filler Metals and Allied Materials for Metal Arc Welding (Developed in co-operation with the Canadian Welding Bureau).
 - .4 CSA W59-M03(R2008), Welded Steel Construction (Metal Arc Welding).
- .3 Environmental Choice Program
 - .1 CCD-047-98(R2005), Architectural Surface Coatings.
 - .2 CCD-048-98(R2006), Surface Coatings - Recycled Water-borne.
- .4 Green Seal Environmental Standards (GS)
 - .1 GS-11-2008, 2nd Edition, Paints and Coatings.
- .5 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .6 The Master Painters Institute (MPI)
 - .1 Architectural Painting Specification Manual - current edition.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for sections and

include product characteristics, performance criteria, physical size, finish and limitations.

.2 Submit two copies of WHMIS MSDS.

.1 For finishes, coatings, primers, and paints applied on site: indicate VOC concentration in g/L.

.3 Shop Drawings:

.1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.

.2 Indicate materials, core thicknesses, finishes, connections, joints, method of anchorage, number of anchors, supports, reinforcement, details, and accessories.

1.4 QUALITY ASSURANCE

.1 Test Reports: submit certified test reports showing compliance with specified performance characteristics and physical properties.

.2 Certifications: submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Replace defective or damaged materials with new.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Steel sections and plates: to CSA G40.20/G40.21, Grade 300W, minimum 30% recycled content.

.2 Steel pipe: to ASTM A53/A53M standard weight galvanized finish, minimum 30% recycled content.

.3 Welding materials: to CSA W59.

.4 Welding electrodes: to CSA W48 Series.

- .5 Bolts and anchor bolts: to ASTM A307.
- .6 Refer to design drawings for member designations.
- .7 Grout: non-shrink, non-metallic, flowable, 15 MPa at 24 hours.

2.2 FABRICATION

- .1 Fabricate work square, true, straight and accurate to required size, with joints closely fitted and properly secured.
- .2 Use self-tapping shake-proof flat round oval headed screws on items requiring assembly by screws or as indicated.
- .3 Where possible, fit and shop assemble work, ready for erection.
- .4 Ensure exposed welds are continuous for length of each joint. File or grind exposed welds smooth and flush.

2.3 FINISHES

- .1 Galvanizing: hot dipped galvanizing with zinc coating 600 g/m², Coating Grade 85, to ASTM A123/A123M.
- .2 Chromium plating: chrome on steel with plating sequence of 0.009 mm thickness of copper 0.010 mm thickness of nickel and 0.0025 mm thickness of chromium.
- .3 Shop coat primer: in accordance with chemical component limits and restrictions requirements and VOC limits of CCD-047a.
- .4 Zinc primer: zinc rich, ready mix in accordance with chemical component limits and restrictions requirements and VOC limits of CCD-047a.

2.4 ISOLATION COATING

- .1 Isolate aluminum from following components, by means of bituminous paint:
 - .1 Dissimilar metals except stainless steel, zinc, or white bronze of small area.
 - .2 Concrete, mortar and masonry.
 - .3 Wood.

2.5 SHOP PAINTING

- .1 Primer: VOC limit 250 g/L maximum to GS-11.
- .2 Apply one shop coat of primer to metal items, with exception of galvanized or concrete encased items.
- .3 Use primer unadulterated, as prepared by manufacturer. Paint on dry surfaces, free from rust, scale, grease. Do not paint when temperature is lower than 7 degrees C.

- .4 Clean surfaces to be field welded; do not paint.

2.6 ANGLE LINTELS

- .1 Steel angles: galvanized, sizes indicated for openings. Provide 150 mm minimum bearing at ends.
- .2 Weld or bolt back-to-back angles to profiles as indicated.
- .3 Finish: shop painted.
.1 Primer: VOC limit 250 g/L maximum to GS-11 when applied onsite.

2.9 ACCESS LADDERS

- .1 Fabricate exterior access ladders, safety cages, platform landing (top of ladder) and curved top rails in hot-dipped galvanized materials. Refer to drawing A7.6 for details.

2.10 BOLLARDS

- .1 Fabricate bollards from 150mm steel pipe, hot dip galvanized, 1200mm high above ground level, with 1500mm below grade level. Bollard to be concrete filled and installed in concrete filled sonotube. Refer to details on drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for metal fabrications installation in accordance with manufacturer's written instructions.
.1 Visually inspect substrate in presence of Departmental Representative.
.2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 ERECTION

- .1 Do welding work in accordance with CSA W59 unless specified otherwise.
- .2 Erect metalwork square, plumb, straight, and true, accurately fitted, with tight joints and intersections.
- .3 Provide suitable means of anchorage acceptable to Departmental Representative such as dowels, anchor

clips, bar anchors, expansion bolts and shields, and toggles.

- .4 Exposed fastening devices to match finish and be compatible with material through which they pass.
- .5 Supply components for work by other trades in accordance with shop drawings and schedule.
- .6 Make field connections with bolts to CSA S16 or Weld field connection.
- .7 Deliver items over for casting into concrete and building into masonry together with setting templates to appropriate location and construction personnel.
- .8 Touch-up rivets, field welds, bolts and burnt or scratched surfaces with primer after completion of:
 - .1 Primer: maximum VOC limit 250 g/L to GS-11.
- .9 Touch-up galvanized surfaces with zinc rich primer where burned by field welding.
 - .1 Primer: maximum VOC limit 250 g/L to GS-11.

3.3 PIPE RAILINGS

- .1 Install pipe railings as indicated.
- .2 Set railing standards in concrete. Grout to fill hole. Trowel surface smooth and flush with adjacent surfaces.

3.4 CORNER GUARDS

- .1 Install corner guards in locations as indicated.

3.5 ACCESS LADDERS

- .1 Install access ladders in locations as indicated.
- .2 Erect ladders 152 mm clear of wall on bracket supports.

3.6 TRENCH COVERS

- .1 Install trench covers in locations as indicated.

3.7 CHANNEL FRAMES

- .1 Install steel channel frames to openings as indicated.

3.8 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11.

3.9 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by metal fabrications installation.

1.1 DESCRIPTION

- .1 This Section specifies the requirements for the supply of all labour, equipment and materials for spot repair and recoating of the inside of the GAC tanks at the Joyceville Water Treatment Plant as per reports by Napier-Reid and Landmark Municipal Services, dated July 4, 2013 and February 25, 2015 respectively.

1.2 REFERENCES

- .1 AWWA - American Water Works Association, 6666 West Quincy Avenue, Denver, Colorado 80235, USA (www.awwa.org).
- .2 ASTM - American Society for Testing and Materials, PO Box C700, 100 Bar Harbor Dr., West Conshohocken, Pennsylvania 19428, USA (www.astm.org).
- .3 NACE International - The Corrosion Society, P.O. Box 218340, Houston, Texas 77218, USA (www.nace.org).
- .4 SSPC - Society for Protective Coatings, 40 24th Street, 6th Floor, Pittsburgh, Pennsylvania 15222, USA (www.sspc.org).
- .5 NSF International - National Sanitation Foundation, P.O. Box 130140, 789 Dixboro Road, Ann Arbor, Michigan 48113-0410, USA (www.nsf.org).
- .6 Environmental Protection Act, R.S.O. 1990 c. E.19, Regulations with regard to abrasive blast cleaning and painting procedures.

1.3 REFERENCE STANDARDS

- .1 The Work undertaken and Products provided in this Specification shall conform, in all respects, to the latest published revisions of the following standards except where specified herein:

- .1 AWWA C210 - Standard for Liquid Epoxy Coating and Lining Systems for the Interior and Exterior of Steel Water Pipelines
- .2 AWWA D100 - Standard for Welded Steel Tanks for Water Storage
- .3 AWWA D102 - Standard for Coating Steel Water Storage Tanks
- .4 AWWA C652-02 - Standard for Disinfection of Water-Storage Facilities
- .5 NACE RP0178-95 - National Association of Corrosion Engineers - Standard Recommended Practice - Fabrication Details, Surface Finish Requirements and Proper Design Considerations for Tanks and Vessels to be Lined for Immersion Service
- .6 NACE RP0188 - Discontinuity (Holiday) Testing of Protective Coatings
- .7 ASTM D16 - Standard Terminology for Paint, Related Coatings, Materials and Applications
- .8 SSPC-SP1 - Solvent Cleaning
- .9 SSPC-SP2 - Hand Tool Cleaning
- .10 SSPC-SP3 - Power Tool Cleaning
- .11 SSPC-SP5/NACE No. 1 - White Metal Blast Cleaning
- .12 SSPC-SP6/NACE No. 3 - Commercial Blast Cleaning
- .13 SSPC-SP10/NACE No. 2 - Near-White Blast Cleaning
- .14 SSPC-SP11 - Power Tool Cleaning to Bare Metal
- .15 SSPC Paint 22 - Epoxy-Polyamide Paints (Primer, Intermediate and Topcoat)
- .16 SSPC Paint 25 - Red Iron Oxide, Zinc Oxide, Raw Linseed Oil and Alkyd Primer (Without Lead and Chromate Pigments)
- .17 SSPC-PA1 - Workmanship Standards
- .18 SSPC-PA2 - Measurement of Dry Coating Thickness with Magnetic Gauges
- .19 SSPC-PA3 - A Guide to Safety in Paint Application
- .20 [SSPC-TR3/NACE 6A192](#) - Dehumidification and Temperature Control During Surface Preparation, Application, and

Curing for Coatings/Linings of
Steel Tanks, Vessels, and Other
Enclosed Spaces

- .21 Occupational Health and Safety
Act, 1990 and Regulations for
Construction Projects
- .22 NSF-61 - American National
Sanitation Foundation Standard
for Products in Contact with
Potable Water
- .23 ANSI Z117.1 - Safety
Requirements for Working in
Tanks and Other Confined Spaces

1.4 RELATED SECTIONS

1.5 SUBMITTALS

- .1 Date Sheets:
 - .1 For each paint system, provide 3
copies of the paint
manufacturer's technical data
sheets, and the paint colours
available (where applicable) for
each Product used in the paint
system that demonstrates
compliance with the
Specification.
 - .2 Submit the required information
on a system-by-system basis.
 - .3 Provide copies of paint system
submittals to the coating
applicator.
 - .4 Indiscriminate submittal of the
manufacturer's literature only
is not acceptable.
 - .5 Product and safety data sheets:
Submit three copies for each
Product.
- .2 Written proposal outlining the method
for protection of adjacent areas to
prevent damage or contamination from
the Work procedures involved.
- .3 Written proposal outlining the methods
and sequence for surface preparation
and application of coatings. Do not
commence any surface preparation or
coating application until the
Consultant's review is complete.
- .4 Written proposals are to contain, but
not be limited to, a description of:
 - .1 Ventilation System, including
forced air.

- .2 Dehumidification Systems.
- .3 Blast Abrasive Recovery Systems.

1.6 DELIVERY,
STORAGE, AND
HANDLING

- .1 Storage:
 - .1 Deliver paint materials to the site in sealed, labeled containers with manufacturer's labels intact. Store products in a protected area that is heated or cooled to maintain temperatures within the range recommended by paint manufacturer.

1.7 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Applicator: A minimum of 5 years' of experience in the application of the specified Products.
- .2 Quality Assurance:
 - .4 Prior to the commencement of painting operations, meet at the site with the material supplier's representative and with the Consultant to review these Specifications, the painting Work to be done and the following related items:
 1. Health and Safety requirements during application.
 2. Equipment use and servicing.
 3. Material storage and application techniques.
 4. Surface preparation and ambient temperature.
 5. Inspection requirements.
 6. Inspection reports.
 7. Hold points or check points.
 8. Disinfection.
 9. Mock-ups or samples of coatings in environments.
 - .5 Submit a report of alternative recommendations for adverse conditions encountered.
 - .6 Arrange with the paint manufacturer to visit the site

at intervals during the surface preparation and painting operations to ensure that the proper surface preparation has been completed, that the specified paint Products are being used, that the proper number of coats are being applied and that the agreed upon finishing procedures are being implemented. The paint manufacturer shall submit written site visit reports of each site visit.

1.8 EQUIPMENT, LABOUR
AND SERVICES

- .1 The Contractor shall furnish all labour, material and equipment necessary to complete the items of Work outlined including cleaning, surface preparation and protective coating application, unless otherwise specifically directed.
- .2 All electrical devices and wiring used shall be explosion proof and shall carry the appropriate C.S.A. approval. All lighting and wiring shall be secured from damage or falling. All electrical installation and equipment shall be subject to approval by a certified electrician at the discretion of the Consultant.

1.9 DAMAGE OR
CONTAMINATION

- .1 It shall be responsibility of the Contractor to adequately protect, shield or cover all structures, stores, machinery, equipment and openings, as required by the Consultant, to prevent damage or contamination from the Work procedures involved. The Contractor shall be responsible for any such loss or damage arising from its failure to adequately protect the items referred to above.

1.10 CLEANING

- .1 The Work area shall be kept clean at all times by the Contractor. Garbage

disposal containers adequate to handle all wastes shall be provided by the Contractor.

1.11 FIRE PREVENTION

- .1 The Contractor shall take precautions against fire in the working areas and provide adequate firefighting equipment.

1.12 SAFETY

- .1 The Contractor shall comply with all regulations established by the Ministry of Labour under the Occupational Health and Safety Act and Regulations for construction projects and other government authorities, including those pertaining to the handling of hazardous paint materials and the emission of volatile organic compounds.

- .2 Lead-based coating systems shall be removed and handled with strict conformance to the Ontario Health and Safety Act and Regulations as established by the Ministry of Labour. The Contractor shall ensure all engineering controls, work and hygiene practices outlined in the Regulations are adhered to at all time during the handling and removal process. The Contractor shall comply with the requirements of the Environmental Protection Act, Revised Statutes of Ontario, 1980, Chapter 141, and the various Regulations under the Act with regard to abrasive blast cleaning and painting procedures.

1.13 COLOUR

- .1 The colour of the coating system shall match existing and approved by the Consultant.

1.14 WORKMANSHIP

- .1 All work performed by the Contractor shall be of the best quality throughout and in accordance with the requirements of SSPC-PA1, unless otherwise specified. Any dispute or difference of opinion as to the interpretation of these Specifications

or regarding the quality of material or workmanship shall be left to the decision of the Consultant, whose decision shall be final and binding on the Contractor.

1.15 ACCESS

- .1 The Contractor shall provide free and safe access to the Work area at all times for the Consultant.

1.16 DETAILS OF WORK

- .1 Any particulars of the Work provided herewith are given only for the guidance of the Contractor who will be held responsible for securing all necessary dimensions and details; the intent of these Specifications being to effect a quality coating system in the area specified.

1.17 MANUFACTURER'S INSTRUCTIONS

- .1 The costing manufacturer's published instructions shall form part of this Specification and shall be acquired by the Contractor. In case of conflict, the decision of the Consultant shall prevail.

1.18 EXCEPTIONS

- .1 There shall be no departure from these Specifications unless directed by the Consultant. The Consultant has the right during the performance of the Work, to make alterations, providing such alterations are instituted before the particular Work requiring changing is commenced, and also that such alterations will not increase the Contractor's cost. Any exceptions required by the Contractor must be presented in writing to the Township prior to the commencement of the Work.

1.19 ENVIRONMENTAL REQUIREMENTS

- .1 Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the coating Product manufacturer.
- .2 Do not apply exterior coatings when relative humidity is outside the

humidity ranges required by coating
Product manufacturer.

- .3 The Contractor shall supply, install and maintain two humidity and two temperature monitoring sensors each at the top, middle and bottom of the containment system to monitor the ambient humidity and temperature conditions respectively, during coating applications.
- .4 Minimum application temperatures shall be as required by manufacturer's instructions.
- .5 Provide lighting level equivalent to 80 foot-candles measured mid-height at substrate surface.
- .6 In addition to any air monitoring requirements of the Ministry of the Environment and the OHSA required for the Work under this Contract, the Engineer, at any time, may determine that additional air monitoring is required to ensure that air quality in other parts of the structure or containment system is within acceptable levels. At the Engineer's request, the Contractor shall provide additional air monitoring equipment and services as necessary, and at its own expense, to verify acceptability of the air quality within the exterior containment system.
- .7 Negative pressure shall be maintained in the enclosure while any coating removal Work is in progress. The negative pressure shall be maintained through an appropriately sized self-cleaning dust collection unit suited for abrasive blasting operations. All air removed from the contained area shall be filtered through the dust collection equipment so as to not release any debris into the external atmosphere.

- .8 All waste materials resulting from abrasive blast cleaning and coating removal operations shall be cleaned up by vacuuming. Sweeping, shoveling, or other mechanical means to remove the waste materials will not be allowed.
- .9 It is the responsibility of the Contractor to ensure that the containment, collection and storage of waste materials is done in strict accordance with all current federal, provincial, and local regulations with respect to waste handling and disposal.
- .10 When abrasive blast cleaning is used, the Contractor shall consider all areas which are subject to any abrasive blast cleaning to be of a containment nature, and which shall be subject to all health and safety standards and practices set forth by any and all federal, provincial, and local agencies, authorities, departments, or governing body involved.
- .11 All waste materials shall be recovered and removed from the Site, and disposed of in accordance with all applicable local, provincial, and federal laws, regulations, and codes. Removed coating, cleaning debris, and abrasive blast cleaning materials shall be cleaned up daily and stored in leak-proof covered containers for disposal. Tank interior blast residue shall be stored separately from exterior blast residue and containers labelled as such. Containers shall be designed to keep water from entering the containers. Collection, handling, and disposal of these materials shall be in conformance with the OHSA, the EPA, and all other governing laws, rules, and regulations. The cost of all disposals under this Contract shall be the responsibility of the Contractor.

- .12 The Contractor is required to furnish copies of all manifests, chain of custody forms, testing results, etc. to the Engineer for materials removed from the Site and disposed of prior to Substantial Performance of the Work.
- .13 The Contractor shall provide the name of the treatment or disposal facility to the Engineer for approval prior to removal of any materials from the Site.
- .14 All materials removed from the Site shall be transported to a treatment or disposal facility as outlined above. The transporter shall obtain the necessary insurances and permits required for transportation of the materials which shall be submitted to the Engineer for approval prior to removal and transporting of materials from the Site.
- .15 All waste materials that remain on the collector system shall be removed at least once a day or more frequently if directed by the Engineer.

1.20 WARRANTY

- .1 In the case of the tank being completed as defined New Lining System, a written warranty shall be supplied to the Owner by both the coating supplier (Manufacturer) and coating applicator (Contractor) for all interior and exterior coating work. The warranty period shall be two (2) years from date of Substantial Completion, and shall include the following:
 - .1 The coating manufacturer shall warrant that the coating system be free from deterioration due to peeling, blistering or other forms of coating failure which can be directly attributed to an abnormal coating system

breakdown, for the two year period.

- .2 The Contractor shall warrant that the surface preparation and coating system application be free from defects caused by faulty workmanship, or failure to follow the Specifications and/or the manufacturer's instructions as set forth in the manufacturer's data sheets, for the two year period.

.2 Warranty Inspection

- .1 At the end of one year and prior to the expiry of the two year Warranty Period, the inside surfaces of the steel tank shall be inspected by the Consultant or its authorized inspectors at a time convenient to the Owner.
- .2 At the discretion and cost of the Owner, dive inspection may be used as an alternative to draining the tank.
- .3 The Contractor shall be on Site during the inspection to open and wash out the tank interior, and shall be fully prepared to immediately start repair procedures if necessary.
- .4 Repairs
 1. Any location where layers of coating have peeled off, bubbled or cracked, and any location where rusting is evident, shall be considered to be a failure of the coating system.
 2. Repairs shall be made by the Contractor at all points where failures are observed by removing the deteriorated coating, cleaning the surface, and recoating with the same coating system.
 3. If the area of failures exceeds 25 percent of the area of a portion of the

tank surface, then for that portion, the entire coating system shall be removed and that section recoated.

4. Repair coating failures as directed by the Consultant and within a period of time acceptable to the Owner.

PART 2 - PRODUCTS

2.1 INTERIOR REPAIR COATING SYSTEM

- .1 The interior coating system shall be an epoxy lining system conforming to the requirements of AWWA D102 for epoxy coatings and the NSF-61 Standard for Tank Coatings. The minimum dry film thickness of the interior coating system shall be 12 mils, whichever is greater. The maximum dry film thickness shall not exceed the maximum thickness as allowed in the NSF 61 approval.
- .2 Materials
 - .1 The basis of design for the interior coating material for all inside surfaces of the steel water tank, and all accessories inside the tank unless otherwise noted, shall be:
 - .1 Tnemec Company Series 141, Series FC22 or Series 22 finish
 2. Equivalent materials by others
 - .2 All coating materials shall be supplied by the same manufacturer.
 - .3 Different lots of material shall be kept to a minimum, consistent with the manufacturer's production facilities for the Product.
 - .4 Paint shall be supplied at the Site in new, unopened containers. Materials older than the manufacturer's published

shelf life shall not be accepted. Damaged containers will not be accepted.

2.2 PAINT .1 Paint shall be supplied at the Site in new, unopened containers.

2.3 MATERIALS .1 Materials older than the manufacturer's published shelf life shall not be accepted. Damaged containers will not be accepted.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS .1 The Contractor shall provide sufficient lighting and appropriate intensity to allow proper abrasive blasting, coating application, inspection and worker safety.

.2 The Contractor shall design and maintain adequate and continuous ventilation in addition to natural convection attained by keeping all tank hatches open during all coating operations. The ventilation system shall be capable of preventing the solvent vapour from reaching the lower explosion limit for the solvent used. Fresh air shall be passed throughout the height of the tank during the time required for coating operations and drying for successive coats, and a minimum 7 Day drying period after the final coat has been applied. The effectiveness of the ventilating system shall be checked and monitored by the Contractor. All equipment shall be explosion proof.

.3 Where heaters or heater systems are approved by the Consultant, they shall be of the indirect heat exchange type. No products of combustion shall be blown into the tank. This refers to direct oil fired heaters which produce

carbon and direct propane fired heaters which produce water, both of which will cause coating failure.

- .4 The Contractor shall measure the air temperature, dew point and other Work area conditions that directly affect the applications of coatings, immediately prior to the commencement, during coating application and curing.

3.2 INSPECTION

- .1 All material and equipment furnished, and Work done, shall be subject to thorough inspection by the Consultant or the appointed Inspection Agency. Such inspection shall not relieve the Contractor of the responsibility for furnishing the qualified labour, etc., necessary to meet the requirements of this Specification and the Reference Standards. The Contractor shall request the Consultant's approval only after the Contractor's own thorough inspection and after the Contractor is satisfied that all the requirements of the Specification have been met.
- .2 Specified inspections are required for each Work stage as follows:
 - .1 Prior to preliminary blast.
 - .7 Prior to surface upgrading and/or repairs.
 - .8 After surface preparation/upgrading.
 - .9 Prior to each phase of final blast.
 - .10 Prior to each coat phase.
 - .11 After each coat phase.
 - .12 After deficiency repairs.
- .3 Any defective Work, whether the result of poor workmanship, use of defective materials, damage through carelessness, or any other cause resulting from the Contractor's actions or omissions, found to exist prior to final acceptance of the Work, shall be repaired or removed immediately when ordered by the

Consultant. In the case of repair, the procedures shall be in an acceptable manner as authorized by the Consultant. In the case of removal, the Work shall be replaced by Work and materials which shall conform to the Specification. This clause shall have full effect regardless of the fact that the defective Work may have been previously overlooked by the Consultant.

3.3 SURFACE PREPARATION

- .1 Interior Repair Coating System
 - .1 Accumulation of sediment, etc., shall be removed by high pressure water cleaning.
 - .2 All repair areas as directed by the Consultant shall be prepared in accordance with the requirements of SSPC-SP10 and include feathering the repair area into the intact existing coating a minimum of 1 inch.
- .2 Quality Control
 - .1 Blast cleaning operations for final surface preparation shall not be continued if steel temperatures are less than 3°C, above the dew point, or when the relative humidity of the air is greater than 50%. Ambient and surface conditions shall be controlled and maintained by the Contractor at all times using dehumidification and heating.

3.4 APPLICATION

- .1 General Requirements
 - .1 The requirements of SSPC PA1 and SSPC PA3, and the coating manufacturer's published instructions shall be followed with regard to the storage of coatings and thinner; mixing, thinning and coating; the application of shop and field coatings; and, drying of coated steel. Some coatings may require additional coats to achieve the

-
- specified thickness when applied by brush or roller.
- .2 Coating materials shall be applied after surface preparation and before any rusting occurs, or any dust or soil has accumulated.
 - .3 Coating materials shall be applied as specified by the manufacturer to attain the required dry film thickness.
 - .4 The coating system shall be carried as far as possible into all nozzle necks and, on exposed flange faces, to the bolt circle.
- .2 Coating Uniformity
 - .1 All coatings shall be uniformly applied without sags, foreign materials contamination, or other blemishes.
 - .2 Such defects shall be removed and repaired at the discretion of the Consultant before proceeding with another coat.
 - .3 Dew Point
 - .1 No coating materials shall be applied when the surface to be coated is less than 3⁰C above the Dew Point.
 - .2 A surface temperature thermometer in intimate contact with the steel shall be used for monitoring purposes.
 - .4 Curing
 - .1 The manufacturer's published curing schedule shall be strictly followed and steel temperatures, rather than ambient, are to be maintained.
- 3.5 HOLIDAY TESTING OF THE INTERIOR LINING REPAIRS
-
- .1 After the interior finish coat has been applied and cured sufficiently, the coating system shall be checked for pinholes, etc., using a high voltage holiday detector, in

accordance with NACE SP0188 -
Discontinuity (Holiday) Testing of
Protective Coatings.

- .2 All deficiencies shall be repaired by the application of the appropriate material, as directed by the Consultant.
- .3 After repairs have cured sufficiently to permit inspection, but before the final cure, repaired areas shall be reinspected for pinholes, etc., and all procedures shall be followed.
- .4 The completed coating system shall be holiday free.

END OF SECTION

PART 1. GENERAL

- 1.1 Intent of Section .1 This section covers the supply, delivery, storage, placement and commissioning of Granular Activated Carbon (GAC) in GAC Tanks, as indicated on the Contract Drawings and as specified herein.
- .2 The Contractor shall assume full responsibility for the overall coordination of the supply and placement of the granular activated carbon media in the contactor tankage.
- .3 The Contractor shall retain the services of a manufacturer certified Subcontractor for the installation of the GAC filter media.
- 1.2 Conformance .1 Conform to the requirements of Division 1 - General Requirements.
- 1.3 Submittals .1 Submit the following shop drawing test reports:
- .1 Apparent Density, sieve analysis, uniformity coefficient and acid tests for GAC.
- .2 Abrasion resistance test results for GAC.
- .3 AWWA B604 test results for GAC.
- .4 Affidavit of Compliance confirming that the GAC complies with AWWA Standard B604 and with the Specifications, as written, with no exceptions.
- .5 Certification that the GAC media has been sourced within North America.
- .6 The Contractor shall submit their proposed procedures for the GAC installation for review and approval prior to undertaking the work.
- 1.4 Standard Specifications .1 Unless otherwise specified in the Contract Documents, all materials, equipment and methods shall conform to the appropriate and latest standard specifications of the AWWA and ANSI, including the following:
- .1 AWWA B100, Standard for Granular Filter Material.
- .2 AWWA B604, Standard for Granular Activated Carbon.
- .3 AWWA C653, Standard for Disinfection of Water Treatment Facilities.
ANSI/NSF 61, Drinking Water System Components - Health Effects.
- 1.5 Measurement and Payment .1 All costs associated with the work of this Section shall be included in the price for this Item in the Bid Form.

PART 2. PRODUCTS

2.1 Granular Activated
Carbon

- .1 Provide a 1650 mm deep layer of granular activated carbon (GAC) for each GAC Tank. There is a total of 2 GAC Tanks.
- .2 GAC Tanks has the following area: 6.16m²
GAC Tanks have a GAC volume: 10.16m³
Influent Flow Rate: 40 m³/hr
Contact Time: 15 minutes
Backwash Flow Rate: 24.4 m/hr
Backwash Cycle: 5 min/3weeks
Backwash Flow: 150 m³/hr
Backwash Volume: 12.5 m³
- .3 Provide GAC media with the following features:
 - .1 Conforms to the specifications and properties of AWWA B100 and AWWA B604 and is certified in accordance with NSF 61.
 - .2 Manufactured from select grades of bituminous coal from a North American source only. Lignite, peat, wood, coconut or sub-lignite based GAC is not acceptable.
 - .3 GAC must be capable of withstanding the abrasion and dynamics associated with repeated backwashing and hydraulic transport.
 - .4 Activation methods must have been carefully controlled to produce a material having a high internal surface area with optimum pore size for effective absorption of a broad range of high and low molecular weight organic contaminants.
 - .5 Material density and particle size designed for packed bed type of absorption.
 - .6 Material to have sufficient density to allow backwash agitation and bed expansion, yet settle rapidly for immediate resumption of service.
 - .7 Conforms to the United States Pharmacopeia Food Chemicals Codes when tested under the conditions of the test outlined in the Food Chemicals Codes, Sixth Edition.
 - .8 Free of foreign materials such as clay, dirt, etc.

- .4 Provide granular activated carbon with the following physical properties:

<u>Item</u>	<u>Specification</u>
.1 Iodine Number (minimum) (mg/g)	1000
.2 Effective Size (mm)	0.55-0.75
.3 Uniformity Coefficient (maximum) (Before backwashing)	1.9
.4 Abrasion Number (minimum) (Ro-tap Method)	75
.5 Particle Size (U.S. Sieve Series)	
.1 Larger than Number 12 (1.70 mm) (Maximum Percent)	5%
.2 Smaller than Number 40 (0.42mm) (Maximum Percent)	4%
.6 Moisture (Maximum Percent) (as packed)	2%
.7 Apparent Density (g/cm ³)	0.52

- .5 Submit sieve test results and corresponding accumulative percent passing, in accordance with Subsections 3.3 and 3.5, using the following sieve opening sizes:

Sieve	Opening Sizes (mm)
3.36	1.180
2.36	0.850
2.00	0.600
1.70	0.425
1.40	0.300

- .6 Virgin granular activated carbon media to be supplied in sealed super-sacks.
- .7 Acceptable GAC Media
- .1 Calgon Carbon Corporation ("Calgon") Filtrasorb[®] 400 granular activated carbon
 - .2 Norit[®] GAC 1240 granular activated carbon
- .8 Acceptable GAC Media Supplier and Installers
- .1 Brenntag Canada Inc.
 - .2 Anthrafilter Filter Media
 - .3 Approved equivalent
- .9 Provide ten percent (10%) extra GAC filter media than required to achieve specified depth. Extra filter media to be stored in an area designated by the Region, sealed in plastic bags.

PART 3. EXECUTION

- 3.1 Underdrain Preparation .1 Before placing the filter media, the filter underdrains shall be cleaned, inspected, tested, and passed by the filter underdrain supplier and accepted by the Consultant to ensure they have not been damaged and are securely fastened.
- .2 Thoroughly clean the filter box of all waste, rubble, loose mortar and cement, etc., before placing filter material.
- 3.2 Sieve Analysis .1 Determine the particle size distribution of the filtering materials in accordance with the current Standard Method of Test for Sieve or Screen Analysis of Fine and Course Aggregates, Designation C136, of the American Society for Testing and Materials, except that wire-cloth sieves shall be used exclusively.
- .2 Use a range of sieves, containing each sieve of the U.S. Standard (4th Root of 2 Ratio) Series, such that the sieve with the largest opening and the sieve with the smallest opening retains not more than one percent by weight of the sample.
- .3 Designate all sieves by the nominal size of opening in millimetres or microns.
- 3.3 Particle Size Distribution of Filtering Materials .1 Supply GAC particle sizes within the limits specified in the Contract.
- 3.4 Samples and Tests .1 Before shipment to Site, collect separate random composite samples from the actual GAC materials to be shipped. Collect the samples in accordance with AWWA B100 and B604. Retain an independent testing company, which may be chosen by the supplier, but must be acceptable to the Consultant, to conduct the following tests on each of the samples collected.
- .1 For GAC, conduct all tests necessary to obtain the information outlined in subsection 2.1.3 and subsection 2.1.4.
- .2 Conduct all tests in conformance with AWWA B100 and B604.
- .3 All material not meeting the requirements of AWWA B100 and B604, NSF 61 and these Specifications will be rejected.

- .4 Retest additional samples if any results are unsatisfactory.
- .5 Do not ship the material to the Site until approval has been given by the Consultant.
- .6 Furnish material equal in all respects to the approved samples.
Once the material has been shipped to Site, place no media in the filters until the Consultant submits on-Site grab samples to its own independent testing laboratory for further testing. Place no media until instructed by the Consultant.

3.5 Placing of GAC Media

- .1 Review with the Consultant, the Region and the manufacturer, the proposed method of media placement in the filter before attempting to install the media.
- .2 Coordinate installation to ensure two GAC Contactors are in operation at all times.
- .3 Any equipment used in placing the GAC media must be cleaned and disinfected in accordance with AWWA C653.
- .4 Protect all media from mixing with other grades of media or with extraneous materials.
- .5 Place the GAC in layers to the depths as specified in the Contract Documents.
- .6 Place the GAC by means of a water injector and distribute in the filter beds by means of a hose (slurry transport).
- .7 Provide proper protection for electrical circuits, equipment, instruments and other GAC Contactors to avoid contamination. Electrical room should be watertight to preclude the entrance of activated carbon dust.
- .8 Follow all applicable confined space regulations, and health and safety precautions in accordance with the Material Safety and Data Sheets (MSDS), including providing adequate mechanical ventilation to avoid the possible depletion of oxygen upon the addition of water to the GAC.

3.6 Preparation of Contractor for Service

- .1 Ensure that the manufacturer's representative certifies that the media is ready for operation before use. In addition, the manufacturer's representative shall instruct the Region's Operations personnel in the proper operation and maintenance of the media supplied.
- .2 After installing the GAC media, prepare the filter for service in accordance with the requirements of

AWWA B100 and Section 7 of AWWA B604 including, but not limited to, the following:

- .1 Start backwash and gradually increase the rate over a period of time until the desired bed expansion is achieved, as specified by the manufacturer, and until the wash water is clean, the backwash rate should be reduced over a period of 3 to 5 minutes at the end of the backwash cycle, so that filter particles become classified with the smallest particles on top.
- .2 No filter media is permitted to enter the backwash trough; therefore any fines or floatables must be physically removed from the top of the media. The cost of scraping and removing fines shall be included in the Contract Price.
- .3 After any fines or floatables are removed, add additional material as necessary to provide the specified thickness of filter media.
- .4 Multiple backwashes may be required during the GAC fill process.
- .5 To disinfect the filter media, backwash with chlorinated backwash water.
- .6 Bacteriological testing in accordance with AWWA Standard C653 must be performed prior to placing the filter into service. Take the representative sample from the filter effluent piping. Satisfactory bacteriological samples (in accordance with AWWA Standard C653) must be received prior to placing the filter into service.
- .7 The Contractor shall be responsible for disposal of all filter media waste material, including any fines deposited in the backwash waste pit, at its own expense. Disposal to the sewer is not permitted.

3.7 Protection

- .1 Take care to avoid damage to the structure, including the wash troughs, underdrains and integral media support caps.
- .2 Cover and protect the walkways around the filters and such other parts of the Site with which the Contractor comes into contact.
- .3 Cover and protect all electrical, equipment, instruments, and other GAC Contactors with polyethylene sheets. Such protection shall be maintained until the GAC filter media is installed.
- .4 Completely repair any portion(s) of the structure damaged during the progress of the Work in a manner satisfactory to the Consultant at the Contractor's own expense.

3.8 GAC Installation
Supervision

- .1 Provide a qualified representative approved by the Contractor for one (1) person-day to review the GAC installation procedures prior to its placement, and to inspect, test and troubleshoot the media installation.
- .2 Ensure that the manufacturer's representative submits a report describing, in detail, the inspection, tests, and adjustments made, quantitative results and suggestions for precautions to be taken to ensure proper maintenance of media supplied. The report must verify that the filter media and installation conforms to all Specifications and manufacturer's requirements.

END OF SECTION

PART 1 - GENERAL

- 1.1 Description .1 This section specifies the supply installation, field testing, and placing into operation of various pressure elements and transmitters including but not limited to those pressure elements identified in the attached Instrumentation Data Sheets (PE/PIT).
- .2 Responsibility shall include supply and installation of all component and Vendor subsystems as to provide a fully functioning system, including supervision, calibration, checkout, start-up operating adjustment and documentation, tagging and compliance with data sheets.
- 1.2 Shop Drawings and Product Data .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittals.
- 1.3 Delivery, Storage and Handling .1 Ship assembled to the degree which is possible. Inform installer of site assembly requirements.
- 1.4 References .1 ISA RP12.6-87, Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations.

PART 2 - PRODUCTS

2.1 Material

- .1 All instrumentation, control, and electrical devices provided under this Section shall be CSA approved and shall bear the CSA approvals seal as detailed in Section 44 00 10 - Process General Requirements.
- .2 Each instrument sensing line shall be complete with an isolation valve. The isolation valves shall conform to Division 44.
- .3 Sensing units shall be mounted so that interference to the sensing function is not caused by surrounding structures. The sensor shall preferably be mounted on its own support, purpose built to manufactures recommendations, to facilitate maintenance and/or adjustment.
- .4 Where amplifier/transmitter electronics is installed in a classified environment the housings shall be suitable for the application. i.e. Class 1, Div 2 and suited to a wet and corrosive environment.

2.2 Gauge Pressure
Meters / Transmitters

- .1 Transmitters shall be capable of providing a 4-20mA signal and shall be of the two-wire type. Process fluid shall be isolated from the sensing elements by AISI Type 316 stainless steel, Hastelloy-C, or cobalt-chromium-nickel alloy diaphragms, and a silicon oil fluid fill. Diaphragm material shall be selected based on the indicated measured process medium for proper operation in the process.

- .2 Vents shall be provided on the sides of the diaphragm housing body. Transmitters shall have self-diagnostics and electronically adjustable span, zero, and damping. Transmitters shall have over-range protection greater than the maximum line pressure. Transmitters shall not be damaged by reverse polarity. Transmitters shall be capable of having an elevated or suppressed zero, as required by the application. Transmitters shall be provided with a 3-1/2 digit LCD display, calibrated in engineering units.
- .3 Mounting and installation hardware shall be 316L stainless steel. Mounting hardware shall be provided to allow pipe-stand or wall mounting, as indicated on the instrument data sheet.
- .4 Each pressure transmitter system shall be provided with a shut-off valve and mounting hardware. The shut-off valve shall be mounted to the transmitter prior to shipment. The manifold shall have test ports on the instrument side of the valve.
- .5 Transmitters shall be configurable as either square root or linear. The effect of static pressure changes on accuracy shall be negligible. The transmitter shall have minimum 15:1 field rangeability.
- .6 For systems which require a dedicated programming device for calibration, maintenance, or troubleshooting, one such programming device shall be

provided for each location. The programming device shall include appropriate operation manuals and shall be included in the training requirements. For systems which allow the programming device functions to be implemented in software, running on a laptop computer, the software shall be provided instead of the programming device.

- .7 Tools and spare parts shall be supplied as required. As a minimum, the following spare parts shall be furnished for each level system:
 - .1 Two spare fuses of each type required.
- .8 If not already provided for elsewhere, provide hand held calibration tool as required.

2.3 Pressure Switches

- .1 Pressure switches shall be diaphragm actuated type switches. Switches shall be field adjustable type, with trip point repeatability better than 1% of actual pressure. Switches shall be housed in EEMAC Type 4 enclosures. Switches shall be differential type where indicated on the Instrument Data Sheet. Switch wetted parts shall be in accordance with the Material Class Sheets. Where not covered by the Material Class Sheets, the switch shall be provided with a teflon coated diaphragm, viton seals, and a stainless steel connection port.
- .2 Panel mounted and surface mounted switches shall be provided with 6 mm NPT connections. All stem mounted switches shall be provided with 12 mm NPT connections.

- .3 All pressure switches shall be ranged in kPa and all vacuum switches in mm water. Unless otherwise indicated, switches shall have a fixed deadband and shall be auto-reset type. As a minimum switches shall be SPDT, rated 10 amperes at 120 volts AC.
- .4 Each switch shall be provided with a threaded end, ball-type shutoff valve. Shutoff valve materials shall be in accordance with the Material Class Sheets. Where not covered by the Material Class Sheets, valves shall have 316SS wetted parts and teflon seals. Multi-port valves shall have all unused ports plugged.
- .5 Each switch shall be powered with a multi-pole receptacle on the switch enclosure for connection of external wiring. The receptacle shall be a male connector with integral leads for each pole. Number of poles shall be equal to the number of switch terminal connections for external wiring (to a maximum of 10 poles per connector). The connector shall be installed in a knockout or hub, with leads connected to the switch terminals. Receptacles shall be as indicated in Installation Standards.
- .6 Where indicated on the Instrument Data Sheet, a diaphragm seal shall be provided for the respective switch. Diaphragm seals shall be thread-attached type with removable AISI Type 316 stainless steel diaphragm, zinc or cadmium plated carbon steel upper housing, and stainless steel lower housing. The upper housing shall be contoured to fit and provide a seat and seal for the diaphragm and shall be designed

to permit removal of the switch with the system under pressure. The lower housing shall be provided with a tapped and plugged 6mm NPT flushing connection. Each diaphragm seal and the switch served shall be factory assembled, filled with a suitable fluid, and calibrated as a unit.

- .7 Each switch shall be provided with all required mounting hardware to securely mount the unit according to the mounting requirements indicated in the Instrument Data Sheet. Mounting and installation hardware shall be 316L stainless steel.

2.9 Miscellaneous

- .1 All indications shall be displayed on a linear scale unless otherwise specified. Local indicators shall be in Engineering units.
- .2 Instruments shall be suitable for the environmental conditions in which they are to be installed. The Supplier shall determine where injurious conditions may be expected to occur and make proper provision to protect the instruments to ensure their proper and reliable operation. Provide power surge protectors, heating cables and devices to protect instruments, equipment and lines from being functionally impaired or damaged by power surges or environmental conditions.
- .3 Those parts of the gauge or switch which are in contact with the process fluid shall be made of materials which are inert to the effects of the process fluid. It shall be incumbent on the Supplier to review the application to ensure that the specified device is suitable for the service conditions.

- .4 All clean service pressure gauges, transmitters and switches shall be installed with a gauge/root valve equal to Whitey SS-6NDGM12-F8 complete with bleed valve SS-BVM8 and SS-1/2 inch plugs as required.
- .5 All dirty service pressure gauges, transmitters and switches shall be installed with an appropriate seal as indicated in the drawings and specified elsewhere

PART 3 - EXECUTION

3.1 Installation

- .1 All mounting plates, pedestals, bolts, shims, angle iron and other miscellaneous steel or hardware items required for the securing of equipment shall be supplied unless specifically noted otherwise.
- .2 All instruments to be installed in accordance with the Manufacturer's installation instructions.
- .3 Each instrument sensing line shall be complete with an isolation valve. The isolation valves shall conform to Divisions 44 equipment requirements.
- .4 Instruments or raceway will be installed so as not to obstruct access routes, equipment maintenance space or space for future equipment.
- .5 Instrument supports shall be located and installed to provide a fully supported, secure system with minimum vibration.

3.2 Wire and Cable

- .1 Single pair twisted shielded cable to be run in conduit. Multipairs shall be Teck run in cable tray.

- .2 Control wiring shall be either multi-conductor Teck run in cable tray or single conductor wire run in conduit.

3.3 Indicators

- .1 Install primary sensors or indicators in uninterrupted straight pipe, minimum 3 pipe diameters downstream and 3 pipe diameters upstream, on supply lines downstream of pumps, or according to manufacturer's recommendations.
- .2 Select instruments so that normal operating point is just above midpoint of instrument range. (60 - 70%)
- .3 All indications shall be displayed on a linear scale unless otherwise specified. Local indicators shall be in engineering units.

3.4 Testing

- .1 These devices will be field calibrated by the Contractor. The Contractor shall be responsible for start-up and testing of the devices and shall perform loop or continuity testing to verify that all electrical connections are correct. Testing shall be in accordance with the testing standards, specified elsewhere in the Contract Documents.
- .2 During testing demonstrate proper calibration and correct operation to the Departmental Representative.
- .3 Upon completion of testing of each device, affix a tag to the instrument certifying that calibration and testing have been completed and specifying the calibration points. Include loop

check sheet and instrument
calibration sheets in instruction
books.

PART 1 - GENERAL

1.1 Shop Drawings
and Product Data

- .1 This section specifies the supply, installation, field testing, and placing into operation of all flow meters, including those supplied as part of preselected equipment packages, various flow switches, flow measuring devices and flow transducers and transmitters as identified in the attached Instrumentation Data Sheets (FE/FIT Flow Elements).
- .2 Responsibility shall include supply and installation of all component and Vendor subsystems as to provide a fully functioning system, including supervision, calibration, checkout, start-up operating adjustment and documentation, tagging and compliance with data sheets.
- .3 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittals.
- .4 The measuring elements of instrumentation designated for Hazardous locations must be in full compliance with the CEC.
- .1 Ship assembled to the degree which is possible. Inform installer of site assembly requirements.

1.2 Delivery, Storage
and Handling

- .1 CSA C22.2 No .0.3 96, Test Methods for Electrical Wires and Cables.

1.3 References

PART 2 - PRODUCTS

2.1 Material

- .1 All instrumentation, control, and electrical devices provided under this Section shall be CSA approved and shall bear the CSA approvals seal as detailed in Section 44 00 10 - Process General Requirements.
- .2 Provide each instrument with mechanisms and enclosures that are corrosion resistant.
- .3 Provide each instrument with mechanisms enclosed in a dust-proof and a moisture-proof case.
- .4 Provide all indicator and gauge dials finished in permanent white with black graduations and figures.
- .5 Each component shall be carefully selected and designed for a long lifetime with ample margin to withstand transient and other surge voltages which may occur in the circuits from any source in the power supply.
- .6 Each component and composite instrument shall be suitable for the location and installation position at the attitude designated on the drawings, eg., horizontal, vertical or sloped position.
 - .1 If sensing systems utilize probes then the probes shall be braced to the structure with a minimum of two 316 SS clamps to prevent sensor movement for any

reason.

- .2 Where probes are suspended into vessels or chambers, stilling tubes shall be used to prevent excessive movement.
- .3 Sensing units shall be mounted so that interference to the sensing function is not caused by surrounding structures. The sensor shall preferably be mounted on its own support, purpose built to manufactures recommendations, to facilitate maintenance and/or adjustment.

.7 Where amplifier/transmitter electronics is installed in an explosive environment, the housings shall be suitable for the application. i.e. Class 1, Div 2 and suited to a wet and corrosive environment.

.8 Provide each instrument powered with 120 VAC with a circuit protector fuse / breaker.

.9 All control panel mounted instruments shall be suitable for flush mounting and shall be furnished with bezel.

2.2 Flow Switches

.1 Flow switches shall be target type switches which utilize a vane or paddle type target to actuate the switch. For pipe sizes greater than or equal to 50 mm, switches shall have an NPT connection for insertion into the process piping. For pipe sizes less than 50 mm, the flow switch shall be factory installed in a spool piece, suitable for flange

or thread mounting in the process piping. Switch wetted components shall be in accordance with the Material Class Sheets. Switches shall contain at least one non-mercury SPDT contact, rated 5 amperes at 120 volts AC. The switch enclosure shall be a minimum EEMAC 4 rated housing. Switches shall be factory calibrated to actuate at the specified flow rates for the given pipe size. All flow switches shall be installed in horizontal piping.

- .2 Mounting and installation hardware shall be in accordance with the Material Class Sheets.
- .3 Tools and spare parts shall be furnished as recommended by manufacturer.
- .4 Each switch shall be provided with a multi-pole receptacle on the switch enclosure for connection of external wiring. The receptacle shall be a male connector with integral leads for each pole. Number of poles shall be equal to the number of switch terminal connections for external wiring (to a maximum of 10 poles per connector). The connector shall be installed in a knockout or hub, with leads connected to the switch terminals. Receptacles shall be as indicated in Installation Standards.

2.3 Magnetic
Flowmeters

- .1 Magnetic flowmeters shall be completely obstruction less, in-line meters with no constrictions in the flow of fluid through the meter.

The meter shall consist of a metallic tube with flanged ends and with grounding rings. Flange diameter and bolt drilling pattern shall comply with ANSI/ASME B16.5, Class 150. Flangeless wafer insert style meters may be used for pipe sizes up to 150 mm, where compatible with adjacent piping flanges. Meters shall be suitable for the maximum range of working pressures of the adjacent piping. Electrode and liner material shall be fully compatible with the process fluid. Each meter shall be factory calibrated, at a facility which is traceable to NIST or other standard acceptable to the Engineer. A copy of the calibration report shall be submitted.

- .2 The meter shall be capable of standing empty for extended periods of time without damage to any components. The meter housing shall withstand submergence in 10 m of water for 48 hours without damage.
- .3 Magnetic flowmeter systems shall provide zero flow stability by means of automatic zero adjustment of a DC excited metering circuit. Converters shall be capable of bi-directional flow measurement. Signal converters shall be of the same manufacturer as the flow element.
- .4 Signal cable from the meter to signal converter shall be provided by the meter manufacturer. A minimum of three meters of interconnecting cable shall be provided. The signal

converter shall be housed in a corrosion-resistant, weatherproof, EEMAC 4 enclosure, suitable for wall or pipe strut mounting. The signal converter shall be suitable for operation over an ambient temperature range of -34 to 60°C, and a relative humidity of 10-100%.

- .5 Each magnetic flowmeter shall be provided with a optional remote mounted or integral, microprocessor-based signal converter (transmitter). The signal converter shall include output damping, self-testing, built-in calibration capability, and an "empty pipe zero" contact input. The overall accuracy of the magnetic flowmeter signal converter shall be -0.5% of actual flowrate for full-scale flow settings of 1-10 m per second. Converter output shall be linear with flowrate. The signal converter shall be provided with an integral four digit LCD indicator, scaled in engineering units.
- .6 The signal converter shall be housed in a corrosion-resistant, weatherproof, EEMAC 4 enclosure, suitable for wall or pipe strut mounting. The signal converter shall be suitable for operation over an ambient temperature range of -34 to 60°C, and a relative humidity of 10-100%.
- .7 Each transmitter shall be powered from 120 volts AC, 60 Hz, single phase. A multi-pole receptacle shall be provided on the transmitter enclosure for connection of AC power

via a cordset in accordance with Installation Standards.

- .8 Magnetic flowmeters shall be factory calibrated by the Contractor to the flow ranges indicated in the Instrument Data Sheets. Copies of the factory calibration data sheets shall be submitted in accordance with the applicable sections of the Contract Documents.
- .9 Each magnetic flowmeter system shall be provided with all required mounting hardware to mount both the element and transmitter according to the mounting requirements indicated in the Instrument Data Sheet. Mounting and installation hardware shall be 316L stainless steel or other material approved by the flowmeter manufacturer for use in the specified conditions.
- .10 For systems where the primary element and transmitter are physically separated, interconnecting cable from the element to the transmitter shall be provided. The cable shall be the type approved by the flowmeter manufacturer for the intended purpose of interfacing the element to the transmitter. Length of cable shall be a minimum of three meters or as indicated in the Instrument Data Sheet.
- .11 For systems which require a dedicated programming device for calibration, maintenance, or troubleshooting, one such programming device shall be provided for each location. The programming

device shall include appropriate operation manuals and shall be included in the training requirements. For systems which allow the programming device functions to be implemented in software, running on a laptop computer, the software shall be provided instead of the programming device.

- .12 Transmitters indicated as requiring a serial interface shall be provided with all accessories required to properly communicate over the serial link. As a minimum, an appropriate cable shall be provided to allow the transmitter serial interface to be connected to a personal computer. One licensed copy of the diagnostic/interface software shall be provided for each facility (two total). Software shall be capable of running under Microsoft's Windows XP operating system. If the software furnished performs the same functions as the programming device, specified elsewhere, then the programming device shall not be furnished.

- .13 Tools and spare parts shall be furnished as recommended by the manufacturer. As a minimum, the following spare parts shall be furnished:

- .1 Two spare fuses of each type required.

3.0 EXECUTION

3.1 INSTALLATION

- .1 Install all instruments in strict accordance with the recommendation of the manufacturer.
- .2 The in-line mechanical installation of items such as flow-meters, is specified in Division 44, Process Mechanical for all vendor packages.
- .3 Carry out installation, calibration and adjustment in accordance with manufacturers installations instructions, recommended practices and as indicated on drawings and elsewhere in these specifications.

3.2 EQUIPMENT MOUNTING

- .1 All mounting plates, pedestals, bolts, shims, angle iron and other miscellaneous steel or hardware items required for the securing of equipment shall be supplied unless specifically noted otherwise.
- .2 All instruments to be installed in accordance with the Manufacturer's installation instructions.
- .3 Each instrument sensing line shall be complete with an isolation valve. The isolation valves shall conform to Divisions 44 equipment requirements.
- .4 Instruments or raceway will be installed so as not to obstruct access routes, equipment maintenance space or space for future equipment.
- .5 Where the removal of filter cartridges and heater elements is

necessary, attention will be paid to instrument locations and tubing runs.

- .6 Instrument supports shall be located and installed to provide a fully supported, secure system with minimum vibration.

3.3 WIRE AND CABLE

- .1 Instrumentation cables shall be as described by Division 25 and 26 of this specification. Single pair twisted shielded cable to be run in conduit. Multipairs shall be Teck run in cable tray.
- .2 Control wiring shall be either multi-conductor Teck run in cable tray or single conductor wire run in conduit.

3.4 GAUGES AND INDICATORS

- .1 Install primary sensors or indicators in uninterrupted straight pipe, minimum 3 pipe diameters downstream and 3 pipe diameters upstream, on supply lines downstream of pumps, or according to manufacturer's recommendations.
- .2 Select instruments so that normal operating point is just above midpoint of instrument range. (60 - 70%)
- .3 All indications shall be displayed on a linear scale unless otherwise specified. Local indicators shall be in engineering units.

3.5 TESTING

- .1 These devices will be field calibrated by the Contractor. The Contractor shall be responsible for start-up and testing of the devices and shall perform loop or continuity testing to verify that all electrical connections are correct. Testing shall be in accordance with the testing standards, specified elsewhere in the Contract Documents.
- .2 During testing demonstrate proper calibration and correct operation to the Owners Representative.
- .3 Upon completion of testing of each device, affix a tag to the instrument certifying that calibration and testing have been completed and specifying the calibration points. Include loop check sheet and instrument calibration sheets in instruction books.

3.6 COMMISSIONING

- .1 Notwithstanding the requirements of all other sections of this contract as they relate to commissioning, commissioning of the instrumentation and control system shall include, but not be limited to the following:
 - .1 Supervise installation of components, wiring connections and piping connections.
 - .2 Supervise wiring continuity and pipe leak tests.
 - .3 Verify instrument calibration and provide written report.
 - .4 Function check and adjust under operational conditions the instruments and control equipment.
 - .5 Coordinate instrument and control

- equipment supplier's service personnel as required for complete system testing.
- .6 Instruct plant personnel in correct method of operation of instruments and control equipment.
 - .7 Direct plant personnel at hand-over as to final adjustment to the system for correct operation of plant.
 - .8 Ensure that the instrumentation and control equipment suppliers cooperate to complete the work of this section.
 - .9 Verify signal levels and wiring connections to all instrumentation and control equipment.

END OF SECTION

INSTRUMENT DATA SHEET

Instrument Type: FLOW METER TRANSMITTER Client: PWGSC Location: Joyceville WTP

Project No. 450-2431
Instrument Spe 25 10 05
Revision

Gen	Tag Number	FE/FIT 101			
	Description of Instrument	Electromagnetic Flow Meter			
	Service	Backwash Water main			
	P&ID No.	P001			
Process/Fluid Data	Line Tag	150-SW-SA1			
	Line Size (mm)	150			
	Fluid	Potable Water			
	Oper. Press Norm/Max (kPa)	1034 kPa			
	Oper. Temp Norm/Max (°C)	5	25		
	Ambient Temperature	15			
	S.G. @ Oper. Temp	1			
	Viscosity @ Oper. Temp				
	Percent Solids and Type	<25 mg/L TS			
	Measurement Function	Flow Rate			
Transmitter	Tag No.	FIT-101			
	Transmitter Type	Remote			
	Power Requirement	120V AC			
	Electrical Connection				
	Contact Type				
	Display Type	LCD			
	Instrument Range				
	Operating Range				
	Output Signal	4 - 20 mA			
	Accuracy	+/- 0.25% of Rate			
	Enclosure Rating	NEMA 4X			
	Enclosure Material				
	Mounting	Wall Mount			
Element	Tag No.	FE-101			
	Sensor Type	DC MAG			
	Measurement Range				
	Lining Material	Hard Rubber			
	Electrode Material	Hastelloy C276			
	Tube Size	150 mm			
	Enclosure Rating	NEMA 4X			
	Enclosure Material	Carbon Steel			
	Process Connection	150 lb. ANSI			
Cable Length	As Required				
Access	Name Plate	Stainless Steel with SS wire			
	Grounding Rings	Hastelloy			
	Sensor Mounting Assembly	All column mount accessories			
	Mounting Straps				
Approval/Enclosure	CSA, NSF 61				
Class/Division/Group	Unclassified				
Manufacturer					
Model Number					
Alternates					
Notes:					
1. Vendor to supply Stainless Steel Tag with Instrument Tag Number clearly stamped on it.					
2. Vendor is to fill in missing data in this specification sheet relevant to the device (i.e. model #)					
3. Contractor is to supply mounting hardware appropriate for the application.					
4. Minimum straight pipe required: 10 pipe diameters upstream and 5 pipe diameters downstream of each flow metre.					
No.	Date	By	Chkd	Appd	Revision

PART 1 - GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 General requirements that are common to NMS sections found in Division 26 - Electrical 27 - Communications 28 - Electronic Safety and Security.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA-C22.1-09 2012, Canadian Electrical Code, Part 1 (21st Edition), Safety Standard for Electrical Installations.
 - .2 CSA C22.2 No.
 - .3 CAN/CSA-C22.3 No. 7-94 R2000, Overhead Systems.
 - .4 CAN3-C235-83 R2006, Preferred Voltage Levels for AC Systems, 0 to 50,000 V.
 - .5 Do underground systems in accordance with CSA C22.3 No.7-06, Underground Systems, except where specified otherwise.
- .2 Electrical and Electronic Manufacturer's Association of Canada (EEMAC)
 - .1 EEMAC 2Y-1-1958, Light Gray Colour for Indoor Switch Gear.
- .3 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .4 The Ontario Electrical Safety Code 2012, and all bulletins (Ontario).
- .5 Hydro requirements and local applicable codes and regulations.

1.3 DESIGN
REQUIREMENTS

- .1 Operating voltages: to CAN3-C235.
- .2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.
 - .1 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.
- .3 Language operating requirements: provide identification nameplates and labels for control items in English.

1.4 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00.
- .2 Product Data: submit WHMIS MSDS.
- .3 Shop drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario.
 - .2 Submit 1 number of copies of 600 x 600mm minimum size drawings and product data to authority having jurisdiction inspection authorities.
 - .3 If changes are required, notify Engineer of these changes before they are made.
- .4 Quality Control: in accordance with Section 01 45 00.
 - .1 Provide CSA certified equipment and material.
 - .2 Where CSA certified equipment and material is not available, submit such equipment and material to authority having jurisdiction inspection authorities for special approval before delivery to site.
 - .3 Submit test results of installed electrical systems and instrumentation.
 - .4 Permits and fees: in accordance with General Conditions of contract. Pay associated fees. Departmental Representative will provide drawings and specifications required by Electrical Inspection Department and Supply Authority at no cost.
 - .5 Submit, upon completion of Work, load balance report as described in PART 3 - Load Balance.
 - .6 Submit certificate of acceptance from Electrical Inspection Department authority having jurisdiction upon completion of Work to Departmental Representative.
- .5 Manufacturer's Field Reports: submit to Departmental Representative, manufacturer's written report, within 3 days of review, verifying compliance of Work and electrical system and instrumentation testing, as described in PART 3 - FIELD QUALITY CONTROL.

1.5 QUALITY
ASSURANCE

- .1 Quality Assurance: in accordance with Section 01 45 00.
- .2 Qualifications: electrical Work to be carried out by qualified, licensed electricians who hold valid Master Electrical Contractor license or apprentices in accordance with authorities having jurisdiction as per the conditions of Provincial Act respecting manpower vocational training and qualification.
 - .1 Employees registered in provincial apprentices program: permitted, under direct supervision of qualified licensed electrician, to perform specific tasks.
 - .2 Permitted activities: determined based on training level attained and demonstration of ability

to perform specific duties.

- .3 Site Meetings:
 - .1 In accordance with Section 01 32 17 and Section 01 32 18.
 - .2 Site Meetings: as part of Manufacturer's Field Services described in Part 3 - FIELD QUALITY CONTROL, 01 31 16, schedule site visits, to review Work, at stages listed.
 - .1 After delivery and storage of products, and when preparatory Work is complete but before installation begins.
 - .2 Twice during progress of Work at 25% and 60% complete.
 - .3 Upon completion of Work, after cleaning is carried out.
- .4 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.06.

1.6 DELIVERY,
STORAGE AND
HANDLING

- .1 Material Delivery Schedule: provide Departmental Representative with schedule within 2 weeks after award of Contract.
- .2 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 21.

1.7 SYSTEM STARTUP

- .1 Instruct Departmental Representative and operating personnel in operation, care and maintenance of systems, system equipment and components.
- .2 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.
- .3 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with aspects of its care and operation.

PART 2 - PRODUCTS

2.1 MATERIALS AND
EQUIPMENT

- .1 Provide material and equipment in accordance with Section 01 61 00.
- .2 Material and equipment to be CSA certified. Where CSA certified material and equipment is are not available, obtain special approval from authority having

jurisdiction inspection authorities 4 weeks before delivery to site and submit such approval as described in PART 1 - Submittals.

- .3 Factory assemble control panels and component assemblies.

2.3 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS

- .1 Verify installation and co-ordination responsibilities related to motors, equipment and controls, as indicated.
- .2 Control wiring and conduit: in accordance with Section 26 29 03 except for conduit, wiring and connections below 50 V which are related to control systems specified in mechanical sections and as shown on mechanical drawings.

2.4 WARNING SIGNS

- .1 Warning Signs: in accordance with requirements of authority having jurisdiction, inspection authorities and Departmental Representative.
- .2 Porcelain enamel decal signs, minimum size 175 x 250 mm.

2.5 WIRING TERMINATIONS

- .1 Ensure lugs, terminals, screws used for termination of wiring are suitable for either copper or aluminum conductors.
- .2 Compression lugs required for all wiring #8 and larger.

2.6 EQUIPMENT IDENTIFICATION

- .1 Identify electrical equipment with nameplates and labels as follows:
 - .1 Nameplates: plastic laminate lamicaid 3mm thick plastic engraving sheet melamine, black matt white finish face, black white core, lettering accurately aligned and engraved into core mechanically attached with self tapping screws.
 - .2 Sizes as follows:

NAMEPLATE SIZES

Size 1	10 x 50 mm	1 line	3 mm high letters
Size 2	12 x 70 mm	1 line	5 mm high letters
Size 3	12 x 70 mm	2 lines	3 mm high letters
Size 4	20 x 90 mm	1 line	8 mm high letters
Size 5	20 x 90 mm	2 lines	5 mm high letters
Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	6 mm high letters

-
- .2 Labels: embossed plastic labels with 6 mm high letters unless specified otherwise.
 - .3 Wording on nameplates and labels to be approved by Departmental Representative prior to manufacture.
 - .4 Allow for minimum of twenty-five (25) letters per nameplate and label.
 - .5 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
 - .6 Identify equipment with Size 3 labels engraved "ASSET INVENTORY No. as directed by Departmental Representative.
 - .7 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
 - .8 Terminal cabinets and pull boxes: indicate system and voltage.
 - .9 Transformers: indicate capacity, primary and secondary voltages.
 - .10 All devices wired from panels - identify circuit fed from.
 - .11 Wiring to instruments to include instrument tag name and cct fed from if applicable.

2.7 WIRING
IDENTIFICATION

- .1 Identify wiring with permanent indelible identifying markings, numbered coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour coding: to CSA-C22.1.

2.8 CONDUIT AND
CABLE
IDENTIFICATION

- .4 Use colour coded wires in communication cables, matched throughout system.
- .1 Colour code conduits, boxes and metallic sheathed cables.
- .2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15m intervals.
- .3 Colours: 25mm wide prime colour and 20mm wide auxiliary colour.

	Prime	Auxiliary
up to 250 V	Yellow	
up to 600 V	Yellow	Green
up to 5 kV	Yellow	Blue
up to 15 kV	Yellow	Red
Telephone	Green	
Other	Green	Blue
Communication Systems		
Fire Alarm	Red	
Emergency Voice	Red	Blue
Other	Red	Yellow
Security Systems		

2.9 FINISHES

- .1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.
- .1 Paint outdoor electrical equipment "equipment green" finish.
- .2 Paint indoor switchgear and distribution enclosures light gray to EEMAC 2Y-1.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Do complete installation in accordance with CSA-C22.1 except where specified otherwise.
- .2 Do overhead and underground systems in accordance with CAN/CSA-C22.3 No.1 except where specified otherwise.

3.2 NAMEPLATES AND
LABELS

- .1 Ensure manufacturer's nameplates, CSA labels and identification nameplates are visible and legible after equipment is installed.

3.3 CONDUIT AND
CABLE INSTALLATION

- .1 Install conduit and sleeves prior to pouring of concrete.
 - .1 Sleeves through concrete: schedule 40 steel pipe, sized for free passage of conduit, and protruding 50mm.
- .2 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.
- .3 Install cables, conduits and fittings to be embedded or plastered over, neatly and close to building structure so furring can be kept to minimum.
- .4 Co-ordinate installation of recessed switches and outlets with concrete block wall installation.
- .5 Prior to conduit and Teck cable tray installation, indicate on a set of drawings proposed conduit and/or cable tray type, routing and grouping. Review drawings with general contractor and other trades to eliminate interferences. Submit review drawings to engineer before proceeding with installation.
- .6 Seismic Restraints
 - .1 The contractor shall retain a specialty consultant to develop seismic restraints and perform seismic calculations in accordance with Ontario Building Code. Calculations, restraint selections and installation details shall be done by a professional engineer experienced in seismic restraint design and installation and licensed in the Province of Ontario.
 - .2 The seismic restraint calculations, selections and installation details shall be submitted as a shop drawing submittal. This submittal shall be signed and sealed by a professional engineer as stated above.
 - .3 The Design Criteria in accordance with Ontario Building Code for a post disaster building. The seismic restraints design to cover all electrical equipment and cable tray/supports.
 - .4 At the completion of the installation, the seismic specialist shall visit the site and review the installation is done in accordance with their design. Once complete the specialist shall provide written certification that the equipment and components have been correctly restrained. This report to forwarded to the consultant.
- .7 At the completion of the installation the seismic specialist shall visit the site and review the installation of the seismic restraints. The specialist shall provide written certification that the systems have been correctly restrained.

3.4 LOCATION OF
OUTLETS

- .1 Locate outlets in accordance with Section 26 05 32.
- .2 Do not install outlets back-to-back in wall; allow minimum 150mm horizontal clearance between boxes.
- .3 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000mm, and information is given before installation.
- .4 Locate light switches on latch side of doors.
 - .1 Locate disconnect devices in mechanical and elevator machine rooms on latch side of floor.

3.5 MOUNTING
HEIGHTS

- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
- .2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
- .3 Install electrical equipment at following heights unless indicated otherwise.
 - .1 Local switches: 1400mm, maximum 1200mm for accessible space.
 - .2 Wall receptacles:
 - .1 General: 300mm, minimum 400 mm for accessible space.
 - .2 Above top of continuous baseboard heater: 200mm.
 - .3 Above top of counters or counter splash backs: 175mm.
 - .4 In mechanical rooms: 1400mm.
 - .3 Panelboards: as required by Code or as indicated.
 - .4 Telephone and interphone outlets: 300mm.
 - .5 Wall mounted telephone and interphone outlets for non-accessible locations: 1500mm.
 - .6 Fire alarm stations: 1500mm maximum 1200 mm for accessible space.
 - .7 Fire alarm bells: 2100mm.
 - .8 Television outlets: 300mm.
 - .9 Wall mounted speakers: 2100mm.
 - .10 Clocks: 2100mm.
 - .11 Door bell pushbuttons: 1500mm, maximum 1200 mm for accessible space.

3.6 CO-ORDINATION
OF PROTECTIVE
DEVICES

- .1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings.

3.7 FIELD QUALITY
CONTROL

- .1 Load Balance:
 - .1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
 - .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
 - .3 Provide upon completion of work, load balance report as directed in PART 1 - Submittals: phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.

- .2 Conduct following tests in accordance with Section 01 45 00:
 - .1 Power generation and distribution system including phasing, voltage, grounding and load balancing.
 - .2 Circuits originating from branch distribution panels.
 - .3 Lighting and its control.
 - .4 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
 - .5 Systems: fire alarm system, communications.
 - .6 Insulation resistance testing:
 - .1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
 - .2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
 - .3 Check resistance to ground before energizing.

- .3 Carry out tests in presence of Departmental Representative.

- .4 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.

- .5 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

3.8 CLEANING

- .1 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.
- .2 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

PART 1 - GENERAL

1.1 RELATED
REQUIREMENTS

.1 Section 26 05 00.

1.2 REFERENCES

- .1 CSA International
.1 CAN/CSA-C22.2 No.18-98(R2003), Outlet Boxes, Conduit Boxes and Fittings.
.2 CAN/CSA-C22.2 No.65-03(R2008), Wire Connectors (Tri-National Standard with UL 486A-486B and NMX-J-543-ANCE-03).
- .2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)
.1 EEMAC 1Y-2-1961, Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).
- .3 National Electrical Manufacturers Association (NEMA)

1.3 ACTION AND
INFORMATIONAL
SUBMITTALS

- .1 Submit in accordance with Section 01 33 00.
- .2 Product Data:
.1 Submit manufacturer's instructions, printed product literature and data sheets for wire and box connectors and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 CLOSEOUT
SUBMITTALS

- .1 Submit in accordance with Section 01 78 00.
- .2 Operation and Maintenance Data: submit operation and maintenance data for wire and box connectors for incorporation into manual.

1.5 DELIVERY,
STORAGE AND
HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
.1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
.2 Store and protect wire and box connectors from nicks, scratches, and blemishes.

- .3 Replace defective or damaged materials with new.

PART 2 - PRODUCTS

2.1 MATERIALS

- .1 Pressure type wire connectors to: CAN/CSA-C22.2 No.65, with current carrying parts of copper alloy sized to fit copper conductors as required.
- .2 Fixture type splicing connectors to: CAN/CSA-C22.2 No.65, with current carrying parts of copper alloy sized to fit copper conductors 10 AWG or less.
- .3 Bushing stud connectors: to EEMAC 1Y-2 NEMA 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.
 - .5 Sized for conductors as indicated.
- .4 Clamps or connectors for TECK cable flexible conduit, as required to: CAN/CSA-C22.2 No.18.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for wire and box connectors installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

- .1 Remove insulation carefully from ends of conductors and cables and:
 - .1 Apply coat of zinc joint compound on aluminum conductors prior to installation of connectors.
 - .2 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CAN/CSA-C22.2 No.65.
 - .3 Install fixture type connectors and tighten to

CAN/CSA-C22.2 No.65. Replace insulating cap.
.4 Install bushing stud connectors in accordance
with EEMAC 1Y-2 NEMA.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 20 01 35 21.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

PART 1 - GENERAL

- 1.1 PRODUCT DATA .1 Provide product data in accordance with Section 01 33 00.
- 1.2 DELIVERY, STORAGE AND HANDLING .1 Packaging Waste Management: remove for reuse and return of pallets and packaging materials in accordance with Section 01 74 20.

PART 2 - PRODUCTS

- 2.1 BUILDING WIRES .1 Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.
- .2 Copper conductors: size as indicated, with 1000 V insulation of cross-linked thermosetting polyethylene material rated RWU90 XLPE, Jacketted.
- 2.2 TECK 90 CABLE .1 Cable: in accordance with Section 26 05 00.
- .2 Conductors:
.1 Grounding conductor: copper.
.2 Circuit conductors: copper, size as indicated.
- .3 Insulation:
.1 Ethylene propylene rubber EP.
.2 Cross-linked polyethylene XLPE.
.3 Rating: 1000 V.
- .4 Inner jacket: polyvinyl chloride material.
- .5 Armour: interlocking aluminum.
- .6 Overall covering: thermoplastic polyvinyl chloride, compliant to applicable Building Code classification for this project.
- .7 Fastenings:
.1 One hole aluminum straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.
.2 Channel type supports for two or more cables at 450mm centers.
.3 Threaded rods: 6 mm diameter to support suspended channels.
- .8 Connectors:
.1 Watertight, approved for TECK cable.

2.3 ARMOURED CABLES

- .1 Conductors: insulated, copper, size as indicated.
- .2 Type: AC90.
- .3 Armour: interlocking type fabricated from aluminum strip.
- .4 Type: ACWU90 PVC flame retardant jacket over armour and compliant to applicable Building Code classification for this project wet locations.
- .5 Connectors: anti short connectors.

2.4 CONTROL CABLES

- .1 Type: LVT: 2 soft annealed copper conductors, sized as indicated:
 - .1 Insulation: thermoplastic.
 - .2 Sheath : cotton braid thermoplastic jacket, and armour of closely wound aluminum wire.
- .2 Type: low energy 300 V control cable: solid stranded annealed copper conductors sized as indicated LVT: 2 soft annealed copper conductors, sized as indicated:
 - .1 Insulation: PVC TW TW 40 degrees C TWH polyethylene.
 - .2 Shielding: tape coated with paramagnetic material tape coated with diamagnetic material wire braid metallized tapes over each conductor pair group over conductors.
 - .3 Overall covering: PVC jackets polyethylene jackets lead sheath aluminum sheath interlocked armour of flat galvanized steel aluminum strip copper strip.
- .3 Type: 600 V stranded annealed copper conductors, sizes as indicated:
 - .1 Insulation: RW90 (x-link).
 - .2 Shielding: metallized tapes over each pair of conductors.
 - .3 Overall covering: thermoplastic jacket with sheath of aluminum interlocked armour and jacket over sheath of PVC.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00.
- .2 Perform tests using method appropriate to site conditions and to approval of Departmental Representative and local authority having jurisdiction over installation.
- .3 Perform tests before energizing electrical system.

3.2 GENERAL CABLE
INSTALLATION

- .1 Install cable in trenches in accordance with Section 33 71 73.02.
- .2 Lay cable in cable trays in accordance with Section 26 05 36.
- .3 Terminate cables in accordance with Section 26 05 20.
- .4 Cable Colour Coding: to Section 26 05 00.
- .5 Conductor length for parallel feeders to be identical.
- .6 Lace or clip groups of feeder cables at distribution centres, pull boxes, and termination points.
- .7 Wiring in walls: typically drop or loop vertically from above to better facilitate future renovations. Generally wiring from below and horizontal wiring in walls to be avoided unless indicated.
- .8 Branch circuit wiring for surge suppression receptacles and permanently wired computer and electronic equipment to be 2-wire circuits only, i.e. common neutrals not permitted.
- .9 Provide numbered wire collars for control wiring. Numbers to correspond to control shop drawing legend. Obtain wiring diagram for control wiring.

3.3 INSTALLATION OF
BUILDING WIRES

- .1 Install wiring as follows:
 - .1 In conduit systems in accordance with Section 26 05 34.
 - .2 In underground ducts in accordance with Section 33 65 73.

3.4 INSTALLATION OF
TECK90 CABLE (0
-1000 V)

- .1 Group cables wherever possible on channels in cable tray.
- .2 Install cable in cable tray, securely supported by hangers.

3.5 INSTALLATION OF
ARMOURED CABLES

- .1 Group cables wherever possible on channels in cable tray.

3.6 INSTALLATION OF
CONTROL CABLES

- .1 Install control cables in conduit cable troughs underground ducts.
- .2 Ground control cable shield.

PART 1 - GENERAL

- 1.1 SECTION INCLUDES .1 Materials and installation for connectors and terminations.
- 1.2 RELATED SECTIONS .1 Section 26 05 33 - Raceway and Boxes for Electrical Systems.
- 1.3 REFERENCES .1 Canadian Standards Association (CSA International)
.1 CSA C22.2 No.
.2 CSA C22.2 No.41-07, Grounding and Bonding Equipment.
- 1.4 PRODUCT DATA .1 Submit product data in accordance with Section 01 33 00.
- 1.5 CERTIFICATES .1 Obtain inspection certificate of compliance covering high voltage stress coming from inspection authority Engineer and include it with maintenance manuals.
- 1.6 WASTE MANAGEMENT AND DISPOSAL .1 Separate and recycle waste materials in accordance with Section 01 74 20.
.2 Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Departmental Representative.

PART 2 - PRODUCTS

- 2.1 CONNECTORS AND TERMINATIONS .1 Copper long barrel compression connectors to CSA C22.2 No. as required sized for conductors.

PART 3 - EXECUTION

- 3.1 INSTALLATION .1 Install stress cones, terminations, and splices in accordance with manufacturer's instructions.
.2 Bond and ground as required to CSA C22.2 No.41.

PART 1 - GENERAL

1.1 WASTE
MANAGEMENT AND
DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 20.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal materials from landfill to metal recycling facility as approved by Departmental Representative.
- .5 Fold up metal banding, flatten and place in designated area for recycling.

PART 2 - PRODUCTS

2.1 SUPPORT
CHANNELS

- .1 U shape, size 41 x 41 mm, 2.5 mm thick, surface mounted, suspended.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Secure equipment to hollow masonry, surfaces with lead anchors.
- .2 Secure equipment to poured concrete with expandable inserts.
- .3 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .4 Fasten exposed conduit or cables to building construction or support system using straps.
 - .1 One-hole steel straps to secure surface conduits and cables 50 mm and smaller.
 - .2 Two-hole steel straps for conduits and cables larger than 50 mm.
 - .3 Beam clamps to secure conduit to exposed steel work.

- .5 Suspended support systems.
 - .1 Support individual cable or conduit runs with 6 mm dia threaded rods and spring clips.
 - .2 Support 2 or more cables or conduits on channels supported by 6 mm dia threaded rod hangers where direct fastening to building construction is impractical.
- .6 For surface mounting of two or more conduits use channels at 450mm on centre spacing.
- .7 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .8 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .9 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .10 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Departmental Representative.
- .11 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

PART 1 - GENERAL

1.1 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.1-09, Canadian Electrical Code, Part 1, 21st Edition.

1.2 SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Provide shop drawings: in accordance with Section 01 33 00.
 - .1 Provide drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.

1.3 DELIVERY,
STORAGE AND
HANDLING

- .1 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 SPLITTERS

- .1 Construction: sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position.
- .2 Terminations: main and branch lugs connection blocks to match required size and number of incoming and outgoing conductors as indicated.
- .3 Spare Terminals: minimum three spare terminals or lugs on each connection or lug block sized less than 400 A.

2.2 JUNCTION AND
PULL BOXES

- .1 Construction: welded steel enclosure.
- .2 Covers Flush Mounted: 25 mm minimum extension all around.
- .3 Covers Surface Mounted: screw-on flat covers.

2.3 CABINETS

- .1 Construction: welded sheet steel hinged door, handle, and catch
- .2 Type E Empty: flush overlapping sides mounting.

PART 3 - EXECUTION

3.1 SPLITTER
INSTALLATION

- .1 Mount plumb, true and square to building lines.
- .2 Extend splitters full length of equipment arrangement except where indicated otherwise.

3.2 JUNCTION, PULL
BOXES AND CABINETS
INSTALLATION

- .1 Install pull boxes in inconspicuous but accessible locations.
- .2 Mount cabinets with top not higher than 2 m above finished floor except where indicated otherwise.
- .3 Only main junction and pull boxes are indicated. Install additional pull boxes as required by CSA C22.1.

3.3 IDENTIFICATION

- .1 Equipment Identification: to Section 26 05 00.
- .2 Identification Labels: size 2 indicating system name voltage and phase or as indicated.

PART 1 - GENERAL

- 1.1 REFERENCES
- .1 Canadian Standards Association (CSA International)
.1 CSA C22.1-09, Canadian Electrical Code, Part 1,
21st Edition.
- 1.2 SUBMITTALS
- .1 Provide submittals in accordance with Section
01 33 00.
- 1.3 DELIVERY,
STORAGE AND
HANDLING
- .1 Deliver, store and handle materials in accordance with
Section 01 61 00.
- .2 Waste Management and Disposal:
.1 Separate waste materials for reuse and recycling
in accordance with Section 01 74 0.

PART 2 - PRODUCTS

- 2.1 OUTLET AND
CONDUIT BOXES
GENERAL
- .1 Size boxes in accordance with CSA C22.1.
- .2 102mm square or larger outlet boxes as required.
- .3 Gang boxes where wiring devices are grouped.
- .4 Blank cover plates for boxes without wiring devices.
- .5 Combination boxes with barriers where outlets for more
than one system are grouped.
- 2.2 GALVANIZED
STEEL OUTLET BOXES
- .1 One-piece electro-galvanized construction.
- .2 Single and multi gang flush device boxes for flush
installation, minimum size 76 x 50 x 38mm or as
indicated. 102mm square outlet boxes when more than
one conduit enters one side with extension and plaster
rings as required.
- .3 Utility boxes for outlets connected to surface-mounted
EMT conduit, minimum size 102 x 54 x 48mm.
- .4 102mm square or octagonal outlet boxes for lighting
fixture outlets.
- .5 Extension and plaster rings for flush mounting devices
in finished tile walls.

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- 2.3 MASONRY BOXES .1 Electro-galvanized steel masonry single and multi gang boxes for devices flush mounted in exposed block walls.
- 2.4 CONCRETE BOXES .1 Electro-galvanized sheet steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.
- 2.5 FLOOR BOXES .1 Concrete tight electro-galvanized sheet steel floor boxes with adjustable finishing rings to suit floor finish with brass faceplate. Device mounting plate to accommodate short or long ear duplex receptacles. Minimum depth: 73 mm for receptacles and communication outlets.
- 2.6 CONDUIT BOXES .1 Cast FS boxes with factory-threaded hubs and mounting feet for surface wiring of devices.
- 2.7 OUTLET BOXES FOR NON-METALLIC SHEATHED CABLE .1 Electro-galvanized, sectional, screw ganging steel boxes, minimum size 76 x 50 x 63mm with two double clamps to take non-metallic sheathed cables.
- 2.8 FITTINGS - GENERAL .1 Bushing and connectors with nylon insulated throats.
.2 Knock-out fillers to prevent entry of debris.
.3 Conduit outlet bodies for conduit up to 35mm and pull boxes for larger conduits.
.4 Double locknuts and insulated bushings on sheet metal boxes.
- PART 3 - EXECUTION
- 3.1 INSTALLATION .1 Support boxes independently of connecting conduits.
.2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.
.3 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.

- .4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Do not install reducing washers.
- .5 Vacuum clean interior of outlet boxes before installation of wiring devices.
- .6 Identify systems for outlet boxes as required.

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PART 1 - GENERAL

1.1 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-C22.2 No. 18-98(R2003), Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware, A National Standard of Canada.
 - .2 CAN/CSA-C22.2 NO. 18.1-04, Metallic Outlet Boxes.
 - .3 CAN/CSA-C22.2 NO. 18.2-06, Nonmetallic Outlet Boxes.
 - .4 CAN/CSA-C22.2 No. 18.3-04(R2009), Conduit, Tubing, and Cable Fittings (Tri-National standard, with ANCE NMX-J-017 and UL 514B).
 - .5 CSA C22.2 No. 45.1-07, Electrical Rigid Metal Conduit - Steel (Tri-National standard, with UL 6 and NMX-J-534-ANCE-2007).
 - .6 CSA C22.2 No. 56-04(R2009), Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
 - .7 CSA C22.2 No. 83-M1985(R2008), Electrical Metallic Tubing.
 - .8 CSA C22.2 No. 211.2-06(R2011), Rigid PVC (Unplasticized) Conduit.
 - .9 CAN/CSA-C22.2 No. 227.3-05, Nonmetallic Mechanical Protection Tubing (NMPT), A National Standard of Canada (February 2006).

1.2 SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00.
- .2 Product data: submit manufacturer's printed product literature, specifications and datasheets.
 - .1 Submit cable manufacturing data.
- .3 Quality assurance submittals:
 - .1 Test reports: submit certified test reports.
 - .2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .3 Instructions: submit manufacturer's installation instructions.

1.3 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 20.
- .2 Place materials defined as hazardous or toxic waste in designated containers.
- .3 Ensure emptied containers are sealed and stored safely for disposal away from children.

PART 2 - PRODUCTS

2.1 CABLES AND REELS

- .1 Provide cables on reels or coils.
 - .1 Mark or tag each cable and outside of each reel or coil, to indicate cable length, voltage rating, conductor size, and manufacturer's lot number and reel number.
- .2 Each coil or reel of cable to contain only one continuous cable without splices.
- .3 Identify cables for exclusively dc applications.
- .4 Reel and mark shielded cables rated 2,001 volts and above.

2.2 CONDUITS

- .1 Rigid metal conduit: to CSA C22.2 No. 45., galvanized steel aluminum threaded.
- .2 Epoxy coated conduit: to CSA C22.2 No. 45., with zinc coating and corrosion resistant epoxy finish inside and outside.
- .3 Electrical metallic tubing (EMT): to CSA C22.2 No. 83, with couplings.
- .4 Rigid pvc conduit: to CSA C22.2 No. 211.2.
- .5 Flexible metal conduit: to CSA C22.2 No. 56, liquid-tight flexible metal.

2.3 CONDUIT FASTENINGS

- .1 One hole steel straps to secure surface conduits 50mm and smaller.
 - .1 Two hole steel straps for conduits larger than NPS 2 50 mm.
- .2 Beam clamps to secure conduits to exposed steel work.
- .3 Channel type supports for two or more conduits at 450mm on centre.
- .4 Threaded rods, 12mm diameter, to support suspended channels.

2.4 CONDUIT FITTINGS

- .1 Fittings: to CAN/CSA C22.2 No. 18, manufactured for use with conduit specified. Coating: same as conduit.
- .2 Ensure factory "ells" where 90 degrees bends for 25 mm and larger conduits.

- .3 Watertight connectors and couplings for EMT.
 - .1 Set-screws are not acceptable.

2.5 EXPANSION
FITTINGS FOR RIGID
CONDUIT

- .1 Weatherproof expansion fittings with internal bonding assembly suitable for 100mm linear expansion.
- .2 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection.
- .3 Weatherproof expansion fittings for linear expansion at entry to panel.

2.6 FISH CORD

- .1 Polypropylene 6mm.

PART 3 - EXECUTION

3.1 MANUFACTURER'S
INSTRUCTIONS

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 INSTALLATION

- .1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .2 Conceal conduits except electrical room.
- .3 Surface mount conduits except where noted.
- .4 Use rigid aluminum threaded conduit except where specified otherwise.
- .5 Use epoxy coated conduit underground in corrosive areas.
- .6 Use electrical metallic tubing (EMT) except in cast concrete above 2.4 m not subject to mechanical injury.
- .7 Use rigid pvc conduit underground.
- .8 Use flexible metal conduit for connection to recessed incandescent fixtures without prewired outlet box connection to surface or recessed fluorescent fixtures.
- .9 Use liquid tight flexible metal conduit for in damp, wet or corrosive locations and as indicated.

- .10 Install conduit sealing fittings in hazardous areas.
 - .1 Fill with compound.
- .11 Minimum conduit size for lighting and power circuits:
19 mm.
- .12 Bend conduit cold:
 - .1 Replace conduit if kinked or flattened more than
1/10th of its original diameter.
- .13 Mechanically bend steel conduit over 19 mm diameter.
- .14 Field threads on rigid conduit must be of sufficient
length to draw conduits up tight.
- .15 Install fish cord in empty conduits.
- .16 Remove and replace blocked conduit sections.
 - .1 Do not use liquids to clean out conduits.
- .17 Dry conduits out before installing wire.

3.3 SURFACE CONDUITS

- .1 Run parallel or perpendicular to building lines.
- .2 Locate conduits behind infrared or gas fired heaters
with 1.5 m clearance.
- .3 Run conduits in flanged portion of structural steel.
- .4 Group conduits wherever possible on channels.
- .5 Do not pass conduits through structural members except
as indicated.
- .6 Do not locate conduits less than 75 mm parallel to steam
or hot water lines with minimum of 25 mm at crossovers.

3.4 CONCEALED CONDUITS

- .1 Run parallel or perpendicular to building lines.
- .2 Do not install horizontal runs in masonry walls.
- .3 Do not install conduits in terrazzo or concrete
toppings.

3.5 CONDUITS IN CAST-IN-PLACE CONCRETE

- .1 Locate to suit reinforcing steel.
 - .1 Install in centre one third of slab.
- .2 Protect conduits from damage where they stub out of
concrete.
- .3 Install sleeves where conduits pass through slab or
wall.
- .4 Provide oversized sleeve for conduits passing through

waterproof membrane, before membrane is installed.
.1 Use cold mastic between sleeve and conduit.

.5 Conduits in slabs: minimum slab thickness 4 times
conduit diameter.

.6 Encase conduits completely in concrete with minimum
25 mm concrete cover.

.7 Organize conduits in slab to minimize cross-overs.

3.6 CONDUITS IN
CAST-IN-PLACE SLABS
ON GRADE

.1 Run conduits 25 mm and larger below slab and
encase in 75 mm concrete envelope.

.1 Provide 50 mm of sand over concrete envelope
below floor slab.

3.7 CONDUITS
UNDERGROUND

.1 Slope conduits to provide drainage.

.2 Waterproof joints (pvc excepted) with heavy coat of
bituminous paint.

3.8 CLEANING

.1 Proceed in accordance with Section 01 74 11.

.2 On completion and verification of performance of
installation, remove surplus materials, excess
materials, rubbish, tools and equipment.

PART 1 - GENERAL

1.1 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-C22.2 No.126-M91(R1997), Cable Tray Systems.
- .2 National Electrical Manufacturers Association (NEMA) standards
 - .1 NEMA FG 1-1993, Fibreglass Cable Tray Systems.
 - .2 NEMA VE 1-2002, Metal Cable Tray Systems.

1.2 SHOP DRAWINGS
AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with section 01 33 00.
- .2 Identify types of cabletroughs used.
- .3 Show actual cabletrough installation details and suspension system.

1.3 WASTE
MANAGEMENT AND
DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 20.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Departmental Representative .
- .5 Fold up metal banding, flatten and place in designated area for recycling.

PART 2 - PRODUCTS

2.1 CABLETROUGH

- .1 Cabletroughs and fittings: to NEMA FG 1 VE 1.
- .2 Ladder type, Class D1 to CAN/CSA C22.2 No.126.
- .3 Trays: extruded aluminum 150, 300, 450 or 600mm wide with depth of 100mm, as required.
- .4 Fittings: horizontal elbows, end plates, drop outs, vertical risers and drops, tees, wyes, expansion joints

and reducers where required, manufactured accessories for cabletrough supplied.

.1 Radii on fittings: 300mm minimum.

.5 Solid covers for complete cabletrough system including fittings.

.6 Barriers where different voltage systems are in same cabletrough.

2.2 SUPPORTS

.1 Provide supports as required.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install complete cabletrough system.

.2 Support cabletrough on both sides.

.3 Remove sharp burrs or projections to prevent damage to cables or injury to personnel.

3.2 CABLES IN CABLETROUGH

.1 Install cables individually.

.2 Lay cables into cabletrough. Use rollers when necessary to pull cables.

.3 Secure cables in cabletrough at 3 m centres, with nylon ties.

.4 Identify cables every 15m with size 2 nameplates in accordance with Section 26 05 00.

PART 1 - GENERAL

1.1 REFERENCES

- .1 CSA International
 - .1 CAN/CSA-C22.2 No.94.1-07, Enclosures for Electrical Equipment, Non Environment Considerations.
- .2 National Electrical Manufacturers Association (NEMA)
 - .1 NEMA 250-2008, Enclosures for Electrical Equipment (1000 Volts Maximum).
- .3 The Munsell System of Colour Notation.

1.2 ACTION AND
INFORMATIONAL
SUBMITTALS

- .1 Submit in accordance with Section 01 33 00.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for electrical cabinets and enclosures and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.

1.3 CLOSEOUT
SUBMITTALS

- .1 Submit in accordance with Section 01 78 00.
- .2 Operation and Maintenance Data: submit operation and maintenance data for electrical cabinets and enclosures for incorporation into manual.

1.4 DELIVERY,
STORAGE AND
HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect electrical cabinets and enclosures from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

PART 2 - PRODUCTS

2.1 MATERIALS

- .1 Enclosure constructed with 2.7 mm thick minimum steel, with weather and corrosion resistant finish to CAN/CSA-C22.2 No. 94.1, Munsell Notation 7.5GY3.5/1.5, size as indicated.
- .2 Entire enclosure to be capable of withstanding maximum impact force of 86 MN/m² area without rupture of material.
- .3 Removable enclosure panels with formed edges, galvanized steel external fasteners removable only from inside enclosure.
- .4 Equip enclosure with hot dipped galvanized mounting rails 1m adjustable horizontally and vertically to enable mounting of equipment at any location within housing.
 - .1 Rails: 14 mm holes and 50 x 14 mm slots on 100 mm centres for horizontal adjustment.
 - .2 Holes in side panel flanges in 60 mm increments for vertical adjustment.
- .5 Cover: tamperproof, bolt-on, domed to shed water.
- .6 Door: 3 point latching, with padlocking means.
- .7 Ventilation panel constructed to allow air circulation yet preventing entry of foreign objects, wild life, and vermin.
- .8 Enclosure construction such as to allow configuration of single or ganged enclosures.
- .9 Enclosure capable of being shipped in knocked-down condition.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for electrical cabinet and enclosure installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from

Departmental Representative.

3.2 INSTALLATION

- .1 Assemble enclosure in accordance with manufacturer's instructions and securely mount on building structure with channels, supports and fastenings.
- .2 Mount equipment in enclosure.
- .3 Label electrical cabinets and enclosure to Section 26 05 00.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 20 01 35 21.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

PART 1 - GENERAL

1.1 REFERENCES

- .1 CSA International
 - .1 CSA C22.2 No.42-10, General Use Receptacles, Attachment Plugs and Similar Devices.
 - .2 CAN/CSA-C22.2 No.42.1-00(R2009), Cover Plates for Flush-Mounted Wiring Devices (Bi-national standard, with UL 514D).
 - .3 CSA C22.2 No.55-M1986(R2008), Special Use Switches.
 - .4 CSA C22.2 No.111-10, General-Use Snap Switches (Bi-national standard, with UL 20).

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for wiring devices and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00.
- .2 Operation and Maintenance Data: submit operation and maintenance data for wiring devices for incorporation into manual.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect wiring devices from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

PART 2 - PRODUCTS

2.1 SWITCHES

- .1 15 20 A, 120 V, single pole, double pole, three-way, switches to: CSA C22.2 No.55 and CSA C22.2 No.111.
- .2 Manually-operated general purpose AC switches with following features:
 - .1 Terminal holes approved for No. 10 AWG wire.
 - .2 Silver alloy contacts.
 - .3 Urea or melamine moulding for parts subject to carbon tracking.
 - .4 Suitable for back and side wiring.
 - .5 Ivory toggle.
- .3 Toggle operated locking fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads and or heating loads.
- .4 Switches of one manufacturer throughout project.

2.2 RECEPTACLES

- .1 Duplex receptacles, CSA type 5-15 R, 125 V, 15 A, U ground, to: CSA C22.2 No.42 with following features:
 - .1 Ivory urea moulded housing.
 - .2 Suitable for No. 10 AWG for back and side wiring.
 - .3 Break-off links for use as split receptacles.
 - .4 Eight back wired entrances, four side wiring screws.
 - .5 Triple wipe contacts and rivetted grounding contacts.
- .2 Single receptacles CSA type 5-15 R, 125 V, 15 A, U ground with following features:
 - .1 Ivory urea moulded housing.
 - .2 Suitable for No. 10 AWG for back and side wiring.
 - .3 Four back wired entrances, 2 side wiring screws.
- .3 Other receptacles with ampacity and voltage as indicated.
- .4 Receptacles of one manufacturer throughout project.

2.3 COVER PLATES

- .1 Cover plates for wiring devices to: CSA C22.2 No.42.1.
- .2 Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.
- .3 Stainless steel, vertically brushed, 1 mm thick cover plates for wiring devices mounted in flush-mounted outlet box.
- .4 Cast cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.

- .5 Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for duplex receptacles as indicated.
- .6 Weatherproof spring-loaded cast aluminum cover plates complete with gaskets for single receptacles or switches.
- .7 All outdoor weatherproof covers to be padlockable.

2.4 SOURCE QUALITY CONTROL

- .1 Cover plates from one manufacturer throughout project.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for wiring devices installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

- .1 Switches:
 - .1 Install single throw switches with handle in "UP" position when switch closed.
 - .2 Install switches in gang type outlet box when more than one switch is required in one location.
 - .3 Mount toggle switches at height in accordance with Section 26 05 00.
- .2 Receptacles:
 - .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
 - .2 Mount receptacles at height in accordance with Section 26 05 00.
 - .3 Where split receptacle has one portion switched, mount vertically and switch upper portion.
 - .4 Install GFI type receptacles as indicated.
- .3 Cover plates:
 - .1 Install suitable common cover plates where wiring devices are grouped.
 - .2 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 20 01 35 21.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.4 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.
- .3 Repair damage to adjacent materials caused by wiring device installation.

PART 1 - GENERAL

1.1 SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00.
- .2 Product Data:
 - .1 Provide fuse performance data characteristics for each fuse type and size above 15A. Performance data to include: average melting time-current characteristics.
- .3 Shop Drawings:
 - .1 Provide shop drawings in accordance with Section 01 33 00.
 - .2 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.

1.2 DELIVERY,
STORAGE AND
HANDLING

- .1 Ship fuses in original containers.
- .2 Do not ship fuses installed in switchboard.
- .3 Store fuses in original containers in storage cabinet.
- .4 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 20.

1.4 MAINTENANCE
MATERIALS

- .1 Provide maintenance materials in accordance with Section 01 78 00.
- .2 Three spare fuses of each type and size installed above 600A.
- .3 Six spare fuses of each type and size installed up to and including 600A.

PART 2 - PRODUCTS

2.1 FUSES - GENERAL

- .1 Fuse type references L1, L2, J1, R1, etc. have been adopted for use in this specification.
- .2 Fuses: product of one manufacturer.

2.2 FUSE TYPES

- .1 Class L fuses.
 - .1 Type L1, time delay, capable of carrying 500%

of its rated current for 10 s minimum.

.2 Type L2, fast acting.

.2 Class J fuses.

.1 Type J1, time delay, capable of carrying 500% of its rated current for 10 s minimum.

.2 Type J2, fast acting.

.3 Class R -R fuses.

.1 Type R1, (UL Class RK1), time delay, capable of carrying 500% of its rated current for 10 s minimum, to meet UL Class RK1 maximum let-through limits.

.2 Type R2, time delay, capable of carrying 500% of its rated current for 10 s minimum.

.3 Type R3, (UL Class RK1), fast acting Class R, to meet UL Class RK1 maximum let-through limits.

.4 Class C fuses.

2.3 FUSE STORAGE CABINET

.1 Fuse storage cabinet, manufactured from 2.0 mm thick aluminum 750 mm high, 600 mm wide, 300 mm deep, hinged, lockable front access door finished in accordance with Section 26 05 00.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install fuses in mounting devices immediately before energizing circuit.

.2 Ensure correct fuses fitted to physically matched mounting devices.

.1 Install rejection clips for Class R fuses.

.3 Ensure correct fuses fitted to assigned electrical circuit.

.4 Where UL Class RK1 fuses are specified, install warning label "Use only UL Class RK1 fuses for replacement" on equipment.

.5 Install spare fuses in fuse storage cabinet.

PART 1 - GENERAL

1.1 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00.

1.2 WASTE
MANAGEMENT AND
DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 DISCONNECT
SWITCHES

- .1 Non-fusible, horsepower rated disconnect switch in CSA Enclosure 4,3R, size as indicated.
- .2 Provision for padlocking in off switch position by three locks.
- .3 Mechanically interlocked door to prevent opening when handle in ON position.
- .4 Fuses: size as indicated, to Section 26 28 14.
- .5 Fuseholders: relocatable and suitable without adaptors, for type and size of fuse indicated.
- .6 Quick-make, quick-break action.
- .7 ON-OFF switch position indication on switch enclosure cover.

2.2 EQUIPMENT
IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00.
- .2 Indicate name of load controlled on size 4 nameplate.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Install disconnect switches complete with fuses if applicable.
- .2 Ensure all wiring enters and exits the sides or bottom. (Do not enter top of unit).

PART 1 - GENERAL

1.1 REFERENCES

- .1 CSA International
 - .1 CSA C22.2 No.14-10, Industrial Control Equipment.
- .2 National Electrical Manufacturers Association (NEMA)
 - .1 NEMA ICS 1-2000(R2008), Industrial Control and Systems: General Requirements.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for control devices and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
 - .2 Include schematic, wiring, interconnection diagrams.

1.3 QUALITY ASSURANCE

- .1 Conduct tests in accordance with Section 26 05 00.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00.
- .2 Operation and Maintenance Data: submit operation and maintenance data for control devices for incorporation into manual.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect control devices from nicks, scratches, and blemishes.

- .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 35 21.

PART 2 - PRODUCTS

2.1 AC CONTROL RELAYS

- .1 Control Relays: to CSA C22.2 No.14 and NEMA.
- .2 Convertible contact type: contacts field convertible from NO to NC, electrically held and 3 poles. Coil rating: 120V. Contact rating: 600V, 10A.

2.2 RELAY ACCESSORIES

- .1 Standard contact cartridges: normally-open - convertible to normally-closed in field.

2.3 PUSHBUTTONS

- .1 Illuminated, Heavy duty Oil tight. Operator extend type, Green, with 1-NO and 1-NC contacts rated at 250 V, 10 A, AC, labels as indicated. Stop pushbuttons coloured red, labelled "stop".

2.4 SELECTOR SWITCHES

- .1 Maintained 3 position labelled H-O-A as indicated heavy duty oil tight, operators wing lever, contact arrangement as indicated, rated 250V, 10A, AC.

2.10 INDICATING LIGHTS

- .1 Heavy duty Oil tight, LED type, push-to-test, lens colour: red amber green as indicated, supply voltage: 120V AC, lamp voltage: 24V DC, labels as indicated.

2.11 CONTROL AND RELAY PANELS

- .1 CSA Type 12 sheet steel enclosure with hinged padlockable access door, accommodating relays timers, labels, as indicated, factory installed and wired to identified terminals.

2.12 CONTROL CIRCUIT TRANSFORMERS

- .1 Single phase, dry type.
- .2 Primary: 600 V, 60 Hz ac.
- .3 Secondary: 120 V, AC.
- .4 Rating: 150, 250, 350, 500 VA as required.
- .5 Secondary fuse: 1, 3, 6, 10A as required.

- .6 Close voltage regulation as required by magnet coils and solenoid valves.

2.13 THERMOSTAT
(LINE VOLTAGE)

- .1 Wall mounted, for exhaust fan control.
- .2 Full load rating: 8 A at 120V AC.
- .3 Temperature setting range: 10°C to 30°C.
- .4 Thermometer Range: 0°C to 50°C.
- .5 Markings in 5° increments.
- .6 Differential temperature fixed at 2°C.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for control devices installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

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

3.3 FIELD QUALITY
CONTROL

- .1 Perform tests in accordance with Section 26 05 00.
- .2 Depending upon magnitude and complexity, divide control system into convenient sections, energize one section at time and check out operation of section.
- .3 Upon completion of sectional test, undertake group testing.
- .4 Check out complete system for operational sequencing.

3.4 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11.
 - .1 Leave Work area clean at end of each day.

- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 20.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

PART 1 - GENERAL

1.1 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CAN/CSA-ISO 9000-05, Quality Management Systems - Fundamentals and Vocabulary.
 - .2 CAN/CSA-Q9000-92, Quality Management and Quality Assurance Standards - Guidelines for Selection and Use.
- .2 The drive shall meet the following specifications:
 - .1 NFPA 70-US National Electrical Code. .2 NEMA ICS 3.1 - Safety standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems.
 - .3 NEMA 250 - Enclosures for Electrical Equipment.
 - .4 CAN/CSA-C22 No.14-95R2001. - Canadian Standards Association.
 - .5 IEC 146 - International Electrical Code.

1.2 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00.
- .2 Submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 33 00. WHMIS acceptable to Labour Canada, and Health and Welfare Canada.
- .3 Submit product data sheets for sills, busbars and compartments. Include product characteristics, physical size and finish.
- .4 Manufacturer's Instructions: Provide to indicate special handling criteria, installation sequence, cleaning procedures and maintenance.

1.3 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00.
- .2 Indicate:
 - .1 Outline dimensions
 - .2 Configuration of identified components.
 - .3 Schematic and wiring diagrams.

1.4 WASTE
MANAGEMENT AND
DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 20.

1.5 CLOSEOUT
SUBMITTALS

- .1 Provide operation and maintenance data for VFD's in pump control panel for incorporation into manual specified in Section 01 78 00.
- .2 Include data for each type and style of VFD.
- .3 As-built Schematic and wiring diagrams.
- .4 Include configuration parameter setting printouts and CD copy of parameter configuration for incorporation into manual in Section 01 78 00.

1.6 EXTRA MATERIALS

- .1 Provide maintenance materials in accordance with Section 01 78 00.

PART 2 - PRODUCTS

2.1 SUPPLY
CHARACTERISTICS

- .1 600V, 60Hz, wye connected, 3 phase, 3 wire, grounded neutral. (No neutral to Motor Control Centre).

2.2 GENERAL
DESCRIPTION

- .1 VFD to be installed as a self contained unit mated with the GAC pump that it will control.
- .2 Indoor CSA 1 gasketed enclosure.
 - .1 Flange mounted 30amp,3 phase, lockable disconnect switch.
 - .2 Door mounted VFD HIM, H-O-A selector switch, Run and Fault Status indicator lights and over-temperature / leak detection relay c/w Reset pushbutton(-supplied loose by Div.44).
 - .3 5% line and 3% load side reactors are to be installed in the enclosure.
- .3 Class I Type B.

2.3 REGULATORY
REQUIREMENTS

- .1 The drive conforms to the following requirements:
 - .1 NFPA 70.
 - .2 IEC 146.
 - .3 C-UL marking to provide an approved listing for Canadian users.
 - .4 UL listing.
 - .1 Manufacturer will furnish the product as listed and classified by Underwriter's Laboratories as suitable for the purpose specified and indicated.
 - .5 EN Standard/CE marked for the following directives:
 - .1 Low Voltage Directive (73/23/EEC) EN50178 Electronic Equipment for use in power installations.

.2 EMC Directive (89/336/EEC) EN61800-3 Adjustable Speed electrical power drive systems Part 3.

.3 The drive shall have an internal EMC filter capable of meeting the Second Environment levels for the EMC directive without the need for additional components. First environment classification shall require an additional, external filter.

2.4 RATINGS

- .1 Input Power:
 - .1 The drive shall be self-adjustable to accept an input voltage range between:
 - .1 600 V AC, three phase -10%.
 - .2 Displacement power factor shall range between 1.0 and 0.95, lagging, over the entire speed range (0.80 for 0.5hp/0.37-3.7kW, 200-600V drives). The efficiency of the drive shall be a minimum of 97% at full load and speed.
- .2 Environment:
 - .1 Storage ambient temperature range: -40°C to 70°C (-40° to 158°F).
 - .2 Operating ambient temperature range without derating: IP56/Type 4X 0°C to 40°C (32°F to 104°F)
 - .3 The relative humidity range is 5% to 95% non-condensing. Shock: 15G peak for 11ms duration. Vibration: 0.152mm (0.006 inches) displacement, 1G peak.
- .3 Reflected Wave:
 - .1 Drives have software to limit the reflected wave due to long cable lengths to a maximum of 2.25 times the bus voltage or 1600V, whichever is less, up to cable lengths of 600 Ft.. Hardware designs also limit peak voltages on the motor.
- .4 Power Conditioning:
 - .1 The drive is designed to operate on an AC supply, which may contain line notching, and up to 10% harmonic distortion. An input isolation transformer shall not be required for protection from normal line transients. If line conditions dictate the use of a transformer, the K factor shall be 4.0 or less.
- .5 Operator I/O:
 - .1 OPERATOR INTERFACE: Interface to the drive shall be a removable Human Interface Module (HIM) with integral display. The door-mounted display shall be an IP66/UL Type 4X LCD style.
- .6 Analog Inputs:
 - .1 Two analog inputs are available. Each input

shall be configured as 4-20mA. The first Analog input shall be used for frequency command from the PLC. Inputs are programmable. Scaling shall be as indicated by pump supplier. Analog input 2 is differentially isolated with a maximum common mode noise rejection of 160V.

- .7 Loss of Reference:
 - .1 The drive is capable of sensing the following. In the event of loss of an analog input reference signal, the drive shall fault.
- .8 Digital Inputs:
 - .1 Six inputs are provided and are configurable as sink or source. All inputs are individually programmable for functions from a list of 29 that include Start (3-wire control), Run (2-wire control), Stop, External fault, Speed select, Jog, Process PI functions and others.
- .9 Digital Outputs:
 - .1 Two Form C (1 N.O - 1 N.C) output relays are provided. Contact output ratings are 250V AC/220VDC, 50VA and 60W (resistive), 25VA and 25W (inductive). The relay outputs shall be IN AUTO and DRIVE FAILED.
- .10 Auto/Manual Modes.
 - .1 The door mounted HIM shall utilize the ALT function key to transfer the drive from Automatic mode to Manual mode and back in the field. This method will be used as the pump hand select.
 - .2 When in Auto mode, the drive receives its frequency command from the programmed source.
 - .3 A local manual control panel mounted adjacent VFD enclosures for these pumps shall be used to control pump speed. A common potentiometer shall provide a frequency command to pumps for manual operation. In addition, local job pushbuttons will be mounting in the panel. The frequency command for the jog pushbuttons will be programmed at the HIM.
 - .4 The user has the choice of preloading the HIM with the current "auto" frequency reference before transferring control to allow for smooth transitions without speed "jumps".
- .11 Communications Interface:
 - .1 The drive has the capability for either internally mounted or externally mounted communications interface cards. Internal cards use drive power and can operate at higher speeds. Externally mounted cards are separately powered and connected to the drive via a cable. The protocol shall be Ethernet, internally mounted interface, 10-100 Mbps, full duplex. Node

configuration shall be by Scada Integrator/Network administrator (-determined by owner).

- .12 Auto Restart:
 - .1 The drive provides up to nine automatic fault reset and restarts following a fault condition before locking out and requiring manual restart. The automatic mode is not applicable to a ground fault shorted output faults and other internal microprocessor faults. The time between restarts is adjustable from 0.5 seconds to 30.0 seconds. Final parameters values will be determined during installation and should initially be 3 restarts, 30 seconds apart.

- .13 The shop assembly to include a flange mounted lockable disconnect, door mounted HIM, Ethernet communication card, incoming fuses, control transformer with primary and secondary fusing, and door mounted hand off auto selector switch and run, fault pilot lights. Also 5% line and 3% load side reactor are to be installed in the enclosure.

- .1 Provide wiring identification in accordance with Section 26 05 00.

2.5 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00.
 - .1 Pump Control panel nameplate: size No. 7, engraved.
 - .2 Individual compartment nameplates: size No. 5, engraved as indicated.

2.6 FINISHES

- .1 Apply finishes in accordance with Section 26 05 00.
- .2 Paint VFD enclosure exterior light gray and interiors white.

2.7 SOURCE QUALITY CONTROL

- .1 Provide manufacturer's type test certificates including short circuit fault damage certification up to short circuit values specified under bus bracing.
- .2 Departmental Representative to witness standard factory testing of complete pump control panel including operation of switches, circuit breakers, starters and controls.
- .3 Manufacturer to provide proof of quality control program in accordance with CAN/CSA-ISO 9000.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Set and secure pump control panel in place on channel bases, rigid, plumb and square to building floor and wall.
- .2 Make field power and control connections as indicated. Provide control wiring from VFD Pump control panels to RPU panels for discrete signals: 'Auto' Run Command, Run Permissive interlock, Run status and Fault status. Also analogue 4-20ma Speed Reference from RPU and Cat.6 Ethernet cable in 19mm Liquid Tyte flexible conduit.
- .3 Ensure Electronic overloads are configured correctly.

,3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00.
- .2 Ensure moving and working parts are lubricated where required.
- .3 Operate vfd's in sequence to prove satisfactory performance of pump control panel during 8 hours period.
- .4 Submit manufacturer's factory trained technicians commissioning/configuration test report to Departmental Representative.
- .5 Provide configuration parameter settings in PDF file and CD copy for drives to Div.25 integrator.

Part 1 - General

1.1 General
Requirements

- .1 This section covers items common to all sections of Division 44.
- .2 Obtain and pay for all required permits and approvals.
- .3 The following codes shall apply:
 - .1 Ontario Building Code; O.B.C.
 - .2 Ontario Building Code Part 7 Plumbing.
 - .3 National Fire Code, N.F.C.
 - .4 National Building Code, N.B.C.
 - .5 Ontario Fire Code.
- .4 All code references shall be the latest edition, including revisions and addenda.
- .5 Materials and equipment to be new and free from blemishes, oxidation, damage, etc. New materials and equipment to be of proven design and quality, and for which replacement parts are readily available. Use current models of equipment.
- .6 It is the intent of the specification that the Contractor is responsible for all of Division 44 work. The Contractor shall be responsible for all Division 44 subtrades. The Contractor shall be responsible for commissioning of Division 44 systems. Division 44 Contractor shall coordinate time of commissioning with plan prepared by Division 01.

1.2 Product Delivery,
Storage, and Handling

- .1 All materials and equipment shall be delivered, handled and stored subject to the provisions contained herein and according to the manufacturer's recommendations.
- .2 Provide temporary storage facilities and heated storage where required for sensitive items such as motors.
- .3 Equipment, including pumps and motors, shall not be placed in temporary or final locations in the new structures before a date approved by the Departmental Representative. The date of delivery into the structure shall be commensurate with the construction progress and the suitability, with respect to temperature, humidity, etc. of the building.
- .4 Take precautions to maintain equipment in good condition and to avoid corrosion or other damage which may affect the equipment's performance. Provide temporary coatings as required to prevent corrosion.
- .5 Leave factory covers in place and prevent entry of foreign materials into working parts of equipment.
- .6 Protect members and bearings with plastic covers.
- .7 Grease all shafts and sheaves to prevent corrosion.
- .8 The Contractor shall recognize the time interval required for complete construction before the structure is

suitable for equipment installation. If equipment is manufactured before it is required at the site, the Contractor shall provide suitable heated dry storage space for the equipment, to the approval of the Departmental Representative. All equipment and motors shall be rotated at least weekly during the storage period, and after installation, until the equipment is placed in normal use.

- .9 All material damaged or otherwise harmfully affected during delivery, storage, handling or installation shall be replaced by the Contractor at his/her own expense.

1.3 Equipment
Supports, Anchors, and
Bases

- .1 The Contractor shall provide all structural work required for foundation and support of units, foundation bolts, sleeves, washers, nuts, shims and templates to locate bolts.
- .2 Anchor bolts shall be set in concrete with one end of the bolt hooked as detailed; or sleeved anchor bolts as detailed may be set in concrete. Expansion type bolts drilled into concrete may not be used in lieu of anchor bolts.
- .3 Provide seismic restraint of equipment, ducting, piping, tanks and machinery in accordance with Section 44 02 41, Seismic Restraints.
- .4 Mount base mounted equipment on chamfered edge housekeeping pads,

minimum of 150mm high and 200mm larger than equipment dimensions all around. Concrete shall be as specified in Section 03 30 00 - Cast-in-Place Concrete. Housekeeping pads for equipment shall be the responsibility of Division 3.

- .5 Provide a minimum of 25 mm non-metallic grout between bedplates and concrete foundation, fill voids, finish and remove wedges after grout is set. Grout shall be non metallic type.
- .6 Where grouting is required for bedplates and equipment bases on concrete foundations, the surface of the concrete foundation shall be roughened to provide a bond.
- .7 All bases shall be finished to match the floor.
- .8 Equipment supports not by equipment manufacturer: fabricate from structural grade steel meeting the requirements of Section 05 50 00 - structural steel. Submit structural calculations with shop drawings.
- .9 Prior to connecting pumping units or other equipment to pipe sections, support complete piping assembly and anchor in perfect alignment with pumping units and sleeves to prevent movement of piping assembly and strain on pumping and equipment.
- .10 Support all valves and risers so that weight of valve or valve assembly is not carried by adjacent horizontal pipe sections.

- .11 Do not secure supports to metal decks when supporting piping, ductwork and other equipment. Provide supplementary steel supported from structural members as required to support piping, ductwork and other equipment where suitable structural members do not exist.

1.4 Equipment
Installation

- .1 Follow the recommended installation details and procedures for all equipment as found in the supplier's technical data, supplemented by the shop drawings, the contract drawings and the specifications and the directions of the Departmental Representative.
- .2 Install mechanical work in advance of concrete pouring as necessary.
- .3 For equipment or material of the same type or classification, install only products of one manufacturer.
- .4 Install all equipment with adequate access for inspection and servicing.
- .5 Employ only skilled tradesmen properly licensed by the Province of Ontario, for all work requiring tradesmen with special skill.
- .6 Motors shall be aligned, shimmed and coupled to fit shafts, to the tolerances given by the manufacturer.
- .7 Set equipment in place and install piping, fittings, valves and other items. Make final adjustments in alignment and elevation before securely fastening equipment and

other items in place.

- .8 Control alignment so that excess forces are not imposed on equipment when piping connections are tightened.
- .9 Do not tighten pipes until grout is set.
- .10 Tighten so that there are no excessive stresses set up in flanges.
- .11 Unions or flanges: provide for ease of maintenance and disassembly.
- .12 Space for servicing, disassembly and removal of equipment and components: provide as recommended by manufacturer or as indicated.
- .13 Equipment drains: pipe to floor drains, or funnel floor/hub drains.
- .14 Install equipment, rectangular cleanouts and similar items parallel to or perpendicular to building lines.
- .15 Provide and install all necessary vibration control components.

1.5 Trial Usage

- .1 The Departmental Representative may use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing. Trial usage to apply to all systems.

1.6 Definitions

- .1 This definition shall apply to all sections and drawings of Division

44.

.1 "CONCEALED" - mechanical services and equipment in hung ceilings and non-accessible chases and furred spaces.

.2 "EXPOSED" - will mean "not concealed" as defined herein, e.g. Mechanical Rooms.

.3 "PROVIDE" - will mean supply, installation and connection.

.4 "T.S.S.A." shall mean "Technical Standards and Safety Authority".

.5 "Finished Areas" will mean areas with finish painted walls and will include Plant Areas and Mechanical Rooms.

.6 "E.S.A." shall mean Electrical Safety Authority.

1.7 Protection of
Openings

.1 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.

1.8 Electrical

.1 Electrical work provided under Division 44 is to conform to electrical specifications.

.2 Provide all controls, disconnects, magnetic starters, transformers, relays, wiring and panels for all motors and devices for packaged equipment as indicated in various specification sections of Division 44.

.3 Control panels provided as part of equipment supplied under Division 44 to be complete with barriered numbered terminal strip for interconnecting of conductors between master control panel and remote control panel and associated

equipment.

- .4 All process instrument devices shall be provided by Division 44 and wired by Division 26. All power and control wiring for process instrumentation shall be provided by Division 26, unless specified to be provided as part of packaged equipment or systems specified in Division 44.
- .5 Panels provided as part of packaged equipment to be complete with required components including but not limited to:
 - .1 One main fused switch of suitable current rating for the station load. Pad lockable in both open and closed positions. Mechanically panel interlocked door to prevent opening when handle is in "on" position.
- .6 Electrical equipment shall bear CSA labels and/or ULC approvals to comply with requirements of electrical utility. Conform to the requirements of the Canadian Electrical Code, Ontario Building Code, local, municipal and provincial authorities. Equipment not complying with above approvals shall have on site inspection by E.S.A., and the Contractor shall provide all necessary work to satisfy E.S.A. requirements in order to obtain approval. All associated fees, cost of material and labour shall be provided by the Contractor. All necessary application or documentation required shall be provided by the Contractor.

1.9 Motors

- .1 Provide motors for equipment as specified.
- .2 If delivery of specified motor will delay delivery or installation of any equipment, install motor approved by the Departmental Representative for temporary use. Final acceptance of equipment will not occur until specified motor is installed.
- .3 Motors under 1/2HP: speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120V, unless otherwise specified or indicated.
- .4 Motors 1/2HP and larger: EEMAC Class B, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 40°C, 3 phase, 575V, unless otherwise specified or indicated.
- .5 Motor efficiency shall be in accordance with CSA C390. Minimum efficiency to be 85%.
- .6 All motor used in conjunction with variable speed drives shall meet NEMA standard MG131 for use with inverter, and to be complete with insulated dry type bearings.

1.10 Belt Drives

- .1 Fit reinforced belts in sheave matched to drive. Multiple belts to be matched sets.
- .2 Use cast iron or steel sheaves secured to shafts with removable keys unless otherwise specified.

- .3 For motors under (7.5kW) 10HP:
standard adjustable pitch drive
sheaves, having plus or minus 10%
range. Use mid-position of range for
specified r/min.
- .4 For motors (7.5 kW) 10HP and over:
sheave with split tapered bushing
and keyway having fixed pitch unless
specifically required for item
concerned. Provide sheave of correct
size to suit balancing.
- .5 Minimum drive rating: 1.5 times
nameplate rating on motor. Keep
overhung loads within manufacturer's
design requirements on prime mover
shafts.
- .6 Motor slide rail adjustment plates
to allow for centre line adjustment.
- .7 Provide one complete set of spare
belts for every drive supplied under
this contract.

1.11 Guards

- .1 Provide guards for unprotected
drives.
- .2 Guards for belt drives:
 - .1 Expanded metal screen welded to
steel frame.
 - .2 Minimum 1.2mm thick sheet metal
tops and bottoms.
 - .3 38mm dia holes on both shaft
centres for insertion of
tachometer.
 - .4 Removable for servicing.
- .3 Provide means to permit lubrication
and use of test instruments with
guards in place.

- .4 Install belt guards to allow movement of motors for adjusting belt tension.
- .5 Guard for flexible coupling:
 - .1 "U" shaped, minimum 1.6mm thick galvanized mild steel.
 - .2 Securely fasten in place.
 - .3 Removable for servicing.
- .6 Unprotected fan inlets or outlets:
 - .1 Wire or expanded metal screen, galvanized, 19mm mesh.
 - .2 Net free area of guard: not less than 80% of fan openings.
 - .3 Securely fasten in place.
 - .4 Removable for servicing.
- .7 Guards to meet safety requirements of Federal and Provincial Ministry of Labour as well as, local authorities having jurisdiction.

1.12 Sleeves

- .1 Pipe sleeves: at points where pipes pass through masonry, concrete, fire rated assemblies, floors/grating, and as indicated.
- .2 Schedule 40 stainless steel pipe, type 304L.
- .3 Stainless steel (type 304L) sleeves with annular fin continuously (type 304L) welded at midpoint:
 - .1 Through foundation walls.
 - .2 Where sleeve extends above finished floor.
- .4 Sizes: maximum 6mm clearance all around, between sleeve and uninsulated pipe or between sleeve and insulation.
- .5 Terminate sleeves flush with surface

of concrete and masonry walls.
Terminate sleeves 100mm above
floors.

- .6 Fill voids around pipes:
 - .1 Caulk between sleeve and pipe in foundation walls and below grade floors with waterproof fire retardant non-hardening mastic.
 - .2 Where sleeves pass through walls or floors, provide space for firestopping. Where pipes/ducts pass through fire rated walls, floors and partitions, maintain fire rating integrity.
 - .3 Ensure no contact between copper tube or pipe and ferrous sleeve.
 - .4 Fill future-use sleeves with lime plaster or other easily removable filler.
 - .5 Coat exposed exterior surfaces of ferrous sleeves with heavy application of zinc rich paint to CGSB 1-GP-181M+Amdt.

- .7 This Division shall prepare sleeving drawings indicating the size and locations of openings required in concrete floor slabs, roof slabs/decks and walls for piping and equipment. In case of failure to provide information in time (i.e. before the concrete is poured) any extras incurred shall be at the expense of this Division.

- .8 Pipe sleeves at points where pipes pass through concrete walls into tanks to be modular mechanical type, complete with stainless steel wall sleeve, consisting of interlocking

synthetic rubber links shaped to continuously fill space between pipe and wall opening. The rubber sealing elements to expand and provide an absolute water tight seal between the pipe and wall opening. Standard of Acceptance to be Link Seal.

- .9 Coordinate all pipe sleeve locations with Division 03 04 05. Penetrations through structural walls/floors/etc. that compromise the integrity of the structure, shall be reinforced so that original design loads are maintained.

1.13 Preparation for Firestopping

- .1 Firestopping material and installation within annular space between pipes, ducts, insulation and adjacent fire separation: specified in Section 07 84 00 - Fire Stopping and Smoke Seals.
- .2 Uninsulated unheated pipes not subject to movement: no special preparation.
- .3 Uninsulated heated pipes subject to movement: wrap with non-combustible smooth material to permit to move without damaging firestopping material.
- .4 Insulated pipes and ducts: ensure integrity of insulation and vapour barrier at fire separation. Insulation material used to meet requirements of ULC listing of firestopping system.
- .5 Fire stopping devices, ULC listed, shall be used where combustible pipes pass through any separation.

1.14 Escutcheons

- .1 On pipes passing through walls, partitions, floors and ceilings in finished areas.
- .2 Type 302 stainless steel, one piece type with set screws.
- .3 Outside diameter to cover opening or sleeve.
- .4 Inside diameter to fit around finished pipe.
- .5 Do not use split-type escutcheon plates.
- .6 Secure to pipe on finished surface but not insulation.
- .7 Escutcheon must cover fire stop device if firestop device is visible within finished room.

1.15 Tests

- .1 Give 24h written notice of date for tests.
- .2 Insulate or conceal work only after testing and approval by the Departmental Representative.
- .3 Conduct tests in presence of the Departmental Representative or authority having jurisdiction.
- .4 Bear costs including retesting and making good.
- .5 Piping: test as specified in relevant sections.
- .6 Equipment: test as specified in relevant sections.

- .7 Prior to tests, isolate all equipment or other parts which are not designed to withstand test pressures or test medium.
- .8 Provide written confirmation for each test conducted.
- .9 Provide any equipment required to conduct tests.
- .10 Test water shall be potable water and should be from a municipal system that treats water with chlorination or some other appropriate means to kill bacteria.

1.16 Painting

- .1 To Section 44 01 46 - Field Painting.

1.17 Spare Parts

- .1 Furnish spare parts as specified in relevant sections.

1.18 Access Doors

- .1 Supply access doors to concealed equipment for operating, inspecting, adjusting and servicing.
- .2 Flush mounted 600 x 600mm for body entry and 300 x 300mm for hand entry unless otherwise noted. Doors to open 180°, have rounded safety corners, concealed hinges, screwdriver latches and anchor straps.
- .3 Material:
 - .1 Corrosive Atmosphere Areas: use stainless steel with brushed satin or polished finish as directed by Departmental Representative.
 - .2 Remaining areas: use prime coated steel.

- .4 Installation:
 - .1 Locate so that concealed items are accessible.
 - .2 Locate so that hand or body entry is achieved.
 - .3 Installation is specified in applicable sections.
- .5 Access doors must maintain fire rating if installed in a fire rated assembly.

1.19 Dielectric
Couplings

- .1 General:
 - .1 To be compatible with and to suit pressure rating of piping system.
 - .2 Where pipes of dissimilar metals are joined.
- .2 Pipes NPS 2 and under: isolating unions.
- .3 Pipes NPS 2% and over: isolating flanges.
- .4 Where dissimilar metals are joined or touch, install dielectric insulation. No dissimilar metals shall touch.

1.20 Drain Valves

- .1 Locate at low points and at section isolating valves unless otherwise specified.
- .2 Minimum NPS 3/4 unless otherwise specified with hose end male thread and complete with cap and chain.

1.21 Demonstration
and Operating and
Maintenance
Instructions

- .1 Refer to additional requirements of and Section - 01 90 00 commissioning.

1.22 Operation and
Maintenance Manual

- .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 80 00 - Operation and Maintenance Manual.

1.23 Shop Drawings
and Product Data

- .1 Submit shop drawings in accordance with the requirements of Section 01 33 00 - Submittals.

1.24 Cleaning

- .1 Clean interior and exterior of all systems including strainers.
- .2 In preparation for final acceptance, clean and refurbish all equipment and leave in operating condition including replacement of all filters in all air and piping systems.
- .3 Upon completion remove temporary protection. Remove stains and smudges from paint work.
- .4 During the course of construction, each - Subcontractor shall keep his work tidy and not allow an accumulation of debris resulting from his work.
- .5 Upon completion of this work he shall leave the premises in a broom clean condition.

1.25 As-built
Drawings

- .1 Site records:
 - .1 The Departmental Representative will provide the Contractor with two extra sets of white prints on which the Contractor shall clearly mark, as the job

progresses, all changes and deviations from that shown on contract drawings. This shall also include changes to existing systems, control systems and low voltage control wiring. After inspection and approval of service lines in trenches, the Contractor shall take as-built measurements, including all depths, prior to commencement of backfilling operations. It will not be sufficient to check off line locations. Definite measurements shall be taken for each service line. The location of buried piping shall be shown on the drawings and dimensioned from fixed points. Drawings shall be kept up-to-date during construction and in addition to field measurements shall include variation orders, field instructions and all other changes. On completion of the building, the Contractor shall forward to the Departmental Representative the two sets of drawings indicating all such changes and deviations for review by the Departmental Representative.

- .2 On a weekly basis, transfer information to reproducibles, revising reproducibles to show all work as actually installed.
- .3 Use different colour waterproof ink for each service.
- .4 Make available for reference purposes and inspection at all times.

- .2 As-built drawings:
 - .1 Refer to requirements specified in Section 01 33 00 - Submittals-
- .3 CAD As-builts
 - .1 Refer to requirements specified in Section 01 33 00 - Submittals.

1.26 Examination of
Site and Information

- .1 The Contractor, before tendering shall examine the site, the existing building construction and services, the Process, Architectural, Structural, Mechanical and Electrical drawings and he shall familiarize himself with the building construction and finish in order that his tender may include everything necessary for the proper completion of the work.
- .2 It shall be this Contractor's responsibility that material and equipment be brought into the building in such assemblies and sizes as to enter into the spaces where they are to be located and to be small enough to be hoisted into the building without difficulty. Any cutting, patching, etc. involved in getting large assemblies into place shall be the responsibility of this Contractor.
- .3 Immediately inform the Departmental Representative during Tender Period, in writing, of all discrepancies, errors, omissions, contradictions and ambiguities. The necessary Addendum or bulletin will be issued to all Bidders. Include a complete cross-checking of Drawing and

Specifications for sizes and quantities to correspond correctly. Data mentioned in the Specifications and not shown on Drawings, and vice-versa, must be interpreted as part of the Work.

- .4 The drawings and specifications are intended to describe complete working systems including all necessary labour and materials. Where items required to complete working system are not specified or showing on drawings, Contractor shall include costs at no additional expense to Departmental Representative.

1.27 Cutting and Remedial Work

- .1 Assume full responsibility for laying out work and for any damage caused by incorrectly located equipment and services.

1.28 Co-ordination

- .1 Locate distribution systems, equipment and materials to provide minimum interference and maximum useable space.
- .2 Where interference occurs, Departmental Representative shall approve relocation of equipment and materials.
- .3 This Contractor shall notify other Subcontractors who are concerned, of all openings, foundation work, hangers, inserts, anchors, or other provisions necessary in their work for the installation of this work and he shall furnish all information and necessary materials in ample time so that proper provisions can be made for same, and shall supply

and correctly and accurately place all inserts, sleeves, anchors, etc.

.4 Division 44 shall supply inserts, hangers, sleeves, anchors, etc. which must be placed within concrete forms to other subcontractors that are concerned. Division 44 shall inform responsible Contractor of locations. Where anchors are required to be drilled and placed, Division 44 shall be responsible for their supply and installation. Pipe hangers and supports listed in Section 44 14 00 and 44 01 45 shall be provided by Division 44.

.5 Excavation, trenching and backfilling required for the work of Division 44 shall be by Division 33. Division 44 shall coordinate the work of Division 33 for their required work. Division 44 shall be responsible for laying out excavation work and advising Division 33 Contractor of required grades.

1.29 Requirements
of Inspection
Departments

.1 All work shall be installed in accordance with all laws and regulations of all authorities having jurisdiction in each case, particularly all affected departments of the Municipality and Province. Electrical equipment supplied must conform to the regulations of CSA and the local utility. Anything necessary to make the work comply with these requirements shall be provided by this Contractor without additional cost to the Departmental Representative.

- .2 The Contractor shall prepare drawings in addition to Engineer's drawings as may be required by various Inspection Departments having jurisdiction, and obtain their approval before proceeding with the work.
- .3 In the event that the Inspection Department's request deviates from the Departmental Representative's layout, Contractor shall consult the Departmental Representative before proceeding with same.
- .4 Provide all inspection certificates prior to request for substantial completion. Include copy of inspection certificates in Operation and Maintenance Manuals.
- .5 All fittings, valves and components used in compressed air systems shall have Canadian Registration Number (CRN) and shall be registered as required for use in Ontario by the T.S.S.A. Anything necessary to make the work comply with these requirements shall be provided by this Contractor without additional costs to the Departmental Representative.
- .6 The Contractor shall coordinate all required inspections by T.S.S.A. and fill out all forms required by T.S.S.A. for the inspections. The Contractor shall pay for all inspection fees.

1.30 Drawings

- .1 The drawings shall be considered to

show the general character and scope of the work and not the exact details of the installation. The installation shall be complete with all accessories required for a complete and operative installation.

- .2 The drawings show the approximate location for the special apparatus and the materials throughout the building. The arrangement shown on the drawings is more or less diagrammatic and as such approximate only, and may be altered, as approved by the Departmental Representative, to meet the requirements of the apparatus, etc., and of the building. Each Subcontractor shall be held responsible for all measurements for his work throughout, and he shall arrange his piping, wiring and apparatus to conform to the Architectural and Structural details in a satisfactory manner and shall cooperate with other contractors to ensure that work shall meet all requirements of diverse Contracts.
- .3 The Contractor is particularly cautioned that small scale Engineer's plans must be supplemented by his own detail drawings where necessary for proper coordination of the work.
- .4 Items shown on the drawings but not specified or specified but not shown shall be included.
- .5 Items obviously required to provide a complete working system, but not specified nor shown shall be included.

- .6 In order to show more clearly the arrangement of the work, plans and sections do not show every valve, thermometer, pressure gauge or other system accessory. Refer to the standards details, piping and instrument diagrams and to the specifications to determine the requirements.
- .7 Certain details indicated on the drawings are general in nature and specific labelled detail references to each and every occurrence of use are not indicated, however, such details shall be applicable to every occurrence on the drawings.
- .8 All piping in finished areas with ceilings shall be concealed in ceiling spaces and shafts or chased into walls. No exposed piping or ductwork shall be installed in such areas unless specifically reviewed by the Departmental Representative. No piping shall be concealed in outside walls.
- .9 Equipment mounted on roof, or housing for such equipment, shall not be closer to the edge of roof than 1.83m, unless specifically reviewed by the Departmental Representative.
- .10 The actual location of switches, control devices, etc. shall be reviewed by the Departmental Representative before installation.
- .11 The location and size of existing services shown on the drawings are based on the best available

information. The actual location of existing services shall be verified in the field before work is commenced. Particular attention shall be paid to buried services.

- .12 Changes and modifications necessary to ensure co-ordination and to avoid interference and conflicts with other trades, or to accommodate existing conditions, shall be made at no extra cost to the Departmental Representative.
- .13 Leave areas clear of piping and ducts where space is indicated reserved for future equipment, and equipment for other trades.
- .14 Adequate space and provisions shall be left for removal of parts requiring regular maintenance and servicing of equipment, with minimum inconvenience to the operation of systems.
- .15 Where equipment is shown to be 'roughed-in only' obtain accurate information from the Departmental Representative before proceeding with the work.
- .16 Before fabricating piping for installation, make certain that such items can be installed as shown on the drawings without interfering with the structure or the work of all other trades. Any problems that cannot be solved in agreement with the other trades affected, shall be submitted for decision. If piping is prefabricated prior to the investigation and reaching of a

solution to possible interference problems, necessary changes in such prefabricated items shall be made at no extra cost to the Departmental Representative.

- .17 Off-sets in piping may not be indicated in all cases, but are to be included in the contract as required.

1.31 Installation,
Interference and
Setting Drawings

- .1 Installation, interference and setting drawings dimensioned and to scale, shall be submitted for review to the Departmental Representative, as may be required or requested by the Departmental Representative to make clear the work intended or to show its relation to adjacent work or to the work of other trades. When an alternative piece of equipment is to be substituted for equipment shown, drawings of the area involved shall be prepared by this division. Three copies of such drawings shall be submitted for review, of which one will be retained by the Departmental Representative.
- .2 Installation working drawings to 1:50 scale for each equipment room showing plan and sections of the plant, services, bases, curbs, drains, motor terminals, shall be prepared by this division.
- .3 Interference drawings are required for shafts, ceiling spaces and wherever there is possible conflict in the positioning of equipment, piping, ductwork subtrades or architectural features.
- .4 The design of the structural framing

of the equipment rooms and pipe spaces and major pipe run supports has been based on assumed loadings supplied during the design phase. Well ahead of the construction of the affected areas, prepare and submit drawings for review to the Departmental Representative showing the layout and weights of all finally selected equipment including details of concrete pads, concentrated pipe loads and point reactions of the equipment onto the structure. Structural design has been based on equipment listed by model number. Alternate equipment if permitted shall not exceed weight and dimensions of equipment listed without prior approval by Departmental Representative. If alternate equipment is not approved by Departmental Representative, Contractor shall supply equipment listed at no additional cost to Project. If alternate equipment is approved, Contractor shall provide all revisions necessary and pay all costs including engineering.

- .5 Pump capacities, control valve sizing, etc., have been based on equipment specified. Upon submission of shop drawings, Contractor shall review with Departmental Representative all design and equipment changes and where required to accommodate design or equipment changes Contractor shall engineer and revise equipment capacities as required. There shall be no extra cost to Departmental Representative for changes to equipment to accommodate changes discussed above. No installations shall proceed until

this coordination has been completed.

1.32 Use of Alternate Equipment .1

Drawings have been prepared only on the basis of the specified material, equipment or systems.

.2 The design, space allocation, orientation, piping, control systems, etc., are arranged to suit the material and equipment named in the text of the specifications or shown on the drawings. The contractor assumes all responsibility for adjustments or extension of the work of this or other Divisions necessary for the accommodation of material, equipment or systems other than that named in the specifications or shown on the drawings.

.3 Alternate or substitute equipment is only permitted when allowed as described in item 34, Conformance.

1.33 Energy Consumption

.1 Departmental Representative may reject equipment submitted for approval on basis of performance or energy consumed or demanded.

1.34 Conformance

.1 Materials specified by referenced standard, select any material that meets or exceeds the specified standard. Materials specified by referenced standard are identified by the term "Standard of Acceptance".

.2 Materials specified by "Prescriptive" or "Performance" specification, select any material meeting or exceeding specification.

- .3 When materials are specified by a Standard, Prescriptive or Performance specifications, upon request of the Departmental Representative, obtain from manufacturer an independent testing laboratory report showing that the material or equipment meets or exceeds the specified requirements.
- .4 Materials, equipment or systems specified by naming one or more materials, select any material, equipment or system named. Materials, equipment or systems specified in this manner are identified by the term "Standard of Acceptance". Where only one name appears in the specification, the tender shall include for the specified equipment. For the purpose of these specifications, the term "Acceptable Material" is deemed to be a complete and working commodity as described by a manufacturer's name, catalogue number, trade name or any combination thereof.
- .5 Manufacturers or subcontractors specified by naming one or more, select any one named. Where only one name appears in the specification, the tender shall include for the specified name.

1.35 Statement of
Prices

- .1 To form a basis for progress payments the successful bidder shall submit a statement of his estimated prices for the various portions of the work, including labour, materials and equipment shown separately. The total price of all

portions of the work shall equal the total price of the work covered under this division.

- .2 The successful bidder shall confer with the Departmental Representative to determine the breakdown of work for this contract.

1.36 Metric
Conversions

- .1 Particular care shall be taken with imperial versus S.I. metric conversions. This applies to all services including, but not limited to, equipment, pipes, ductwork and site services in both new and existing installations.
- .2 When covering from one form of measure to the other, do not round-off numbers.

1.37 Schedule

- .1 This Contractor shall provide a schedule outlining all aspects of the work in sufficient detail to track the progress of the work. Include all critical dates, including delivery to and return of shop drawings to Departmental Representative, inspection dates, dates for training and commissioning systems. Submit schedule to Departmental Representative for review at start of project.
- .2 Contractor shall review schedule on a regular basis and at each construction meeting. The Contractor shall provide additional workers as required to meet the schedule. Update schedule as required in conjunction with General Contractor and Departmental Representative.

1.38 Pipe Troughs

- .1 Avoid running piping above electrical, telephone and server rooms. If unavoidable provide pipe troughs beneath piping.
- .2 Provide galvanized steel troughs below all pipes or groups of pipes passing over electrical, telephone and server rooms.
- .3 Troughs to be fabricated from 1.0mm (20 ga.) galvanized steel, formed wide enough to catch drips from piping.
- .4 Troughs to be adequately supported and sloped for positive drainage. Provide low point drain and pipe to nearest funnel floor drain, hub drain or janitor sink.

1.39 Hoisting and Rigging

- .1 In accordance with the construction schedule provide and arrange for transportation, of all equipment and materials to site, and for the rigging, hoisting, storing and setting in place of equipment. Include for offloading. Obtain from suppliers all weights for equipment and provide Crane equipment of adequate capacity for hoisting. Protect all surfaces and structure during hoisting and rigging. Provide heavy metal plates to protect surfaces. Do not overload structure.

1.40 Workmanship and Qualifications of Workers

- .1 Perform the work in a neat and careful manner so that items are installed, and will remain, plumb, square and straight. Items not so installed will be rejected and redone at no extra cost to the Departmental Representative.

- .2 When required either by the specifications or manufacturer's instructions, have manufacturer or his accredited agent or the supplier supervise the work.
- .3 Provide qualified tradespeople to perform all the work. Provide a full time on site supervisor to supervise the work of Division 44. When requested of the Departmental Representative, the Contractor shall provide documentation demonstrating experience of tradespeople and supervisor. If tradesperson or supervisor does not have adequate experience or qualifications remove from site and provide suitable replacement. Provide resume of site supervisor to Departmental Representative prior to start of project. Departmental Representative has the right to reject or remove at any time any worker or site supervisory if in his opinion the individual does not possess the required experience or qualifications. When personnel has been removed or rejected provide suitable replacement.
- .4 No horseplay will be tolerated on site at any time. The Contractor shall be responsible for putting an immediate end to all horseplay.

1.41 Certificates,
Permits & Fees

- .1 The Contractor shall give all necessary notices, obtain all required permits, and pay all fees, in order that the work herein specified may be carried out, and he shall furnish any certificates

needed as evidence that the work installed conforms with the laws and regulations of the Municipality, Province, and the local utility.

- .2 The Contractor shall apply and pay for the registration of the compressed air piping with the T.S.S.A. The Contractor shall pay all T.S.S.A. registration fees.

1.42 Special Tools

- .1 Provide one set of special tools required to service equipment as recommended by manufacturers.

1.43 Inspection/
Takeover Procedures

- .1 Contractor's Inspection: The Contractor and all Subcontractors shall conduct an inspection of the Work, identify deficiencies and defects; repair as required. Notify the Departmental Representative in writing of satisfactory completion of the Contractor's Inspection and that corrections have been made. Request a Departmental Representative's Inspection.
- .2 Departmental Representative's Inspection: Departmental Representative and the Contractor will perform an inspection of the Work to identify obvious defects or deficiencies. The Contractor shall correct Work accordingly. If during the Departmental Representatives inspection it is obvious that the work is incomplete, the Departmental Representative will notify the Contractor without provision of a deficiency list and the Contractor shall complete and correct deficiencies as per item .1

- .3 Final Inspection: When the items noted above are complete, request a final inspection of the Work by the Departmental Representative. If Work is deemed incomplete by the Departmental Representative, complete the outstanding items and request a reinspection.
- .4 Declaration of Substantial Performance: When the Departmental Representative considers deficiencies and defects have been corrected and it appears requirements of the Contract have been substantially performed, make application for Certificate of Substantial Performance. All other requirements noted elsewhere shall be completed prior to request for Certificate of Substantial Completion.
- .5 Do not apply for substantial performance until:
 - .1 All systems are complete and operation.
 - .2 All systems have been commissioned and successfully past testing over the entire range of their operating capacities under automatic control. (Note: seasonal or environmental conditions resulting in the delay of some testing will be accommodated by issuance of conditional certificate).
 - .3 Commissioning and testing reports have been submitted for the Departmental Representative's review.
 - .4 Air and water balancing has been completed and reports have been submitted for the Departmental

Representative's review.

.5 "As-built" and/or record drawings have been prepared and submitted for the Departmental Representative's review.

.6 Operations and Maintenance Manuals have been prepared and submitted for the Departmental Representative's review.

.7 The Owner, operating and maintenance personnel have received training on all systems and equipment and the required certificate has been submitted to the Departmental Representative.

1.44 Existing
Systems

- .1 Connections into existing systems to be made at time approved by Departmental Representative. Request written approval of time when connections can be made. Include for any overtime and premium charges.
- .2 Be responsible for damage to existing plant by this work.
- .3 Where connections are made to existing services, existing insulation shall be made good under this division.

1.45 Schedule,
Access, Protection
and Clean-up

- .1 The construction schedule places restrictions on the duration of construction within areas and the duration of shut-down of equipment. Refer to the General Conditions and Phasing for all requirements.
- .2 Access to the site is limited to location and time of day. Access to areas of the building is limited to location and time of day. Refer to

the General Conditions for all requirements.

- .3 Refer to the security and protection requirements in the General Conditions, conform to all requirements. There shall be no smoking, and the site shall be kept clean at all times.

1.46 Abandoned Services

- .1 Within the work areas of the existing building unknown abandoned services may be encountered. Obtain clarification from the owner regarding these services and remove any sections of services from the work areas as directed.

1.47 Cutting and Patching

- .1 The cost of cutting, patching and finishing is not included in this divisions contract.
- .2 This division shall advise the trade responsible for cutting, in advance of the time required, of the location and extent of cutting required, and any other pertinent information.
- .3 This division shall advise the trade responsible for patching and finishing of any pertinent information such as, clearance requirements.
- .4 Refer also to item 28, Coordination and 12, Sleeves for other coordination requirements. It is the intent that in new construction all holes and openings are to be sleeved and that cutting and patching be limited.

- .5 In case of costs arising to correct work, due to failure to provide coordination information on time, incorrect sizes or locations or other incorrect pertinent information, shall not be extra to Departmental Representative.

1.48 Delivery
Handling and
Storage

- .1 Deliver materials to designated areas off the site working area.
- .2 Inspect fabricated material for damage in transit.
- .3 Replace materials found to be defective in manufacture or damaged in handling after delivery. Include furnishing of material and labour required for replacement of installed material found to be defective.
- .4 Load and unload materials so as to avoid shock or damage.
- .5 Handle pipe and fittings so that coatings and linings will not be damaged. Replace or repair to satisfaction of Departmental Representative damaged pipes or fittings.
- .6 Place materials in safe storage to satisfaction of Departmental Representative. Keep interiors of pipe, fittings, and other accessories clean. Store valves in a manner that will protect them from damage by freezing.

1.49 Cleaning &
Disinfection

- .1 The Contractor will internally clean and flush all piping to remove all large debris prior to disinfecting.

- .2 Provide necessary chemicals and equipment to clean and disinfect system (including piping, reservoir, tanks, equipment and accessories) to requirement of Ministry of Environment and as described in AWWA C651-05, C652-11 and C653-03. After testing, provide water quality test report.
- .3 The contractor shall internally clean and flush all existing and new reservoirs, tanks, piping and other equipment. This includes flushing of the existing watermains prior to commencing commissioning of the booster station.
- .4 Until the required bacteriological test results on samples taken are proved acceptable, do not connect these systems to the existing water supply.
- .5 Submit for review, prior to proceeding, a detailed description of the work procedure for disinfection of all lines, tanks and equipment prior to commencing any work.
- .6 Provide personnel protection for workers handling chemicals and provide temporary eye wash and safety showers as required.
- .7 Provide all disinfection chemicals required to complete the work.
- .8 Provide chemicals to neutralize chlorinated water prior to disposal. Dispose in an approved manner. The

maximum combined chlorine residual before disposal is 1 mg/L.

- .9 Leakage tests of reservoirs and tanks or pressure tests of piping shall occur prior to flushing and then disinfection. Upon completion of disinfection, drain and then refill for bacteriological testing.
- .10 Cleaning and Disinfection of Pipelines.
 - .1 Supply all materials, equipment and labour required to carry out the disinfection.
 - .2 Prior to disinfection, thoroughly clean pipelines by means of swabbing, hose streams, brushes or other means to remove all foreign material. Clean oil and grease with appropriate solvents. Use materials that will not impart taste and odour to potable water.
 - .3 Flush pipelines with potable water until a turbidity free water is obtained at all ends.
 - .4 Provide all couplings and shut-off valves necessary for flushing, draining and disinfecting pipelines and tanks.
- .11 Introduce chlorine and water at rates that produces chlorine concentration in the water throughout the length of pipe as required by AWWA C651-99.
- .12 Carry out final flushing by discharging the chlorinated water to either a suitable surface drain, a storm sewer or a sanitary sewer.
- .13 Discharge chlorinated water after reducing chlorine residual to no

greater than 1 mg/L. The Departmental Representative will review the methods employed for disposal of all chlorinated water.

- .14 Fill the pipelines with potable water and allow to stand for 24 hours. Samples will be obtained by the Departmental Representative for bacteriological tests.
- .15 The Departmental Representative will take samples and test for chlorine residual. If the result is satisfactory, the Departmental Representative will notify the Contractor to drain the pipe for the next procedure.
- .16 If there is any indication of contamination, repeat flushing and disinfection, or take other measures that the Departmental Representative considers appropriate, all at the contractor's expense. The disinfection is considered acceptable when the coliform counts meet the requirements in the AWWA Standard and Ontario Drinking Water Objectives.

1. GENERAL

1.1 SCOPE

- .1 This standard defines materials and insulation methods to be used for insulating piping in cold service.
- .2 Jacket material shall be aluminum, unless otherwise noted.
- .3 This section does not apply to all service water piping. All service water piping (both cold and hot) shall be insulated in accordance with Section 20 07 13 - Thermal Insulation for Piping.

1.2 GENERAL REQUIREMENTS

- .1 Contractors shall submit with their proposals information on intended practices and application methods specifically not covered in this specification. The following are typical items and details that shall be included, where applicable:
 - a. Removable insulation housing.
 - b. Additional insulation supports.
 - c. Expansion joints in insulation.
- .2 Insulation shall be new and undamaged, dry, free of foreign contaminants and delivered to the site in unopened factory-sealed cartons. Contractor shall ensure that all materials are protected from damage.
- .3 Unless otherwise specified on drawings or in this standard, all insulation materials, accessories and finishes shall be applied in accordance with the manufacturer's currently-published recommendations and instructions.
- .4 Insulators shall be experienced and use the Thermal Insulation Association of Canada Standards where not covered by this specification, purchase documents and manufacturer's recommendations.

- .5 Threaded fittings or connections are to be insulated before straight pipe sections are covered. Flange shall be covered after pipe is covered.
- .6 Insulation materials must be protected from the weather at all times. Each day's work shall be weatherproofed before being left for the night. Insulation that becomes wet or damaged during application must be removed and replaced at Contractor's expense.
- .7 Prefomed elbows shall be used instead of mitered pieces, unless specifically approved by Departmental Representative.

1.3 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with the Section 44 00 10 - Process General Requirements and Section 01 33 00.
- .2 Submit for approval manufacturer's catalogue literature related to installation fabrication for pipe, fittings, valves and jointing recommendations.

 2. MATERIALS

2.1 ALUMINUM JACKETS

.1 Aluminum jackets shall be as follows:

Aluminum Jacket	Use
Alloy 3003, or 3105 0.4mm thickness with moisture barrier (laminated polyethylene and 40#, min., virgin kraft paper) on inside, smooth finish, weatherproof "z" type longitudinal joint.	Jacketing for straight pipe up to 600mm O.D.
Alloy 3003, 0.5mm thickness, with 50mm minimum straight end section for overlapping adjacent jacketing and with moisture barrier (laminated polyethylene and 40#. Min., virgin kraft paper) on inside.	Elbows and Fittings
Alloy 1100, 0.5mm minimum thickness with "extension" (to weatherproof complete flange assembly area), with 50mm minimum straight end sections for overlapping adjacent jacketing and with moisture barrier (laminated polyethylene and kraft paper) on inside.	Flanges and Valves
Preformed Aluminum seal strap 40mm minimum width and 0.4mm minimum thickness.	Sealing of Circumferential joints

2.2 MISCELLANEOUS MATERIAL

.1 Miscellaneous materials used shall be as follows:

Miscellaneous Material	Use
Aluminum Flashing Alloy 3003	Sealing openings for nozzles
Emulsion Mastic	Coating and sealer per insulation manufacturer's recommendation.
Wing Seals, 8mm Minimum of 9.5mm minimum width Type 302 or 304.	Tightening Bands

2.3 BAND MATERIAL

.1 Band materials shall be as follows:

Band Material	
Type 302 or 304 stain less steel 9.5mm ⁽¹⁾ min. width and 0.4mm min. thickness.	Securing single or outer layer of insulation.
NOTE (1): For final outer diameters of 300mm and larger use 12mm min. width.	

2.4 THERMAL INSULATION

.1 The material shall be foamed resin combined with elastomers to produce a flexible cellular material.

.2 Thermal Conductivity

Mean temperature, °C	Maximum Conductivity BTU-in/Ft ² -F-hr
24	0.27
32	0.276

.3 Water absorption: 5% by weight

.4 Water vapour Permeability: 0.1 perm/in.

.5 Flame Spread Rate 25 or less (per ASTM E84 and CAN/ULC - S102 "Surface Burning Characteristics of Building Materials and Assemblies")

.6 Smoke Development 50 or less (per ASTM E84 and CAN/ULC - S102 "Surface Burning Characteristics of Building Materials and Assemblies")

.7 Thickness: As indicated on piping and instrument drawings.

2.5 FLASHING COMPOUND

.1 Non-shrink, permanently flexible, for applications with insulation systems.

- .2 Service temperature range: -73°C to 149°C.
- .3 Average non-volatile: 97% by weight.
- .4 Color: gray.

3. EXECUTION

3.1 PREPARATION

- .1 Contractor shall apply the insulation only after the piping system has been inspected and tested to the satisfaction of the Departmental Representative, and approval to proceed has been given.
- .2 Contractor shall wipe or brush clean all surfaces of dirt, dust, grease, etc. Surfaces must be dry when insulation installation starts and remain so during installation.
- .3 Insulation materials must be protected from the weather at all times. Each day's work shall be weatherproofed before being left for the night. Insulation that becomes wet or damaged during application must be removed and replaced.

3.2 INSTALLATION

- .1 Insulation shall be dry and free of foreign matter when installed.
- .2 The Contractor shall furnish and install all supports and anchorage, beyond those shown on the drawings and not provided by others, that may be required to adequately support the insulation. Permission for welding of clips, studs or other insulation supports must be obtained prior to welding. Only qualified welders using qualified welding procedures shall be used. Attachments shall conform to the applicable piping code, specifications and contract drawings. Departmental Representative shall be notified prior to installation of additional support elements.

- .3 Insulation shall be installed so as to fit snugly against the piping.
- .4 Where single layer insulation is used, the insulation will be applied with butt joints staggered and all joints tightly butted and coated with joint sealer. A finish shall then be applied in a manner specified in this standard. For factory-applied jacketing, lap edges shall be sealed per manufacturer's recommendations
- .5 On multiple-layer insulation, the additional layer or layers shall be applied with side and end joints staggered over joints of preceding layer.
- .6 Only the joints of the outer layers of multiple-layer applications shall be coated with specified joint sealer before installation. The joints shall be drawn together when inner insulation layers are applied so that only a very thin vapor seal separates the sections of insulation.
- .7 Insulation shall be applied with all joints fitted to eliminate voids. Large voids 5mm and larger shall not be filled with coating, but eliminated by refitting or replacing insulation.
- .8 Install vapor stops at locations as shown on the detail drawings.
- .9 Each layer of pipe insulation shall be secured in place with stainless steel bands spaced on 229mm centers (except for insulation having outside diameters of less than 300mm, which shall have bands spaced at 150mm centers).
- .10 The bands shall be tightened with a mechanical tightening tool and secured with steel wing seals.
- .11 Contraction joints shall be installed in both horizontal and vertical straight run piping when the differential contraction between the pipe and insulating material exceeds 9.6mm per 30m of run.
 - .1 Joints shall be loosely filled with cushioning material.

- .2 Contraction should be provided by and in the flanged cover of flanged joints when they occur in the line.
- .12 Insulation on fittings shall consist of prefabricated fitting covers of the material and thickness specified.
- .1 Fitting covers shall be applied in the same manner as pipe insulation. Insulation straps shall be so located that maximum strength and securement shall be obtained. Fitting fillers are not necessary, provided all joints are properly sealed.
 - .2 Protruding metal parts shall be thoroughly sealed.
 - .3 Piping is to be supported per drawing details. Piping supported on shoes or resting on structural members shall be insulated at the support, but shall have a vapor stop on either side of the support. The stop shall be similar to the detail drawings and shall end 50mm on either side of the support.
 - .4 Outer surface of fitting covers shall be reinforced and finished in the same manner as specified for pipe insulation. Care shall be exercised that reinforcing cloth overlaps connecting pipe insulation a distance of not less than 150mm.
- .13 On horizontal piping, the jacket and insulation longitudinal joints shall be located on the side of the pipe - and in weather-wise position. Joints between mitered pieces, where approved by Departmental Representative, shall be sealed with a weatherproof sealing compound secured with preformed bands and clips.
- .14 Finish
- .1 Aluminum jackets shall be used, unless otherwise noted.
 - .2 Joints shall be staggered (a minimum of 75mm) with respect to insulation joints. Joints on horizontal lines shall be at 3 or 9 o'clock position.
 - .3 Longitudinal joints on outdoor insulation shall be

located away from the worst prevailing weather conditions. All lapped joints shall be assembled so as to shed water.

- .4 The closures for all exposed wires and bands shall be located so as to reduce the possibility of injury to personnel - specifically, closure on pipe which is adjacent to ground or walkway level, shall be on bottom or side away from the traffic.
- .5 Field-applied jackets with continuous longitudinal friction-type joints, and sealing strips and bands for circumferential joints shall be applied per the manufacturer's instructions. Additional bands shall be installed to secure the jackets on a maximum of 229mm centers.
- .6 Field-applied jackets cut from rolls (or with sharp longitudinal edges) shall have the longitudinal edge given a 12mm inch fold to conceal the cut edge. They shall fit tightly to the insulation with a minimum 50mm longitudinal lap sealed with weatherproof flashing compound. Circumferential joints shall be lapped a minimum of 75mm, sealed with weatherproof flashing compound, and secured with bands per paragraph 2.3. Additional bands shall be installed to secure the jackets on a maximum of 229mm centers. All other cutouts shall have the sharp edges rolled over to conceal the cut edge.
- .7 On vertical piping, 300 series stainless steel Z clips (maximum spacing of 600mm) shall be used on successive jackets.

- .15 Prior to requesting acceptance of the work, the Contractor shall inspect the completed installation to ensure that there are no open punctures, cracks, abraded areas, or areas where both sides of metal laps are not in contact ("fishmouths"). The areas in which these are found shall be refinished per the prescribed finish procedures. Small "fishmouths" may be closed with self-tapping screws.
- .16 Z-clips, J-clips and bond seals shall be formed such

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INSTALLATION OF
THERMAL INSULATION
ON COLD PROCESS
PIPING

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that the raw edge of the metal is folded inside such
that edges will not present a cutting hazard to
personnel.

PART 1 - GENERAL

1.1 References

- .1 CGSB 1-GP-60M-78, Enamel, Interior, Gloss, Alkyd Type.
- .2 References shall be the latest update version.
- .3 Standard for pipe identification in Water and Wastewater Treatment Plants, MOE, 1989.

1.2 Samples

- .1 Submit samples in accordance with Section 01 33 00 - Submittals.
- .2 Submit samples and lists of proposed wording for approval before engraving for the following:
 - .1 Nameplates.
 - .2 Pipe markers.
 - .3 Valve tags.

1.3 Product Data

- .1 Submit product data in accordance with Section 44 00 10 and 01 33 00.

PART 2 - PRODUCTS

2.1 Manufacturers Nameplates

- .1 Provide metal nameplate on each piece of equipment, mechanically fastened complete with raised or recessed letters.
- .2 Indicate size, equipment model, manufacturer's name, serial number, voltage, cycle, phase and power of motors.

2.2 System Nameplates

- .1 Colour:
 - .1 Hazardous: red letters, white background.
 - .2 Elsewhere: black letters, white background (except where required otherwise by applicable codes).

- .2 Construction:
.1 3 mm thick, laminated plastic or white anodized aluminum, matte finish, square corners, letters accurately aligned and machine engraved into core.

- .3 Sizes:
.1 Conform to following table:

Size #	Dimensions (mm x mm)	No. of Lines	Letter Height (mm)
1	10 x 50	1	3
2	13 x 75	1	5
3	13 x 75	2	3
4	20 x 100	1	8
5	20 x 200	1	8
6	20 x 100	2	5
7	25 x 125	1	12
8	25 x 125	2	8
9	35 x 200	1	20

- .2 Use average of 25 letters/numbers (maximum) per nameplate.
.3 Use size #6 for terminal cabinets and control panels.
.4 Use size #9 for equipment in equipment rooms.
.5 Use size #9 for tanks.

2.3 Piping

- .1 General:
.1 To CGSB 24-GP-3a.
.2 Identify medium by lettered legend, classification by primary and secondary colours, direction of flow by arrows.
.3 Complete painting of all ferrous piping, valves and fittings plus labelling every 3m meters.
.4 Non-ferrous materials will be colour banded maximum every 3 meters rather than completely

painted.

.2 Sizes:

.1 Legend: block capitals to following table:

Outside Dia. of Pipe or Insulation mm	Size of Letters mm
30	13
50	19
150	32
250	63
Over 250	88

.2 Primary colour bands:

.1 At valves and fittings: 500 mm long.

.2 Elsewhere: 1000 mm long.

.3 Secondary colour bands: 50 mm wide, 75 mm in from one end of primary colour band.

.4 Arrows:

.1 Outside diameter of pipe/insulation 75 mm and greater: 150 mm long x 50 mm high.

.2 Outside diameter of pipe/insulation less than 75 mm: 100 mm long x 50 mm high.

.3 Use double headed arrows where flow is reversible.

.3 Material:

.1 Paint: to CGSB 1-GP-60M.

.2 Legend markers, arrow colour bands: plastic coated cloth material with protective overcoating and waterproof contact adhesive undercoating, suitable for 100% RH and continuous operating temperature of 150°C and intermittent temperature of 200°C. Apply to

prepared surfaces. Wrap tape around pipe or pipe covering with ends overlapping one (1) pipe diameter.

- .3 Waterproof and heat resistant plastic marker tags: for pipes and tubing 20 mm nominal and smaller.

.4 Colours:

- .1 Where not covered by table below, submit legend colours to Departmental Representative for approval. Entire system to be painted with prime colour except stainless steel where bands shall be applied for primary and secondary colours.

- .5 Background colour marking and legends for piping systems:

<u>LEGEND MARKINGS</u>	<u>BACKGROUND COLOUR</u>
Drain Piping And Valves	Grey With Black Handwheels
Potable Water Piping And Valves	Blue With Red Hand Wheels
Sodium Hypochlorite Solution	Yellow

2.4 Valves and
Controllers

- .1 Brass tags with 12 mm lettering and numbers.
- .2 Furnish Departmental Representative with six identification flow diagrams of approved size for each system. Include valve tag schedule, designating number, service, function and location of each tagged item and normal operating position of valves.

2.5 Controls
Identification

- .1 Identify all systems, equipment, components, controls and sensors.
- .2 Inscription to identify function and, (where applicable) fail-safe position.

2.6 Equipment

- .1 Provide equipment nameplates for each piece of equipment.
- .2 Equipment nameplates shall contain lettering 100mm high and be mounted on equipment in a location visible from normal passage/approach.

PART 3 - EXECUTION

3.1 General

- .1 Do identification work in accordance with CGSB 24-GP-3a except where specified otherwise.
- .2 Provide ULC and or CSA registration plates, as required by respective agency.
- .3 Provide identification only after all painting has been completed.

3.2 Location of
Nameplates

- .1 In conspicuous location to facilitate easy reading from operating floor and to properly identify equipment and/or system.
- .2 Provide stand-offs for nameplates on hot surfaces and insulated surfaces.
- .3 Do not insulate or paint over plates.

3.3 Piping

- .1 Locations:
 - .1 On long straight runs in open areas.
 - .2 Adjacent to all changes in direction, exceeding 3m.
 - .3 At least once in each small room

- through which piping passes.
- .4 On both sides of visual obstruction or where run is difficult to follow.
 - .5 On both sides of any separation such as walls, floors and partitions.
 - .6 Where piping is concealed in pipe chase, ceiling space, or other confined space, at entry and leaving points and adjacent to each access opening.
 - .7 At beginning and end points of each run and at each piece of equipment in run.
 - .8 At point immediately upstream of major manually operated or automatically controlled valves. Where this is not possible, place identification as close to valve as possible, preferably on upstream side.
 - .9 Legend to be easily and accurately readable from usual operating areas and all readily accessible points.
 - .10 Plane of legend to be approximately at right angles to most convenient line of sight with consideration of operating positions, lighting conditions, reduced visibility of colour or legends caused by dust and dirt and risk of physical damage.
- .2 Application:
- .1 Complete painting of all ferrous piping, valves and fittings plus labelling every linear 3 metres maximum identifying the contents and the direction of flow (comply with Occupational Health and Safety Act (OHSA) 66(1)(a), (b)

-
- and (c);
- .2 For all non-ferrous material, piping will be colour banded every linear 3 metres maximum rather than completely painted.
- 3.4 Valves and Controllers
- .1 Secure tags with non-ferrous chains or closed "S" hooks for valves and operating controllers at plain sight of equipment they serve.
- .2 Install one copy of flow diagram and valve schedule mounted in frame with non-glare glass where directed by Departmental Representative. Provide one copy in each operating and maintenance instruction manual.
- .3 Consecutively number valves in system.

1. GENERAL

1.1 SCOPE

- .1 This specification covers hydrostatic testing and pneumatic testing of piping after erection and prior to initial operation.
- .2 References
 - .1 All references to codes and standards shall be to the latest edition of the following including addenda, etc...
 - .1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME) B31.1 - Power Piping and B31.3 Process Piping.
 - .3 Applicable codes including ANSI/ASME B31.1, B31.3, and standards shall apply. All references to codes and standards shall be to the latest issue of the same.
 - .4 In the event repairs or additions are made following the pressure tests, the affected piping shall be retested, using the test procedures applied to the original system.
 - .5 All piping shall be hydrostatic tested.
 - .6 All piping shall be tested as required by the T.S.S.A.
 - .7 Acceptance of system under test shall follow Section 44 01 28, "Piping System Acceptance".

1.2 RESPONSIBILITY AND RECORDS

- .1 Construction Contractor shall be responsible for all testing. Contractor shall see that all required tests are made in accordance with this specification and shall arrange for tests to be witnessed by Departmental Representative.
- .2 The Contractor shall see that adequate records are maintained. These shall include test pressure, temperature, duration, date and time of day test fluid,

and signatures of Departmental Representative's and Contractor's representatives who witnessed the test, identification of piping system tested. Contractor shall provide a test plan and schedule to Departmental Representative at start of work. The format of these records shall be approved by the Departmental Representative before field pressure testing begins.

- .3 It shall be the responsibility of the Contractor, in accordance with the Departmental Representative's instructions, to ensure that no equipment or piping is subjected to a higher pressure than indicated in the test requirement documents furnished by the Departmental Representative.
- .4 Test procedures shall be reviewed with Departmental Representative as part of the normal safety review.

2. MATERIALS

Not Applicable.

3. EXECUTION

3.1 PREPARATION FOR TESTING

- .1 Piping that is not to be tested shall be isolated. If isolation is impractical, the test conditions shall be determined by agreement with Departmental Representative's representative.
- .2 Lines (not intended to carry liquids) which are spring or counterweight supported shall be temporarily blocked up if hydrostatic tested, in order to sustain the weight of test fluid. Blocks shall be removed immediately after the system is drained.
- .3 All valves within the system to be tested, except as described in Paragraphs 3.1.4, and 3.1.6, shall be in an open position.
- .4 Shut-off valves in instrument lead lines from process lines and equipment shall be closed and instruments disconnected.

- .5 All dirt, debris or loose foreign materials shall be removed by flushing from piping prior to hydrostatic testing.
- .6 Relief valves and safety valves shall be blanked off at the inlet flange of the valves. Screwed relief and safety valves shall be removed and replaced with plugs or caps.
- .7 All flanges, threaded joints and field welds shall be left bare of insulation and free of all visual obstructions. All underground pipe joints, except those encased in concrete anchors, if any, shall be left exposed. Underground lines shall be adequately shored to prevent pull-out of joints.
- .8 The Contractor shall supply all materials (blanks, plugs, vents, gaskets and drain valves) necessary for testing. Blank flanges, blank plates, etc., shall be selected to withstand the test pressure. After tests the materials shall remain the property of Contractor, except drain valves which shall remain in place.
- .9 Blank flanges, blank plates, etc., shall have handles painted a bright color to make them readily identifiable for removal prior to start-up operations.
- .10 After testing is completed, piping shall be blown out with plant air to remove all debris.
- .11 All welded attachments (such as pipe supports and hangers) shall be made before testing.
- .12 Piping and equipment shall be thoroughly vented of air before the final hydrostatic test pressure is applied. Vent connections shall be located at high points of system.
- .13 Insulation is not to be applied over any joints in the piping prior to completion of test.
- .14 All instrument floats not rated for the test pressure shall be removed before hydrostatic testing.
- .15 Control valves not resistant to the test pressure shall be removed from the piping system prior to test.
- .16 Expansion joints shall be provided with restraints to withstand the added pressure load under test, or shall be removed or isolated from the test.

- .17 Precautions shall be taken by opening vents or by other means to prevent building up excessive pressure in equipment adjacent to portions of the piping under tests.
- .18 Restrictions to flow, such as orifice plates and mixing nozzles, shall not be installed or shall be removed. Where necessary, items removed shall be replaced with temporary spool pieces provided by Contractor.
- .19 Lines containing check valves shall have the source of pressure on the upstream side of the valve. If this is impossible, the check valve shall be blanked off or removed.
- .20 If the test fluid in the system is subject to thermal expansion, precautions shall be taken to avoid excessive pressure.
- .21 All pipe runs and interconnecting branch lines subject to the same test conditions, shall preferably be tested at the same time. Equipment shall be isolated from testing unless authorized by the Departmental Representative.

3.2 HYDROSTATIC TEST PRESSURE

- .1 The hydrostatic test pressure shall meet the ASME/ANSI B31.1 Piping Code Requirements for compressed air systems. Other piping systems hydrostatic test pressures shall be in accordance with ASME B31.3 for Normal Fluid Service.
- .2 Generally, the hydrostatic test pressure shall be determined within the following guidelines:
 - .1 1% times the pressure class of the piping and flanges (i.e. 1034KPa system - test pressure = 1550KPa).
 - .2 Non metallic piping shall be tested as required by ASME B31.3 but within manufacturer's limitations.

3.3 ALTERNATE TESTS

- .1 When pressure testing is not feasible, (examples are large diameter lines not designed to withstand the weight of the water and refractory lined piping) an alternative test may be considered with the approval of the Owner. The alternatives are as follows:

- .1 A combination of 100% radiography plus liquid penetrant examination plus a sensitive leak test.
- .2 A combination of 100% radiography plus magnetic particle examination plus a sensitive leak test.

3.4 TEST PROCEDURE

- .1 All testing must be scheduled and coordinated with Departmental Representative.
- .2 Hydrostatic pressure shall be applied by means of a suitable test pump which shall not be connected to the pipe line until ready to test. An approved operator shall constantly attend the pump whenever it is connected to the pipe line. The pump shall be disconnected whenever the pump operator or the inspector leaves the pump or test site for any reason.
- .3 The pump shall be disconnected or suitable block and bleed valves operated during the period the test pressure is being held.
- .4 At least two indicating test gages shall be provided, one on the pump or air source and one on the piping to be tested. The gages are to be checked frequently against a "standard" gage or dead weight tester and should read between 1% times (min) to 3 times (max) the test pressure.
- .5 The piping under test shall be held at full test pressure for at least % hour without leaks.
- .6 Clean water shall be used as the testing medium when hydrostatic testing materials other than stainless steel. Other liquids may be used when necessary and upon approval by Owner.
- .7 Hydrostatic testing of austenitic stainless steel shall be performed using potable water. Test water in stainless steel piping shall be immediately drained after test and all residual water removed.
- .8 When water is used in cold weather, it shall be heated or protected by inhibited antifreeze to avoid freezing. Water temperature during testing shall be a minimum of 15.5°C. Prior approval shall be obtained from the Departmental Representative for the use of antifreeze.
- .9 Retesting of lines after repair shall be done at pressures

originally specified for the test.

- .10 Underground pressure lines shall be tested before backfilling.
- .11 Instruments shall be tested in accordance with the recommendations of Departmental Representative's Instrument Engineer.

3.5 DRAINING AFTER HYDROSTATIC TESTING

- .1 All lines shall be drained after the hydrostatic test.
- .2 After pump suction and discharge lines have been drained, the piping shall be reassembled. It is imperative that a temporary strainer be installed in the pump suction at this time.

3.6 FINAL PROCEDURES AFTER PRESSURE TESTING

- .1 Replace all control valves and check valve action for proper direction.
- .2 Remove all temporary blocks from spring or counter-weight supported pipelines.
- .3 Replace all orifice plates and mixing nozzles, and other in-line instrumentation.
- .4 Connect all instruments removed for the testing operation.
- .5 Remove all temporary blanks and blinds.
- .6 Use all new gaskets when replacing control valves, orifice plates, blanks, blinds, etc.
- .7 Valves which were closed for pressure testing and/or draining shall be returned to the proper position.
- .8 Temporary piping supports shall be removed.
- .9 Replace all relief valves and safety valves.
- .10 Remove any restraints that may have been provided for expansion joints.
- .11 Disconnect test equipment, test pump, test gages and test safety valves.

1. GENERAL

1.1 SCOPE

- .1 This specification defines the requirements for testing and acceptance of construction of piping systems.

1.2 PURPOSE

- .1 A procedure for inspecting, testing and accepting completed process, utility, and other miscellaneous piping systems after installation by a construction Contractor.
- .2 The procedure develops the essential features based on the three phases of a testing program, namely:
 - 1. Pretest requirements
 - 2. Test requirements
 - 3. Post-test requirements
- .3 An organization routing from inception to acceptance is also described.

1.3 APPLICABLE SPECIFICATION SECTIONS

- .1 This procedure is to be used with the following specification sections which establish the design criteria for the tests.
Section 44 40 00 - Process Piping

2. MATERIALS

Not Applicable

3. EXECUTION

3.1 PIPING TESTING PROCEDURE

- .1 The focal point is the pipe test package, which is an accumulation of information about the pipeline system to be tested. For each test made, there is a particular package describing, through drawings and specifications, what is required to make that piping system complete. The pipe test package is separated into three phases, defined as follows:

Pretest - Pipeline system completed to the point that is physically ready for a test and that each component in the system can withstand the potentially greater than normal weights and pressures of the test. All radiographic examinations are complete and documented.

Test - The piping system is filled with test media, pressurized, tested to specific requirements and witnessed.

Post-Test - Test blinds and test medium have been removed and all items have been installed. The piping is now ready for precommissioning.

The exceptions to this system are "in-service" tests where the basic elements of this total procedure are followed, except that the proposed pressure test is deferred until after the service has been turned on.

3.2 DOCUMENTATION

- .1 Pipe inspection, testing and acceptance require the preparation of a master testing plan for the systems. Piping test numbers are assigned and these documents are cross referenced to insure that all pipe lines to be constructed are included within the pipe test master plan.
- .2 The Contractor shall assemble individual test packages containing:
- .1P&ID - P&ID highlights the pipelines to be included in the test system and establishes the in-line devices, line and equipment isolation that must be accomplished

prior to the initiation of the test.

- .2 Piping Inspection and Acceptance Record - This form provides the pipe test descriptions. Sign-off locations are provided for pre-test inspection approval, hydrotest witness and post test acceptance.
- .3 Inspection Punch list Sheet - Used to highlight incomplete and/or incorrect installation found during inspection. Same sheet is used for sign-off of the inspection punch list after completion.
- .3 Upon completion of the Piping Systems Acceptance Package, the Contractor shall prepare a progress tracking system based on the number of packages and the status of inspection, testing and acceptance.

3.3 ORGANIZATIONAL RESPONSIBILITIES

- .1 The piping test package must be routed through the organizations involved with construction and operation of the piping systems. Any change or deficiency found during the pipe test and inspection process is best located and identified as soon as possible. Then the change or deficiency can be corrected without an additional and costly hydrostatic test.
- .2 The following outline shows the flow of the test package throughout the construction organization.
 - .1 Pre-Test
 - a. Contractor prepares pipeline master testing plan.
 - b. Contractor assembles test packages.
 - c. Inspection by Contractor and sign-off of pre-test mechanical inspection or preparation of a punchlist list and correction before submitting to Departmental Representative.
 - .2 Engineer Inspection Activities
 - a. Inspection by Engineer's Construction & Operations Group(s) and preparation of a punchlist.
 - b. Engineer's Construction Group identifies punchlist items requiring completion prior to

- test. Returns punctilist list to Contractor. Contractor completes critical punch list items and returns to Engineer's Construction Group.
- c. Engineer's Construction Group then checks that all punchlist items have been completed prior to signing the approval for test.
- .3 Contractor Activities
- a. Works off punchlist list items and resubmits to Engineer for approval for hydrotest.
- b. Prepares for test.
- .4 Test
- .1 Contractor Activities
- a. Fills system to be tested with water or other test medium as noted on line list.
- b. Applies test procedure according to line list or as amended by Engineer's Construction Group.
- c. Tightens lines as needed.
- d. Holds pressure for at least one-half hour before calling Departmental Representative to witness.
- .5 Engineer's Construction Activities
- a. Witness hydrotest.
- b. Sign-off test inspection portion of Piping Inspection and acceptance Record.
- .6 Contractor Activities (when applicable)
- a. Route copy of signed test package to mechanical, electrical, instrumentation, insulation and painting Contractors as a signal that pipeline system is now cleared for other work to proceed; i.e., final alignment of pumps, prime painting of welds, topcoating coating of insulated and uninsulated lines.
- .3 Post-Test
- .1 Contractor Activities
- a. Vent lines
Remove blinds
Plug vents and drains
Replace instruments and specialty items

Remove temporary supports

Check off and sign post-test check list

- b. Rechecks the pipeline system to be sure line is mechanically complete.

.2 Engineer's Construction Activities

- a. Engineer's Construction Group shall reinspect the pipeline system to make sure that all elements are complete except for heat tracing and insulation.
- b. Engineer's Construction Group then submits a post-test punchlist list or signs-off as complete and accepted.

.4 Final Disposition

.1 Contractor Activities

- a. The Contractor transmits test packages to Engineer's Construction Group after each package is accepted by Departmental Representative.
- b. Punchlist list items preventing completion of a test package due to material deliveries are considered complete if those punchlist list items are transferred to the master project punchlist list.

PART 1 - GENERAL

1.1 Codes and
References

- .1 Perform work and material to be in accordance with the following:
 - .1 ANSI/ASME B31.1, Power Piping, (SI Edition).
 - .2 MSS-SP-58, Pipe Hangers and Supports - Materials, Design and Manufacturer.
 - .3 MSS-SP-69, Pipe Hangers and Supports - Erection and Application.

1.2 Shop Drawings
and Product Data

- .1 Submit shop drawings and product data in accordance with Section 44 00 10 - Process General Requirements and Section 01 33 00.
- .2 Submit shop drawings and product data for following items:
 - .1 Upper attachment.
 - .2 Middle attachment.
 - .3 Pipe attachment.
 - .4 Riser clamps.
 - .5 Shields and saddles.

1.3 Maintenance
Data

- .1 Provide maintenance data for incorporation into manual specified in Section 44 00 10.

1.4 Design
Requirements

- .1 Construct pipe hanger and support to manufacturer's recommendations utilizing equipment manufacturer's regular production components, parts and assemblies.
- .2 Design hangers and supports to support systems under all conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.

- .3 Provide for vertical adjustments after erection and during commissioning.
- .4 Ensure that supports, guides, anchors do not transmit excessive quantities of stress or heat to building structure.
- .5 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS-SP-58.

1.5 Scope

- .1 This specification covers the design, selection, application, fabrication and installation procedures for field engineered pipe supports for pipe sizes 50mm in diameter and smaller, unless noted otherwise.
- .2 Refer to line list on drawings for lines which are to have field engineered pipe supports.

PART 2 - PRODUCTS

2.1 General

- .1 Fabricate hangers, supports and sway braces in accordance with ANSI B31.1 and MSS-SP-58.
- .2 Support from structural members, where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members. Do not suspend from metal deck.
- .3 All supplementary structural members and supports shall be hot dipped galvanized after fabrication. All steel hangers and rods shall be hot dipped galvanized. All supports beneath liquid levels in tanks shall be type 304L stainless steel.

- .4 Provide seismic bracing of piping in accordance with Section 44 02 41 - Seismic Restraints.
- .5 Provide 1.5mm thick bondable teflon isolation material to isolate stainless steel piping from galvanized steel supports where not insulated overlap at least 10mm, either side of support.
- .6 Provide rubber hose over threaded rod on all pipe clamps.

2.2 Upper Attachments

- .1 Upper Attachments:
 - .1 Concrete:
 - .1 Hollow core block concrete: Adhesive material applied with screen tube.
 - .1 Acceptable material: Hilti Hit Adhesive Anchors, HY-20.
 - .2 Coordinate minimum embedment of adhesive anchors with anchor manufacturer.
 - .2 Solid cast in place concrete or hollow core slabs: Adhesive material fastened into solid base.
 - .1 Acceptable material: Hilti Hit Adhesive Anchors, HY150.
 - .2 Coordinate anchor locations with precast slab supplier so that anchor locations provide adequate concrete thickness.
 - .3 Coordinate spacing of hangers with precast slab supplier so that support loads do not exceed slab

capacities. Provide supplementary steel as required so that supports can be placed where required if adequate bearing does not exist.

- .4 Coordinate minimum embedment of adhesive anchors with anchor manufacturer.
 - .5 Submit anchor manufacturer's embedment and precast slab suppliers recommendations for anchoring to structural engineer prior to drilling for supports.
- .2 Steel beam (bottom flange):
- .1 Cold piping NPS 2 and under: malleable iron C clamp to MSS-SP-58, type 19. ULC listed. Complete with restraining clip.
 - .1 Standard of Acceptance: Anvil fig.61.
- .3 Steel beam (top):
- .1 Cold piping NPS 2 and under: malleable iron "top of beam" C clamp to MSS-SP-58, type 19. ULC listed. Complete with restraining clip.
 - .1 Standard of Acceptance: Anvilfig.61.
- .4 Steel joist:
- .1 Cold piping NPS 2 and under: steel washer plate with double locking nuts.
 - .1 Standard of Acceptance: Anvil fig.60.

- .5 Steel channel or angle (bottom):
 - .1 Cold piping NPS 2 and under; malleable iron C clamp to MSS-SP-58, type 23. ULC listed. Complete with restraining clip.
 - .1 Standard of Acceptance: Anvil fig.86.

- .6 Steel channel or angle (top):
 - .1 Cold piping NPS 2 and under; malleable iron "top of beam" C clamp to MSS-SP-58, type 19. ULC listed. Complete with restraining clip.
 - .1 Standard of Acceptance: Anvil fig.61.

2.3 Middle Attachment (rod)

- .1 Carbon steel threaded rod electro-galvanized.
 - .1 Standard of Acceptance: Anvil fig.146.
- .2 Ensure that hanger rods are subject to tensile loading only.
- .3 Provide linkages where lateral or axial movement of pipework is anticipated.

2.4 Pipe Attachment

- .1 Cold piping, steel or cast iron: hot piping steel, with less than 1 inch horizontal movement; adjustable clevis to MSS-SP-58, type 1. ULC listed. Galvanized finish.
 - .1 Standard of Acceptance: Anvil fig.260.
- .2 Uninsulated Cold copper piping; uninsulated hot copper piping with less than 1 inch. horizontal movement; adjustable clevis to MSS-SP-58, type 1. Copper plated.
 - .1 Standard of Acceptance: Anvil

fig.CT-65.

- .3 Suspended hot piping, steel and copper, with horizontal movement in excess of 1 inch; pipe roller to MSS-SP-58, type 43. Galvanized finish.
 - .1 Standard of Acceptance: Anvil fig.174 and fig.171.

- .4 Bottom supported hot piping, steel and copper: pipe roller stand to MSS-SP-58, type 45.
 - .1 Standard of Acceptance: Anvil fig.271.

- .5 Pipe hangers and supports on all cold pipework and hot pipework above NPS 1 must be oversized to accommodate thermal insulation and to avoid penetrating the vapour barrier.

2.5 Riser Clamps

- .1 Steel or cast iron pipe: galvanized carbon steel to MSS-SP-58, type 42. ULC listed.
 - .1 Standard of Acceptance: Anvil fig.261.
- .2 Copper pipe: carbon steel copper finished to MSS-SP-58, type 42.
 - .1 Standard of Acceptance: Anvil fig.CT-121.

2.6 Saddles and Shields

- .1 Cold piping NPS 1-1/4 and over: protection shield with 25mm maximum thickness of polyisocyanurate insulation under shield with uninterrupted vapor barrier.
 - .1 Standard of Acceptance: Anvil fig.167.
- .2 Hot piping NPS 1-1/4 and over: protective saddle with insulation under saddle.

- .1 Standard of Acceptance: Anvil fig.160 to 166.
- .2 Tack weld protective saddle to pipe.

2.7 Seismic Restraints

- .1 Provide seismic restraints of piping and equipment to Section 44 02 41 - Seismic Restraints.

2.8 Finish

- .1 Fabricated support material shall be hot dipped galvanized. Support material submerged and/or in tanks shall be type 304L stainless steel.
- .2 Bolt threads in assembled components shall be painted. Stainless steel or other corrosion-resistant material need not be painted.
- .3 Supplementary and structural steel shall be hot dipped galvanized. Supplementary and structural steel materials submerged and/or in tanks shall be type 304L stainless steel.

PART 3 - EXECUTION

3.1 Installation

- .1 Install in accordance with:
 - .1 Manufacturer's instructions and recommendations.
- .2 Vibration Control Devices:
 - .1 Install on piping systems at pumps, boilers, chillers, cooling towers, elsewhere as indicated.
- .3 Clamps on riser piping:
 - .1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.
 - .2 Bolt-tightening torques to be to

- industry standards.
- .3 Steel pipes: Install below coupling or shear lugs welded to pipe.
- .4 Cast iron pipes: Install below joint.

- .4 Clevis plates:
 - .1 Attach to concrete with 4 minimum concrete inserts, one at each corner.

- .5 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.

- .6 Use approved constant support type hangers where:
 - .1 Vertical movement of pipework is 13mm or more, transfer of load to adjacent hangers or connected equipment is not permitted.

- .7 Use variable support spring hangers where:
 - .1 Transfer of load to adjacent piping or to connected equipment is not critical.
 - .2 Variation in supporting effect does not exceed 25% of total load.

- .8 Support plastic piping as per manufacturer recommendations.

3.2 Hanger Spacing

- .1 Spacing and middle attachment (rod) diameter as specified in paragraphs below or as in table below, whichever is more stringent.
- .2 Copper piping: up to NPS 1/2: every 5 ft.
- .3 Within 300mm of each horizontal elbow.
- .4 Non metallic piping per manufacturer's instructions.

Maximum Pipe Size:	Maximum Rod Diameter	Spacing	Steel	Copper
up to 1...	10mm		2.1m	1.8m
1%	10mm		2.7m	2.4m
.	2	10mm	3.0m	2.7m

3.3 Hanger Installation

- .1 Install hanger so that rod is vertical under operating conditions.
- .2 Adjust hangers to equalize load.
- .3 Support from structural members. Where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members.
- .4 Do not suspend from metal deck.
- .5 Anchoring of piping shall be as per manufacturers recommendations. Submit anchorage system for review before installation.
- .6 The use of perforated band, wire chain, or solid ring type hangers will not be accepted.
- .7 Prior to connecting pumping units or other equipment to pipe sections, support complete piping assembly and anchor in perfect alignment with pumping units and sleeves to prevent movement of piping assembly and strain on pumping units or equipment.
- .8 Support all valves and risers so that weight of valve or valve assembly is not carried by adjacent horizontal pipe sections.

3.4 Horizontal
Movement

- .1 Angularity of rod hanger resulting from horizontal movement of pipework from cold to hot position not to exceed 4° from vertical.
- .2 Where horizontal pipe movement is less than 13mm, offset pipe hanger and support so that rod hanger is vertical in the hot position.

3.5 Final
Adjustment

- .1 Adjust hangers and supports.
 - .1 Ensure that rod is vertical under operating conditions.
 - .2 Equalize loads.
- .2 Adjustable clevis.
 - .1 Tighten hanger load nut securely to ensure proper hanger performance.
 - .2 Tighten upper nut after adjustment.
- .3 C-clamps.
 - .1 Follow manufacturer's recommended written instructions and torque values when tightening C-clamps to bottom flange of beam. Provide restraining clip.
- .4 Beam clamps:
 - .1 Hammer jaw firmly against underside of beam.

3.6 Seismic
Restraints

- .1 Provide bracing of piping and equipment in accordance with Section 44 02 41 Seismic Restraint.

1. GENERAL

1.1 Scope

- .1 This standard covers the fabrication, and installation procedures for engineered pipe supports. This generally applies to piping 65mm diameter and larger, unless noted otherwise.
- .2 Refer to arrangement drawings for piping dimensions to determine which lines require engineered pipe supports.

1.2 Codes

- .1 Standards and Specification Sheets:
The codes, standards, and specification/data sheets listed shall be the latest edition.
 - CAN3-S16.1 Steel Structures for Buildings
 - ASME B31.1 Power Piping
 - MSS-SP-58 Pipe Hanger and Support - Materials, Design and Manufacture
 - MSS-SP-69 Pipe Hangers and Supports - Selection and Application
 - MSS-SP-89 Pipe Hangers and Supports - Fabrication and Installation Practices
 - ANSI B18.2.1 Square and Hex Bolts and Screws
 - ANSI B18.2.2 Square and Hex Nuts
 - ANSI B1.1 Unified Screw Threads (UN and UNR Thread Forms)
 - ANSI/ASME Pipe Threads, General Purpose B1.20.1
 - CSA W47.1 Certification of Companies for Fusion Welding of Steel Structures.

1.3 Pipe Supports
Design

ASME B31.3 Process Piping

- .1 Contractor shall engineer and design pipe support systems for piping of 65mm dia and larger in accordance with ASME B31.3 for Normal Fluid Service. Pipe supports shall be engineered and certified by a Professional Engineer licensed to practice in Ontario.
- .2 Contractor shall submit to Departmental Representative for review all support details.
- .3 Operating and installation loads, direction and amount of movement shall be shown on the detail drawings.
- .4 Supplementary steel required for attachment to roof, wall or floor structure shall be engineered and supplied by the Contractor. Supplementary steel for rod hangers shall be engineered and supplied by the Contractor. All supports and supplementary steel shall be hot dipped galvanized after fabrication. All supports and supplementary steel submerged in tanks shall be type 304L stainless steel.
- .5 All field welds and shop welds of non-catalog items will be indicated on the detail drawing using American Welding Society standard welding symbols.
- .6 The location of a particular support assemblies shall be shown on the drawings issued to Departmental Representative for review.
- .7 Support loads shall not exceed building elements design loadings. Contractor shall review with structural Engineer building loads and shall space or

design supports so that building elements design loads are not exceeded.

- .8 Provide bracing of piping in accordance with Section 44 02 41 Seismic Restraint.
- .9 Construct pipe hanger and support to manufacturer's recommendations utilizing equipment manufacturer's regular production components, parts and assemblies.
- .10 Design hangers and supports to support systems under all conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.
- .11 Provide for vertical adjustments after erection and during commissioning.
- .12 Ensure that supports, guides, anchors do not transmit excessive quantities of stress or heat to building structure.
- .13 Maximum rod length to be 1.5m. Pipes requiring supports with rod lengths greater than 1.5m shall have supplementary steel attached to structure to reduce rod length to less than 1.5m.
- .14 Main blower and pump suction/discharge headers shall be supported from below utilizing supplementary steel support racks which have base plates secured to floor.
- .15 All supports to be arranged to provide maximum access to valves and other equipment requiring access.
- .16 Do not weld directly to stainless steel

pipes with steel supports. Provide clamps with bondable teflon sheet between clamp and stainless steel pipe.

1.4 Dimensional Tolerances

- .1 This section covers maximum tolerances in fabricated pipe supports except for cast or forged products.
- .2 Tolerances for raw materials such as strip, sheet, bar, plate, pipe, tubing, structural and bar size shapes shall be in accordance with recognized standards and specifications. Tolerances for casting and forgings shall be in the individual manufacturers standards.
- .3 Manufacturing Tolerances:
 - .1 Cut Lengths - Linear
 - .1 Hanger rods - 12mm
 - .2 Structural shapes, pipe, tubing - 3mm.
 - .3 Plates & bars - 3mm
 - .2 Threads:
 - .1 Screw threads to ANSI B1.1, Class 1A, 2A and 2B
 - .2 Pipe threads to ANSI/ASME B1.20.1
 - .3 Weld Sizes - All welds plus only, no minus
 - .4 Angularity - all manufacturing methods to - 4 degrees
 - .5 Holes - Drilled or Punched Only
 - .1 Location - center to edge, or center to center, - 1.6mm
 - .2 Diameter - plus .2 times metal thickness or minus 0.8mm

1.5 Shop Drawings

- .1 Submit shop drawings in accordance with the Section 01 33 00 - Submittals.

1.6 Qualification

- .1 Use organizations approved under the

of Workmanship

Canadian Welding Bureau to the requirements of CSA W47.1, Division 2, to undertake welding operations using welders qualified to perform the type of welds required.

2. MATERIALS

2.1 General

- .1 Fabricate hangers, supports and sway braces in accordance with ANSI B31.1 and MSS-SP-58.
- .2 Support from structural members, where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members. Do not suspend from metal deck. Anchoring of piping and equipment shall be to manufacturers recommendations. Submit anchorage system, arrangement and type of hanger supports with calculations for review. Supplemental steel to be galvanized after fabrication.
- .3 Finishes:
 - .1 Hangers and supports: galvanized after manufacturer.
 - .2 Use electro-plating galvanizing process.
 - .3 Ensure steel hangers in contact with copper piping are epoxy coated.
- .4 Provide seismic bracing of piping in accordance with Section 44 02 41, Seismic Restraints.
- .5 Use components for intended design purpose only. Do not use for rigging or erection purposes.

.6 Steel sections (except tube sections) and plates: to CSA G40.21, type 300W.

.7 Welding Materials: to CSA W59.1.

2.2 Upper Attachments

.1 Upper Attachments:

.1 Concrete:

.1 Hollow core block concrete: Adhesive material applied with screen tube.

.1 Acceptable material: Hilti Hit Adhesive Anchors, HY-20.

.2 Coordinate minimum embedment of adhesive anchors with anchor manufacturer.

.3 Submit anchor manufacturer's recommendations for anchoring to structural engineer prior to drilling for supports.

.2 Solid cast in place concrete or hollow core slabs: Adhesive material fastened into solid base.

.1 Acceptable material: Hilti Hit Adhesive Anchors, HY150.

.2 Coordinate anchor locations with precast slab supplier so that anchor locations provide adequate concrete thickness.

.3 Coordinate spacing of hangers with precast slab supplier so that support loads do not exceed slab capacities. Provide supplementary steel as

required so that supports can be placed where required if adequate bearing does not exist.

- .4 Coordinate minimum embedment of adhesive anchors with anchor manufacturer.
 - .5 Submit anchor manufacturer's embedment and precast slab suppliers recommendations for anchoring to structural engineer prior to drilling for supports.
- .2 Steel beam (bottom flange):
- .1 Cold piping NPS 2 and under: malleable iron C clamp to MSS-SP-58, type 19. ULC listed.
 - .1 Standard of Acceptance: Anvil fig.61.
 - .2 Cold piping NPS 2% and larger and all hot piping: malleable iron beam clamp to MSS-SP-58, type 28 or 29. ULC listed.
 - .1 Standard of Acceptance: Anvil fig.229.
- .3 Steel beam (top):
- .1 Cold piping NPS 2 and under: malleable iron "top of beam" C clamp to MSS-SP-58, type 19. ULC listed.
 - .1 Standard of acceptance; Anvil fig.61.
 - .2 Cold piping NPS 2% and larger and all hot piping: steel jaw, hook rod with nut, spring washer and plain washer, to MSS-SP-58, type 25. ULC listed.

- .1 Standard of Acceptance:
Anvil fig.227.
- .4 Steel joist:
 - .1 Cold piping NPS 2 and under: steel washer plate with double locking nuts.
 - .1 Standard of Acceptance:
Anvil fig.60.
 - .2 Cold piping NPS 2% and larger and all hot piping: steel washer plates with double locking nut, carbon steel clevis and malleable iron socket.
 - .1 Standard of Acceptance:
Anvil: washer plate fig.60; clevis, fig.66; eye nut, fig.290.
- .5 Steel channel or angle (bottom):
 - .1 Cold piping NPS 2 and under; malleable iron C clamp to MSS-SP-58, type 23. ULC listed.
 - .1 Standard of Acceptance:
Anvil fig.86.
 - .2 Cold piping NPS 2% and larger and all hot piping; universal channel clamp. ULC listed.
 - .1 Standard of Acceptance:
Anvil fig.226.
- .6 Steel channel or angle (top):
 - .1 Cold piping NPS 2 and under; malleable iron "top of beam" C clamp to MSS-SP-58, type 19. ULC listed.
 - .1 Standard of Acceptance:
Anvil fig.61.
 - .2 Cold piping NPS 2% and larger and all hot piping: steel jaw, hook rod with nut, spring washer and plain washer, to MSS-SP-58, type 25. ULC listed.
 - .1 Standard of Acceptance:

Anvil fig.227.

2.3 Middle
Attachment (rod)

- .1 Carbon steel threaded rod electro-galvanized finish.
 - .1 Standard of Acceptance: Anvil fig.146.
- .2 Ensure that hanger rods are subject to tensile loading only.
- .3 Provide linkages where lateral or axial movement of pipework is anticipated.

2.4 Pipe
Attachment

- .1 Cold piping, steel or cast iron: hot piping steel, with less than 25mm horizontal movement; adjustable clevis to MSS-SP-58, type 1. ULC listed. Galvanized finish.
 - .1 Standard of Acceptance: Anvil fig.260.
- .2 Uninsulated Cold copper piping; uninsulated hot copper piping with less than 25mm horizontal movement; adjustable clevis to MSS-SP-58, type 1. Copper plated.
 - .1 Standard of Acceptance: Anvil fig.CT-65.
- .3 Suspended hot piping, steel and copper, with horizontal movement in excess of 25mm; pipe roller to MSS-SP-58, type 43. Galvanized finish.
 - .1 Standard of Acceptance: Anvil fig.174 and fig.171.
- .4 Bottom supported hot piping, steel and copper: pipe roller stand to MSS-SP-58, type 45.
 - .1 Standard of Acceptance: Anvil fig.271.
- .5 Pipe hangers and supports on all cold

pipework and hot pipework above NPS 1 must be oversized to accommodate thermal insulation and to avoid penetrating the vapour barrier.

- .6 Do not weld supports directly to stainless steel pipes. Provide clamps welded to support plates. Provide bondable teflon sheet between clamps and stainless steel pipes.

2.5 Riser Clamps

- .1 Steel or cast iron pipe: galvanized carbon steel to MSS-SP-58, type 42. ULC listed.
 - .1 Standard of Acceptance: Anvil fig.261.
- .2 Copper pipe: carbon steel copper finished to MSS-SP-58, type 42.
 - .1 Standard of Acceptance: Anvil fig.CT-121.
- .3 Provide bondable 1.5mm thick teflon sheet between clamps and stainless steel pipes. Overlap min. 10mm either side of support.

2.6 Saddles and Shields

- .1 Cold and hot piping NPS 1... and over: protection shield with high density insulation (25.4mm thick polyisocyanurate) under shield with uninterrupted vapour barrier.
 - .1 Standard of Acceptance: Anvil fig.167.
- .2 Hot piping NPS 1... and over: protective saddle with insulation under saddle.
 - .1 Standard of Acceptance: Anvil fig.160 to 166.
 - .2 Tack weld protective saddle to carbon steel pipe.

3. EXECUTION

3.1 Fabrication

- .1 Fabricate hangers, supports and sway braces in accordance with ANSI B31.1, B31.3 and MSS-SP-58.
- .2 This section covers fabrication of pipe support components and assemblies.
 - .1 Material of construction shall be CSA G40.21, type 300W unless otherwise noted. Plates, rods, bars, etc. which are used for the fabrication of support assemblies may be cut to shape or size by shearing, sawing, machining, grinding or thermal cutting.
 - .2 Thermal cutting processes shall be suitable for the material to which it is applied. After thermal cutting, slag shall be removed prior to further fabrication or use. Discolouration remaining on the flame cut surface is not considered to be detrimental oxidation.
 - .3 Drilling and punching shall be performed as required by drawings and specifications.
 - .4 Screw threads shall be in conformance with ANSI B1.1 Class 1A, 2A and 2B for coarse thread series and Class 2A & 2B for the eight thread series.
 - .5 Pipe threads shall be in accordance with ANSI/ASME B1.20.1 either straight or tapered as required.
 - .6 All threaded rod shall be hot-dip galvanized
 - .7 Welding shall be performed where indicated on the detail drawings in accordance with the welded joint requirements specified in the CAN3-S16.1. When welding any

attachment to a pressure pipe, such welding shall to the specific applicable welding procedures which have been qualified in accordance with Section IX of the ASME Boiler & Pressure Vessel Code and T.S.S.A. Pressure Vessels branch requirements. A copy of the fabricator's procedures and weld qualification record shall be submitted for owner review and record.

- .8 Fabricate supports in accordance with ASME B31.1, Power Piping.

3.2 Finish -
(Painting/
Galvanizing)

- .1 Fabricated support material shall be hot dipped galvanized. Support material submerged in tanks shall be type 304L stainless steel.
- .2 Bolt threads in assembled components shall be painted. Stainless steel or other corrosion-resistant material need not be painted.
- .3 Supplementary and structural steel shall be hot dipped galvanized. Supplementary and structural steel materials submerged in tanks shall be type 304L stainless steel.

3.3 Inspection

- .1 There will be an inspection program to ensure that all aspects of work performed comply fully with specified requirements. The owner may elect to conduct inspection during fabrication.

3.4 Marking

- .1 When pipe supports are to be shop fabricated, each pipe support shall have its identifying mark number painted on with water-proof paint in letters at least 20mm high.

3.5 Pipe Support
Installation

- .1 Engineered pipe supports shall be located in strict accordance with the pipe support location drawing supplied by the Contractor and certified. Relocation and reorientation of any pipe support from the specified location shall not be permitted without written permission of the Contractors design engineer.
- .2 Installed pipe supports shall be used only for their intended purpose. They shall not be used for rigging or erection purposes.
- .3 The contractor is responsible for developing an installation sequence giving priority to major components and groups of piping closest to the supporting structure.
- .4 Prior to connecting pumping units or other equipment to pipe sections, support complete piping assembly and anchor in perfect alignment with pumping units and sleeves to prevent movement of piping assembly and strain on pumping units or equipment.
- .5 Support all valves and risers so that weight of valve or valve assembly is not carried by adjacent horizontal pipe sections.
- .6 Provide heavy rubber material between pipe and galvanized supports.
- .7 Provide plastic hose material over all threaded rods used as part of pipe clamps.
- .8 All material in contact with the supported pipe shall be of the same

material unless separated by suitable means.

- .9 All material welded to the supported pipe shall be of the same material as the pipe.
- .10 Clamps on riser piping:
 - .1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.
 - .2 Bolt-tightening torques to be to industry standards.
 - .3 Steel pipes: Install below coupling or shear lugs welded to pipe.
 - .4 Cast iron pipes: Install below joint.
 - .5 Provide bondable teflon sheet between clamps and stainless steel pipes.
- .11 Use approved constant support type hangers where:
 - .1 vertical movement of pipework is 13mm or more, transfer of load to adjacent hangers or connected equipment is not permitted.
- .12 Use variable support spring hangers where:
 - .1 transfer of load to adjacent piping or to connected equipment is not critical.
 - .2 variation in supporting effect does not exceed 25% of total load.
- .13 Provide support within 300mm (12") of each horizontal elbow.
- .14 Space supports for non-metallic pipe as per manufacturer's instructions.

3.6 Hanger
Installation

- .1 Install hanger so that rod is vertical under operating conditions.
- .2 Adjust hangers to equalize load.
- .3 Do not suspend from metal deck.

3.7 Horizontal
Movement

- .1 Angularity of rod hanger resulting from horizontal movement of pipework from cold to hot position not to exceed 4° from vertical.
- .2 Where horizontal pipe movement is less than 13mm (½") offset pipe hanger and support so that rod hanger is vertical in the hot position.

3.8 Final
Adjustment

- .1 Adjust hangers and supports.
 - .1 Ensure that rod is vertical under operating conditions.
 - .2 Equalize loads.
- .2 Adjustable clevis:
 - .1 Tighten hanger load nut securely to ensure proper hanger performance.
 - .2 Tighten upper nut after adjustment.
- .3 C-clamps:
 - .1 Follow manufacturer's recommended written instructions and torque values when tightening C-clamps to bottom flange of beam.
- .4 Beam clamps:
 - .1 Hammer jaw firmly against underside of beam.

3.9 Seismic
Restraint

- .1 Provide seismic restraint of systems in accordance with Section 44 02 41 - Seismic Restraint.

1. GENERAL

1.1 SCOPE

- .1 This specification outlines the requirements for field surface preparation and field painting of metallic surfaces.

1.2 GENERAL REQUIREMENTS

- .1 The Contractor shall provide all supervision, labor, tools, equipment (including but not limited to compressors, scaffolding, brushes, mixers and spray devices) drop cloths, protective covers and filters and materials necessary to prepare and paint surfaces.
- .2 Clean-up, debris removal and disposal according to all applicable laws and regulations are the responsibility of Contractor unless the Departmental Representative provides a written exemption.
- .3 The following items, although galvanized, shall be painted when colour coding or additional corrosion protection is necessary.
 - .1 Bolting and associated hardware for painted structural steel and painted steel piping.
 - .2 Painted pipe clevis and other painted pipe supports.

1.3 SURFACE CLASSIFICATION

- .1 The following surfaces have been cleaned and primed by others (unless otherwise noted in Contract Documents).
 - .1 Shop fabricated equipment including items supplied with manufacturer's standard paints such as pumps, motors, agitators, compressors, etc.
 - .2 All in-line carbon steel instruments and valves.
- .2 The following surfaces shall not be painted, unless otherwise specified.
 - .1 Plastics and rubber.
 - .2 Aluminum and copper materials.
 - .3 Galvanized surfaces (except for touch-up of damaged galvanizing, bolting and pipe supports).
 - .4 Insulation, except where bituminous insulation

- mastic covering is utilized.
- .5 Stainless steel piping and piping components.
- .3 The following surfaces shall not be painted but shall be protected during surface preparation and paint application:
- .1 Instrument and electrical panel boards, push buttons, controls, switches, fuse boxes, valve operators, or valve controllers.
 - .2 Sprinkler heads.
 - .3 Fire extinguishers.
 - .4 Glass parts of all instruments and gauges.
 - .5 Valve stems and PSV's.
 - .6 Machined surfaces of moving parts.
 - .7 Gasket surfaces.
 - .8 Identification nameplate and pipe line identification marks (except to renew).
 - .9 Removable signs shall be removed during surface preparation and paint application. After acceptance of painting activity signs shall be securely reinstalled.
 - .10 Electrical light fixtures, light bulbs, power connections.
 - .11 Concrete floors.
 - .12 Coatings on existing equipment and piping (outside the scope of project).
 - .13 Equipment nameplates.
 - .14 Stainless steel valves. (Unless valves are not insulated and piping identification painting is specified).
- .4 Any paint spilled, splashed, or misapplied on items listed in Paragraph 1.3.2 or 1.3.3 must be removed before job is accepted as complete. Items listed in Paragraph 1.2.3 that are damaged or would be damaged by restoring the surface shall be replaced by Contractor.
- .5 The items and surfaces to be field painted and paint systems to be used are listed in the Painting Schedule. This typically includes:
- .1 Uninsulated surfaces of carbon steel.
 - .2 Exposed carbon steel of uninsulated and insulated piping including back-up flanges, valves, bolting, supports and attachments.
 - .3 Exposed carbon steel parts of alloy or non-metallic equipment.
 - .4 Exposed stainless steel piping and valves for identification purposes.

- .5 Refer to Section 44 00 90 - Mechanical Identification for colour schedule for exposed piping painted for identification purposes.
- .6 Departmental Representative supplied equipment have been painted by the manufacturer and requires no further painting. Touch up any damaged surfaces to match manufacturer's paint system.
- .7 Galvanized steel supports and galvanized steel building components damaged due to welding and other operations shall be touched up in accordance with Section 09 91 23.

 2. MATERIALS

2.1 PAINTING SCHEDULE - Carbon Steel

TYPE ITEM	TEMPERATURE RANGE °F (2)	SURFACE PREPARATION	PRIME COAT & APPLICABLE SPECIFICATION SECTION	INTERMEDIATE COAT & APPLICABLE SPECIFICATION SECTION	FINISH COAT & APPLICABLE SPECIFICATION SECTION
Piping (3)					
Insulated & Un-Insulated Indoor	-28°C to 93°C	Near-White Blast	Enamel primer as per item 2.7	Enamel finish coat as per item 2.8	Enamel finish coat as per item 2.8
Un-Insulated Outdoor	-28°C to 93°C	Near-White Blast	Enamel primer as per item 2.7	Enamel finish coat as per item 2.8	Enamel finish coat as per item 2.8
Pipe Supports - See Note 1					

Note:

- (1) The supports touching the pipe (ie. shoes, saddles, hangers, etc.) shall be painted as per the requirements for the pipe and all the pipe support touching hot piping above 150°C shall be painted as per the requirements for the pipe. All structural steel supports shall be hot dipped galvanized. Galvanized steel supports and galvanized steel building components damaged due to welding and other operations shall be touched up in accordance with Section 44 01 52.
- (2) To determine which temperature range a pipe to be painted falls into, refer to operating temperature of line, listed

in Line List on P & ID drawings.

- (3) Piping colours are provided in Section 44 00 90.
- 2.2 Inorganic zinc and zinc-rich organic primed items should be aged (weathered) for 24 hours at 21°C and for 48 hours when the temperature is 10°C or less prior to topcoating with high build topcoats. By field topcoating shop primed items, the open, porous surface of these primers generally have sufficient time to fill with carbonates and sulfates and, therefore, the risk of blistering and/or pinholing of topcoats is minimized. Shop application of topcoats over freshly applied primers should be avoided.
- 2.3 Near-white blast surface preparation shall be in accordance with Steel Structures Painting Council (SSPC) and National Association of Corrosion Engineers (NACE) Standard SSPC-SP-10 (NACE-2), "Near White Metal Abrasive Blast". Removal of at least 95% of all surface matter leaving the area free of all visible residues.
- 2.4 All carbon steel surfaces shall be solvent cleaned as per SSPC-SP-1, "Solvent Cleaning" to remove all oil, grease and similar contaminants prior to near white blast surface preparation.
- 2.5 Painting Schedule - Austenitic Stainless Steel
Paint piping only when required for identification purposes as noted in Section 44 00 90.

NOTES

1. Always protect austenitic stainless steel from zinc coating.
 2. Associated carbon steel surfaces shall have surface preparation, primer, and topcoat designated in Specification 44 01 48.
- 2.6 Painting of Galvanized Piping and Supports
- .1 Galvanized piping and supports shall receive one coat of vinyl wash primer, one coat Moore's Retardo Rust Inhibitive Paint and two coats of Satin Impervo Enamel.
 - .2 Prepare surfaces and apply paint in accordance with manufacturers recommendations.

- .3 Paint galvanized piping only when required for identification purposes as noted in Section 44 00 90.

2.7 Enamel Primer

- .1 Enamel Primer to be an alkyd enamel Rust Inhibitive paint intended for the proposed application.
- .2 Preparation of Surfaces:
 - .1 Where conventional primer is used touch up shop paint primer on steel with CAN/CGSB-1.40-M89 to CGSB 85-GP-14M.
- .3 Application:
 - .1 Sand and dust between each coat to remove defects visible from distance up to 1.5m using No.00 sandpaper.
 - .2 Apply paint by brush; rollers may be used elsewhere. Spray paint only when requested or approved by Departmental Representative.
 - .3 Use only unadulterated paint. Thin as specified by manufacturer.
 - .4 Do not paint caulked joints except as directed by the Departmental Representative.
 - .5 Touch up visible suction spots on dried primer and ensure that they are sealed before application of second coat. Repeat on second coat if still visible.

2.8 Enamel Intermediate and Finish Coats

- .1 Enamel Intermediate and finish coat to be satin alkyd low lustre paint intended for the proposed application.
- .2 Preparation of Surfaces:
 - .1 Where conventional primer is used touch up shop paint primer on steel with CAN/CGSB-1.40-M89 to CGSB 85-GP-14M.
- .3 Application:
 - .1 Sand and dust between each coat to remove defects visible from distance up to 1.5m using No.00 sandpaper.
 - .2 Apply paint by brush; rollers may be used elsewhere. Spray paint only when requested or approved by Departmental Representative.
 - .3 Use only unadulterated paint. Thin as specified by manufacturer.
 - .4 Do not paint caulked joints except as directed by the Departmental Representative.
 - .5 Touch up visible suction spots on dried primer and

ensure that they are sealed before application of second coat. Repeat on second coat if still visible.

3. EXECUTION

3.1 PAINTING

- .1 Prior to applying any coating, all previously applied paints shall be sufficiently dried or cured to permit topcoating. All surfaces shall be unscarred, in good condition and free of oils, greases, excessive gloss, dust or other contaminants.
- .2 Surfaces which have been primed or painted shall not be handled, worked on or otherwise disturbed until primer or paint is completely dry and/or set.
- .3 Surface preparation, cleaning and painting operations shall be scheduled so that contamination of freshly applied paint is prevented.

3.2 MATERIALS

- .1 The paint materials, their solvents and catalysts shall be supplied by the same paint manufacturer.
- .2 All materials shall be delivered and stored in their original packages with their labels intact and seals unbroken.
- .3 All paint materials shall be stored under cover in a dry place and protected from freezing temperatures and excessive heat. The paint materials shall be stored in accordance with paint manufacturer's instructions.
- .4 Material substitutions are not allowed without prior written approval of owner.
- .5 Compressed air used for blast cleaning, for removal of abrasives on blasted surfaces and for spray application shall be oil and moisture-free.

3.3 TOUCH-UP AND REPAIR

- .1 Items painted with manufacturer's standard coating and

operating shall be touched-up (where required) with paint of equal type. If the paint film is extensively damaged or is of unknown generic type, the item shall be solvent, hand or power tool cleaned and fully coated with primer and finish coat of equal type.

- .2 All primed areas that have been damaged (by welding, scarring, etc.) shall be spot cleaned and touched up prior to applying the subsequent coats. These areas shall be cleaned, using solvent and power tools to remove all loose paint, heat degraded paint, rust bloom, scale, dirt, grease, oils or other foreign contaminant and to develop adequate anchor patterns. Adherent primer at edge of damaged area shall be roughened and feathered back from cleared area. After cleaning, reapply coating to cleaned areas to meet dry film requirements in referenced specification.
- .3 Primed surfaces that are damaged and require greater than 30% touch-up shall have complete surface preparation and have full prime coat application to meet dry film requirements in reference specifications.
- .4 Where existing steel surfaces finish coating have been damaged from welding or other operations; Contractor shall power wire brush the damaged area and then paint as per specifications for pipe supports.

3.4 COLOURS

- .1 Final paint coat colour selection shall be made at the job site by the Departmental Representative using standard colours of approved paint suppliers according to the following General Colour Guide:
 - .1 The selected colours shall be supplied from single batch lots (to avoid colour variation). For large order of paints, minimum number of batch lots shall be supplied.
 - .2 Final topcoat colour section shall result in colour contrast between coats.
 - .3 Failure to provide contrasting colours (unless prior written approval is granted by Departmental Representative), incorrect colour, varying colour (because of use of multiple lots of coating) shall be grounds for rejection.

- .4 Areas rejected because of items listed above shall be repaired/replaced to Departmental Representative's satisfaction at the Contractor's expense.
- .5 Colours must be cut in a neat straight line where two colours meet.
- .6 Where colours are selected to meet plant or governmental safety requirements, colour tones and wave length characteristics shall comply with these requirements.
- .7 Contractor may utilize additional finish coat(s) of the same finish material or different generic system (i.e. aliphatic urethane) to meet special or safety colour requirements, provided that:
 - .1 Prior written Departmental Representative approval is granted.
 - .2 Coating is an approved product from an approved supplier per the appropriate Specification.
 - .3 Coating will be at least as chemically and ultraviolet resistant as the specified topcoat.
 - .4 Film build requirement of the selected topcoat system is satisfied.

3.5 FIELD SURFACE PREPARATION AND PAINTING PRIOR TO ERECTION

- .1 Copper slags and high chloride bearing abrasives shall not be used as abrasive blast media.
- .2 Unless otherwise prohibited, Contractor may request permission to set up a surface preparation and/or painting area to:
 - .1 Satisfy "shop" abrasive blast cleaning and "shop" priming requirements.
 - .2 Conduct "field" or in-situ abrasive blasting, surface preparation, primings or intermediate topcoating. Finish coating shall only be conducted after erection, unless written approval to do otherwise is granted by Departmental Representative.
- .3 Contractor may conduct surface preparation and/or painting in conjunction with Paragraph 3.5.2 if the following additional requirements are satisfied:
 - .1 Temperature and humidity criteria for application are not exceeded.

- .2 Abrasive from blast cleaning does not damage or interfere with function of Engineer equipment.
- .3 Stands or supports used to facilitate surface preparation and/or painting are of sufficient height from ground to prevent contamination of prepared and/or painted surfaces.
- .4 Degree of handling damage is not excessive or would not require full recoating.
- .5 Touch-up of damaged painting will not create an unsightly appearance when coating application is completed.

3.6 SAFETY AND EQUIPMENT PROTECTION

- .1 Contractor should take into account possible wind shifts, exhaust fan drafts, high personnel traffic areas, and the proximity of instruments, controls, rotating equipment or other equipment susceptible to damage from particulate matter or painting.
- .2 Personnel safety is of key importance. Areas to have surface preparation and/or painting shall be cordoned off with warning signs or safety ribbons. Walkways in the vicinity of blast cleaning are to be cordoned off with visqueen or tarps to help isolate the effects of sandblasting.
- .3 Filter presses, pumps, motors, turbines, compressors and other rotating equipment are highly susceptible to damage from particulate matter. Therefore, it is of utmost importance that this type of equipment be protected and that protection is maintained for the duration of the work. Details of protection methods are outlined in the "Application" section of this procedure.
- .4 The work shall be conducted in such a manner as not to damage any existing buildings, structures, insulation, piping, equipment, etc. Any such damage shall be required by Contractor at its expense, unless Contractor is directed otherwise by Departmental Representative in writing.
- .5 "Safe Work" permits are required for grinding, chipping, blast cleaning and painting. In addition to the "Safe Work" permits, "Hot Work" permits are required if there is a source of ignition for flammable materials in the area. Dry abrasive blasting, welding,

cutting, electrical devices, needle guns, and grinding equipment are representative of this type of work.

- .6 "Safe Work" and "Hot Work" permits are issued by the General Contractor group for the area in which work is to be done. These permits are in written form and must be obtained prior to commencing work, and shall be good only for the time and work indicated on the permit. They will not be issued until the procedures for equipment and personnel protection are complete and approved by the Departmental Representative.
- .7 Protective coverings are to be checked prior to each shift to be sure they are intact. The Contractor should periodically tour his area to be sure that the protection is maintained. If equipment has been exposed, it is the responsibility of the Contractor that this be corrected immediately, even if it means stopping on-going work.
- .8 It is the responsibility of the Contractor to protect plant personnel and equipment. Should Departmental Representative deem that the Contractor is not adequately maintaining the protection of equipment and personnel, all work may be stopped until the protection of equipment is corrected.
- .9 Contractor Equipment
 - .1 All equipment required by the Contractor shall be operated safely and be in a safe condition. Departmental Representative reserves the right to forbid the use of any equipment which the Departmental Representative believes to be unsafe.
 - .2 All pressurized equipment shall have pressure gauges and regulators, as recommended by equipment manufacturer and shall meet all applicable Local, Provincial and Federal Regulations. The pressure device shall be maintained in safe working order. All pressurized equipment shall meet all applicable laws and regulations.
- .10 The safety rules for Contractors are to be followed. They will be strictly enforced; failure to comply can lead to expulsion from the site.
- .11 Electric motors, compressors, turbines, tank vents, etc., are to have foam filter material over any air intakes, with no openings to allow sand or paint chips

to enter. The filters shall be a minimum of 20mm thick.

- .12 Motor shaft seals, couplings, gear boxes and bearings are to be enclosed with visqueen or other suitable material and sealed in a manner that will prevent particulate damage.
- .13 Piping, equipment, insulation, and other items near surfaces which are to be cleaned and painted shall be protected from overblast damage and over spray with visqueen, tarps, rubber, or other suitable material approved by Departmental Representative.
- .14 Drains and drainage trenches shall be covered to prevent sand or debris from entering. This also includes safety shower drains and eyewash stations. Drain covers are to be removed at the end of project. The painting contractor must remove any debris or sand that could possibly wash into the drains. Contractor shall be liable for the cost of cleaning drains that become plugged as a result of his work.
- .15 Instrumentation, tubing, wiring and gauges are to be wrapped with visqueen and taped to keep debris out and wrapped with rubber sheeting if there is the possibility of damage from overblast or overspray.
- .16 Unless Departmental Representative indicates otherwise, all work associated with protection of plant equipment and personnel shall be performed by Contractor.

3.7 INSPECTION

- .1 Contractor shall provide Departmental Representative with full access to all items being prepared, cleaned and/or painted.
- .2 Contractor, at the request of Departmental Representative's inspector, shall place one handful from each bag of abrasives into a bucket of clean water to detect clays, oils or other objectionable foreign matter. Typically these materials float on water surface.
- .3 Contractor is to utilize and provide for Departmental

Representative's use all testing tools and equipment to ensure compliance with humidity and temperature criteria and to inspect all phases of surface preparation, materials and paint application/cure. All testing tools and equipment shall be calibrated and in good working condition.

- .4 Contractor shall repair at his expense, all rejected surface preparation and coating application to Departmental Representative's satisfaction.
- .5 Contractor is to provide, in writing, details to Departmental Representative of all corrective action on rejected surface preparation, materials and applications.

1. GENERAL

1.1 SCOPE

This standard outlines a paint system using a one component zinc rich primer for field touch-up of galvanized steel surfaces operating below 66°C.

1.2 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with the Section 44 00 10 - Process General Requirements and Section 01 33 00.

2. MATERIALS

2.1 The acceptable primers are:

- .1 Galvanox Type I, Subox Division, Carboline Co., 40 Burlews Ct., Hackensack, NJ 07901.
- .2 Z.R.C. Cold Galvanizing Compound, ZRC Chemical Products Co., 21 Newport Avenue, Quincy, MA 02171.
- .3 Galvicon, Southern Coatings, P.O. Box 460, Slidell, LA 70459.

3. EXECUTION

3.1 SURFACE PREPARATION

- .1 Weld areas and small areas of damaged galvanizing shall be hand or power tool cleaned in accordance with Steel Structures Painting Council SSPC-SP-2 or 3, latest editions.
- .2 If large areas of damaged galvanized are to be cleaned, use brush blast cleaning per Steel Structures Painting Council SSPC-SP-5, latest edition.
- .3 All grease, oils or other foreign matter shall be removed in accordance with solvent cleaning SSPC-SP-1,

latest edition and per manufacturer's recommended practice.

- .4 Clean all exposed carbon steel per above and adjacent adherent galvanized for a distance of 12mm minimum.

3.2 APPLICATION

- .1 The specific manufacturer's instructions must be followed for handling, mixing, curing, application, thinning, equipment, re-coat time, cleaning of equipment, and storage.
- .2 Primer shall not be applied when the metal surface or ambient air temperature is below 4.4°C or is expected to drop to 1.7°C before the primer has dried. The relative humidity of the surrounding air shall not exceed 90% at the time of application. Primer shall not be applied when metal surface or ambient temperature is greater than 38°C.
- .3 Primer shall not be applied when the surface temperature is less than 15°C above the dew point of the surrounding air.
- .4 Primer shall not be applied to damp surfaces or in rain, fog or mist.
- .5 Surfaces to be primed shall be dry and free of atmospheric contamination, dust, grease, abrasives, and other foreign matter.
- .6 The steel shall be primed within eight hours of surface preparation.
- .7 The primer may be applied by brush or spray. For brush application, do not mix to prevent settling of zinc pigment. For brush application, fully load brush and apply smoothly onto surface to be coated (do not brush over primer).
- .8 Apply two coats of primer to a total dry film build between 3 and 4 mils.

3.3 INSPECTION

- .1 All phases of surface preparation may be checked by Engineer. The latest NACE Visual Standards for Blast

Cleaned Surfaces will be used to determine compliance with standard. All primer materials and all phases of application are subject to inspection by Engineer.

- .2 Insufficient dry film thickness, bleeding, holidays, blisters, runs, sags, improper cure, dry spray, or extensive blemishes are causes for rejection.
- .3 All materials, application and workmanship not meeting this standard or manufacturer's instructions shall be repaired or replaced at contractor's expense.

3.4 SAFETY

- .1 In addition to safety requirements in contract documents, the paint formulator's safety recommendations shall be used.
- .2 Contractor's safety procurers, including the ventilation requirements of .3 below, must be discussed with the Engineer before work can begin. These procedures must conform to all applicable laws and regulations.
- .3 When applying primer in enclosed area, ventilation shall be provided during the time of application and three hours thereafter. Ventilation procedures must ensure that the air quality does not endanger the health of workers inside an enclosed area. Contractor shall follow all applicable laws and regulations. In addition, the contractor must also ensure that the air content inside any confined space never exceeds the permissible exposure limit (PEL) and one half the lower explosive limit (LEL) of any constituent of the paint system.
- .4 All smoking materials, matches, flames, and spark producing tools and equipment are prohibited within 15m of the application area.
- .5 Only portable lighting fixtures which are specifically approved as a complete assembly for use in a Class I, Division I location shall be used in enclosed areas when applying any part of a primer system. Supply voltage for lighting shall not exceed 32 volts.

1. GENERAL

1.1 REFERENCES (All references shall be the latest edition
including all addenda)

- .1 ANSI/ASME B31.1 Power Piping and B31.3 Process Piping.
- .2 ANSI/ASME Boiler and Pressure Vessel Code:
 - .1 Section 1: Power Boilers.
 - .2 Section V: Nondestructive Examination.
 - .3 Section IX: Welding and Brazing Qualifications.
 - .4 Section XIII, Division 1: Rules for Construction of Pressure Vessels.
- .3 CSA W47.2, Certification of Companies for Fusion Welding of Aluminum.
- .4 CSA W48 series, Electrodes.
- .5 CSA B51, Boiler, Pressure Vessel and Pressure Piping Code.
- .6 CAN/CSA-W117.2, Safety in Welding, Cutting and Allied Processes.
- .7 CSA W178.1, Certification of Welding Inspection Organizations.
- .8 CSA W178.2, Certification of Welding Inspectors.
- .9 CAN/CGSB-48, Spot Radiography of Welded Butt Joints in Ferrous Materials.
- .10 AWS B3. 0, Welding Procedures and Performance Qualifications.
- .11 AWS C1.1-66, Recommended Practices for Resistance Welding.
- .12 AWS W1, Welding Inspection.
- .13 Technical Standards and Safety Authority, Pressure Vessels Branch. (T.S.S.A.).
- .14 Ontario Boilers and Pressure Vessels Act.

- .15 ASTM A53, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
- .16 CSA W47.1, Certification of Companies for Fusion Welding of Steel Structures.
- .17 ASTM A105/A105M, Forgings, Carbon Steel, for Piping Components.
- .18 ASTM A106, Seamless Carbon Steel Pipe for High Temperature Service.
- .19 ASTM A193/A193M, Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
- .20 ASTM A234/A234M, Piping Fittings of Wrought Carbon and Alloy Steel for Moderate and Elevated Temperatures.
- .21 ASTM A307, Carbon Steel Bolts and Studs, 60,000 psi Tensile.
- .22 ASTM A182, Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
- .23 ASTM A403, Wrought Austenitic Stainless Steel Piping Fittings.
- .24 ASTM A312, Seamless and Welded Austenitic Stainless Steel Pipes.
- .25 AWWA C500, Metal Seated Gate Valves for Water Supply Service.
- .26 AWWA C504, Rubber Seated Butterfly Valves.
- .27 AWWA C508, Swing Check Valves for Waterworks Service, 2 in. to 24 in. NPS.
- .28 AWWA C509, Resilient Seated Gate Valves for Water Supply Service.
- .29 AWWA C510, Double Check Valve, Backflow Preventer Assembly.
- .30 AWWA C511, Reduced Pressure Principle Backflow Prevention Assembly.

- .31 AWWA C540, Power Actuating Devices for Valves and Sluice Gates.
- .32 AWWA C550, Protective Epoxy Interior Coatings for Valves and Hydrants.
- .33 AWWA C606, Grooved and Shouldered Joints.
- .34 AWWA C800, Underground Service Line Valves and Fittings.

1.2 WELDERS QUALIFICATIONS

- .1 Welding qualifications to be in accordance with CSA B51, T.S.S.A., B31.1 and Section IX of the ASME Boiler and Pressure Vessels Code.
- .2 Use qualified and licensed welders possessing certificate for each procedure to be performed from T.S.S.A.
- .3 Furnish welder's qualifications to Departmental Representative.
- .4 Each welder to possess identification stamp issued by T.S.S.A.
- .5 Certification of companies for fusion welding of aluminum to be in accordance with CSA W47.2.

1.3 INSPECTORS QUALIFICATIONS

- .1 Inspectors to be qualified to CSA W178.2, and T.S.S.A.

1.4 WELDING PROCEDURES

- .1 Registration of welding procedures in accordance with CSA B51 and T.S.S.A.
- .2 Copy of welding procedures to be available for inspection at all times.
- .3 Safety in welding, cutting and allied processes to be in accordance with CAN/CSA-W117.2.

1.5 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 44 00 10 - Process General Requirements and Section 01 33 00 - Submittals.

2. PRODUCTS

2.1 GENERAL

- .1 All products for use in compressed air piping systems shall be registered by the Technical Standards and Safety Authority, Pressure Vessels Branch, for use in a pressure piping system.
- .2 All products shall be in accordance with the requirements of ASME B31.1, "Power Piping" for compressed air system; and ASME B31.3 for other piping systems for "Normal Fluid Service".
- .3 Products shall be new, clean, and identifiable.
- .4 Screwed couplings shall be full length. (Half coupling are not permitted, unless specifically called for on the drawings).
- .5 Mill test reports and material certifications shall be available for the Departmental Representative's review, and shall be provided to the Departmental Representative if requested.
- .6 Reducing fittings used to join pipe or other components will be sized to have the "heavier" wall thickness.
- .7 All butt welding elbows shall be long radius, unless otherwise specified on the drawings.
- .8 Ball and plug valves on insulated lines will be supplied with extension stems to provide 50mm minimum clearance outside insulation.
- .9 Dimensions and construction of various classes of piping components, ie: fittings, flanges and valves shall be in accordance with the appropriate ANSI, API or MSS standards listed below:

All codes and standards shall be the latest edition.

Industry Standards:

ANSI-B16.34	Valves - Flanged, Threaded, and Welding End
API-598	Valve Inspection and Test
ANSI B16.10	Face -to-Face and End-to-End Dimensions of Valves
API602	Compact Carbon Steel Gate Valves, Class 800
API607	Fire Test for Soft Seated Quarter Turn Valves
MSS SP-25	Standard Marking System for Valves, Fittings, Flanges, and Unions
MSS SP-71	Cast Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-80	Bronze Gate, Globe, Angle and Check Valves
MSS SP-70	Cast Iron Gate Valves, Flanged and Threaded Ends
ANSI B16.11	Forged Steel Fittings, Socket Welding and Threaded
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings
ANSI B16.5	Pipe Flanges and Flanged Fittings
ANSI B16.10	Face-to-Face and End-to-End Dimensions of Valves
ANSI/ASME B16.20	Metallic Gaskets for Pipe Flanges - Right Joint, Spiral-Wound and Jacketed
ANSI/ASME B31.1	Power Piping
ANSI/ASME B31.9	Building Services Piping

- .10 Electrodes shall be in accordance with CSA W48 series. Select the appropriate electrode and filler for the piping being welded. Submit selections to Departmental Representative as part of shop drawing submissions.
- .11 All piping components including pipe, couplings, flanges, mechanical grooved couplings, nuts, bolts, supports, valves, valve actuators, etc., submerged in liquids and/or within 2 meters above the highest liquid level shall be stainless steel.
- .12 All piping, valves, gates, etc. installed on the potable water piping shall be NSF 61 certified and be suitable for potable water applications.

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PROCESS PIPING

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2.2 STAINLESS STEEL (TUBING)-SX1

ANSI RATING:	Not Applicable			PIPING MATERIALS:	Stainless Steel Tubing		
SERVICE LIMITS:	689 KPa @ 204°C 3448 KPa @ 177°C			CORROSION ALLOWANCE:	0.00mm		
ITEMS	NOMINAL SIZES		RATING	ENDS	TRIM	DESCRIPTION	TAG NO
	FROM	TO					
Tubing	----	6mm O.D.	----	----	----	SMLS,SS,tube,A269, Gr. TP-304,0.7mm wall thickness.	----
	----	10mm O.D.	----	----	----	SMLS,SS,tube,A269, Gr. TP-304,0.9mm wall thickness.	----
	----	12mm O.D.	----	----	----	SMLS,SS,tube,A269, Gr. TP-304,0.9mm wall thickness.	----
	----	20mm O.D.	----	----	----	SMLS,SS,tube,A269, Gr. TP-304,1.2mm wall thickness.	----
	----	25mm O.D.	----	----	----	SMLS,SS,tube,A269, Gr. TP-304,1.65mm wall thickness.	----
Fitting (Tube)	6mm O.D.	25mm O.D.	----	----	----	"SWAGelok" or equal, type 316SS compression type fittings.	----
Needle Valve	6mm	13mm	6000#	THD	316SS	Needle valve, 316SS body, bonnet & stem, PTFE packing	TNUAT
Globe Valve	½"	2"	200#	THD	Bronze	Bronze body, union bonnet, ISRS	BBHAB
	3"	4"	125#	FLG FF	Bronze	C.I. body, bolted bonnet, OS&Y	CBEHB

Note: Tubing shown on drawings is indicated as O.D.

2.3 STAINLESS STEEL PIPING (SA1)

ANSI RATING:	Class 150 RF			PIPING MATERIALS:	TP 304L Stainless Steel		
SERVICE LIMITS:	1586 KPa @ -29°C to 38°C 1103 KPa @ 177°C			CORROSION ALLOWANCE:	0.00mm		
ITEMS	NOMINAL SIZES (NPS)		RATING	ENDS	TRIM	DESCRIPTION	TAG NO
	FROM	TO					
Ball Valve Note: 1,2	%	10	CLASS 150	FLG RF	316SS	316SS body, reinforce PTFE seats, PTFE seals.	TFFFT
	12	20	CLASS 150	FLG RF	316SS	316SS body, reinforce PTFE seats, PTFE seals.	TFFFT
	%	2	ANSI CLASS 150	THD	316SS	Bronze body, PTFE seats, PTFE packing, chrome plated s/s ball	TFFFT
Check Valve Note: 9	%	2	ANSI Class 150	THD	Bronze	Bronze body, bronze swing disc, swing type	BCFAB
	2	20	300 CWP	125 FLG FF		Silent globe check valve, cast iron body, bronze seat, bronze disc, SS spring. FM approved.	CUEHA
Check Valve Supervised	2%	20	CLASS 125	FLG FF		Check valve, swing type with weight and lever. Iron body, bolted cover, s/s shafts c/w supervisory switch	CCEFT

2.3 STAINLESS STEEL PIPING (SA1)

ANSI RATING:	Class 150 RF			PIPING MATERIALS:	TP 304L Stainless Steel		
SERVICE LIMITS:	1586 KPa @ -29°C to 38°C 1103 KPa @ 177°C			CORROSION ALLOWANCE:	0.0mm		
ITEMS	NOMINAL SIZES (NPS)		RATING	ENDS	TRIM	DESCRIPTION	TAG NO
	FROM	TO					
Butterfly Valve	2%	20	175 CWP	Lug	316SS	Resilient seated butterfly valve, lug style, cast iron body, 316s/s disc & shaft, EPDM seat & seals. Lever actuator for up NPS 2%. Manual gear actuator for NPS 3 and above.	CHGLT
OS&Y Gate Valves	2%	12	250 CWP	FLG FF	316SS	OS&Y, Cast iron body, EPDM coated DI wedge, resilient seated, ULC Listed/FM Approved	CAJHA
OS&Y Gate Valves (Supervised)	2%	12	250 CWP	FLG FF	316SS	OS&Y, Cast iron body, EPDM coated DI wedge, resilient seated, ULC Listed/FM Approved, c/w supervisory switch	CAJHA
Globe Valve	2	10	200 CWP	FLG FF	Bronze	Cast iron body, bronze trim, disc	CBHBB
Knife Gate Valve	2	24	150 CWP	Lug	316SS	304s/s body, 304s/s gate, EPDM seat	RVFLT

2.3 STAINLESS STEEL PIPING (SA1) - Cont'd

ANSI RATING:	Class 150 RF			PIPING MATERIALS:	TP 304L Stainless Steel		
SERVICE LIMITS:	1586 KPa @ -29°C to 38°C 1103 KPa @ 177°C			CORROSION ALLOWANCE:	0.00mm		
ITEMS	NOMINAL SIZES (NPS)		RATING	ENDS	TRIM	DESCRIPTION	TAG NO
	FROM	TO					
Vent & Drain Valve	¾	1%	ANSI Class 150	THD	316SS	Bronze Body, PTFE seats, PTFE seal, 2 piece construction chrome plated s/s ball	BFFAT
Pipe:	¾	2	S/40S	PE	----	Electric fusion welded stainless steel, A312 TP304L, Joint Eff. = .80.	----
	2%	24	S/10S	BE	----	Electric fusion welded stainless steel, A312 TP304L, Joint Eff. = .80.	----
Nipple	¾	2	Note:7	As req'd	----	Smls stainless steel, A312, TP304L, 2", 3", and 4" long.	----
Swages	¾	6	Note:7	As req'd	----	Smls stainless steel, A312, TP304L.	----
Flange (Welded)	¾	¾	150 RF	SW	----	SS, A182 Gr. F304L	----
	1	24	150 RF	----	----	Blind flange SS, A182 GR. F304L	----
	1	24	150 RF	----	----	SS, A182 Gr. F304L, slip-on or weldneck	----
	1	24	150 FF	----	----	Lap-joint carbon steel A105, for use with stub ends. Galvanized	----
Flange (Groove) Note:2	¾	24	150 RF	----	----	Blind FLG. SS, A182 Gr. F304L.	----
	2%	24	Note:3	GE	----	Ductile iron adapter flange.	----

2.3 STAINLESS STEEL PIPING (SA1) - Cont'd

ANSI RATING:	Class 150 RF			PIPING MATERIALS:	TP 304L Stainless Steel		
SERVICE LIMITS:	1586 KPa @ -29°C to 38°C 1103 KPa @ 177°C			CORROSION ALLOWANCE:	0.00mm		
ITEMS	NOMINAL SIZES (NPS)		RATING	ENDS	TRIM	DESCRIPTION	TAG NO
	FROM	TO					
Coupling (s/s) (Groove) Note: 2,4	2%	24	Note: 3	GE	----	Cast type 304 stainless steel housing with EPDM gaskets for water service and fluoroelastomer for air service	----
Coupling (c/s) (Groove) Note: 2,5	2%	24	Note: 3	GE	----	Cast type carbon steel housing with EPDM gaskets for water service and fluoroelastomer for air service	----
Stub End	1	24	S/10S	BE	----	Lap-stubs, MSS Type A Short, SS, A403 Gr. WP 304L.	----
Fitting	%	2	3000#	SW	----	Socket weld, SS, A182 Gr. F304L.	----
	2%	24	S/10S	BE	----	Butt weld, SS. A403 Gr. WP 304L.	----
Fitting Notes:10	2%	10	S/10S	GE	----	Grooved end, ss A403 Gr. WP 304L	----
Union	%	2	150#	THD	----	Unions to be type 304 s/s. General dimensions to conform to ASA B16.3 for M.I. screwed fittings	----
Bolting	Alloy stud bolts, A193 Gr. B8 with heavy hex nuts A194 Gr. 8						----
Gasket Notes:6	1/8" thick, full face, neoprene rubber or EPDM, punched holes to match class of flanges as required.						1AP

2.3 STAINLESS STEEL PIPING (SA1) - Cont'd

ANSI RATING:	Class 150 RF			PIPING MATERIALS:	TP 304L Stainless Steel		
SERVICE LIMITS:	1586KPa @ -29°C to 38°C 1103KPa @ 177°C			CORROSION ALLOWANCE:	0.00mm		
ITEMS	NOMINAL SIZES		RATING	ENDS	TRIM	DESCRIPTION	TAG NO
	FR OM	TO					
Instr. Conns. Note:2	Pressure:		Piping Conn:	NPS	3/4 SW		BFFAT
			Instr. Conn:	NPS	3/4 FNPT		
			Block Valve:			3/4 THD Ball Valve	
	Flow:		Piping Conn:	NPS	% FNPT (seal weld at orifice flg's)		BFFAT
			Instr. Conn:	NPS	% FNPT		
			Block Valve:			% THD Ball Valve	
	Temperature:		Instr. Conn:	NPS	1 FNPT		
	NOTES: 1. For NPS 2 and smaller sizes, use flanged valves when mating against flanged vessel or equipment nozzles. Otherwise use threaded valves. 2. End type GE denotes grooved end per manufacturer's specifications. 3. Grooved end couplings maximum joint working pressure as per manufacturer's limitations for groove type and gasket material limitations. 4. S/S grooved end couplings to be used where piping submerged in fluid. 5. C/S coupling not to be used if joint submerged in fluid. 6. Gaskets referenced are acceptable, as noted, for all fluids contained in SA1 piping. 7. Use Sch. 80S for all threaded nipples and swages. Wall sch. To match pipe for all plain and beveled end swages and nipples. 8. Not Used 9. Not Used 10. Glavanized Victaulic couplings will be the Standard of Acceptance for grooved couplers and fittings.						VIC

2.4 PVC PIPING (PA7)

ANSI RATING:	Class 150 FF			PIPING MATERIALS:	Polyethylene (HDPE)/Polyvinyl Chloride (PVC)		
SERVICE LIMITS:	1034 KPa @ -18°C to 21°C 758 KPa @ 49°C			CORROSION ALLOWANCE:	0.00mm		
ITEMS	NOMINAL SIZES (NPS)		RATING	ENDS	TRIM	DESCRIPTION	TAG NO
	FROM	TO					
Ball Valve Note: 7	%	6	Class 150	Socket	PTFE	PVC true union, PTFE seats, Viton seal	8FFCO
Check Valve Note: 5	%	4	150#	Socket	PTFE	PVC body, union body, Viton seals, ball type.	88FCO
Pipe	%	8	S/80	PE	HDPE	NSF 61, AWWA 900	----
Flange	%	8	Class 150 FF	Socket	PVC	ASTM D2467, PVC 1120 or 1220	----
Fitting Note: 7	%	8	S/80	Socket	PVC	ASTM D2467, PVC 1120 or 1220	----
Bolting	All	Hex head carbon steel machine bolts with heavy hex nut and two flat washers each, galvanized. ASTM A307 Gr. B.					----
Gasket Note: 4	All	EPDM rubber, full face, punched holes, 1/8" thick.					1AP
Instr. Conns.	Pressure: Piping Conn: NPS ¾ Socket Instr. Conn: NPS ¾ FNPT Bleed Valve: NPS ¾ Ball Valve, SW x THD. Block Valve: NPS ¾ Ball Valve, SW Flow: Piping Conn: NPS % SW Instr. Conn: NPS % FNPT Block Valve: NPS % Ball Valve, SW x THD Temperature: Instr. Conn: NPS 1 FNPT						8FFVO 8FFCO 8FFVO

2.4 PVC PIPING (PA7) - Cont'd

ANSI RATING:	Class 150 RF			PIPING MATERIALS:	TP 304L Stainless Steel		
SERVICE LIMITS:	1034 KPa @ -18°C to 21°F 758 KPa @ 49°C (Note:6)			CORROSION ALLOWANCE:	0.00		
ITEMS	NOMINAL SIZES		RATING	ENDS	TRIM	DESCRIPTION	TAG NO
	FR OM	TO					
	<p>NOTES:</p> <ol style="list-style-type: none"> 1. For potable water service: <ul style="list-style-type: none"> · CSA Seal of Approval is required. · Mains shall be disinfected per Part 7, Ontario Building Code 2. Method of joining shall be by solvent cementing. Flush the piping to remove completely excess solvent cement prior to putting in service. 3. Installation shall be in strict accordance with manufacturer's procedures. 4. Refer to Gasket List. 5. Where PVC piping passes through a fire rated wall or ceiling use fire stop device certified to CAN4-S115 and ULC listed. 6. Service limits indicate pressure ratings for pipe up to NPS8 diameter, fittings up to NPS 6 diameter. Consult manufacturer for pressure ratings of NPS 8 fittings. 7. Use ball valves for vent and drain connections. 						

2.5 VALVE LIST

- .1 Valves shall be as listed in the Valve List attached to the process specification.

2.6 GASKET LIST

TAG NO.	Description/Acceptable Material	Rating PSI
1AP	1/8" thick, Ethylene Propylene Rubber (EPR or EPDM), full face, punched holes Standard of Acceptance: Garlock 8314	125#
2AK	1/8" thick restructured PTFE with barium sulfate filler, ring type. Standard of Acceptance: Garlock style 3504, "Gylon" blue	150#
3XA	1/8" thick, Klingerite 3XA gaskets containing neoprene and styrene butadiene rubber with asbestos filler.	150#
5AF	Spiral wound gasket, 304 stainless steel and flexible graphite sealing material, 1/8" thick CS gage ring, API 601/ B16.20 (latest issue), yellow with gray stripes. Standard of Acceptance: <u>Flexitallic</u> <u>Parker</u> <u>Lamons</u> <u>Fluorocarbon</u> Type CG 913 WR Flexseal Style RW	150#

2.7 PRESSURE GAUGES

- .1 Industrial pressure gauge, 112mm dia. face, reinforced thermal plastic case with pressure relieving back, stainless movement components, high temperature acrylic window, wetted parts to be 316 stainless steel, ANSI B40.1 Grade 2A - 0.5% full scale accuracy, NPS ... stem bottom mounting, liquid filled.
- .2 All Pressure gauges on discharge side of pump shall have a range of 0 to 1380 kPa (0 to 200 psig). All pressure gauges on suction side of pumps shall have a range of -101 kPa to 0 to 103 kPa (-30" Hg to 0 to 15 psig).
- .3 Orientation of pressure gauges on pipe circumference shall be coordinated with Departmental Representative.

2.8 FLEXIBLE CONNECTION

- .1 For Flexible Connection of standard lengths:
 - .1 Type 316L s/s braided, corrugated metal hose complete with Class 150 raised face stainless steel flanges.
 - .2 Maximum working pressure to be 1064KPa @ 177°C.
 - .3 Length: 300mm flange to flange, minimum live length of 216mm.
- .2 For Flexible Connections requiring short lengths:
 - .1 Multi-ply stainless steel bellows complete with Class 150 carbon steel flat faced flanges.
 - .2 Maximum working pressure to be 1446KPa @ 121°C.
 - .3 Overall face to face length to be 150mm for nominal pipe sizes of 50mm thru 200mm inclusive, and 200mm face to face for nominal pipe sizes of 250mm thru 350mm inclusive.

2.9 QUICK CONNECT

- .1 Quick connectors shall be Kamlock type quick connectors, constructed of 304L or 316L stainless steel, seals to be compatible with piping service. Flanged ends for pipe connections NPS 2½ and larger, threaded ends for connections NPS 2 and smaller. Couplers shall be NSF 61 Certified.
- .2 Provide female cap with chain for male end.
- .3 Sizes: Line size as per drawings.

2.12 SINGLE BRAIDED STANDARD PRESSURE HOSE

- .1 Single braided standard pressure hose.
- .2 Material to be SS321 Stainless Steel complete with FNPT connections.

- .3 Size: 6 to 50 mm
- .4 Length: As required to suite site conditions with adequate additional length to provide easy manipulation and handling of hose.
- .5 Minimum hose working pressure: 2600 kPa.

3. EXECUTION

3.1 INSTALLATION

- .1 Piping and piping components shall be installed, fabricated, assembled and tested in accordance with drawings, specification, the ASME/ANSI code B31.1, "Power Piping" for compressed air, ASME B31.3 (Normal Fluid Service) for other piping systems and the T.S.S.A., Boilers and Pressure Vessels Act. Potable water shall be installed as per Part 7 of the Ontario Building Code.
- .2 Piping and components shall be installed free of all foreign materials.
- .3 Threaded connections which are not seal welded shall be made up using an approved thread sealant. Threaded connections which are seal welded (back welded) shall be made up dry. Sealants shall be as specified below:
PTFE Tape - any screwed pipe joint (up to 260°C)
PTFE Liquid or Paste - any screwed pipe joint (up to 260°C).
- .4 Bolt threads except Teflon-coated bolts and studs, shall be coated prior to assembly with an approved lead free thread compound.
- .5 Heat tracing shall be installed by the Contractor in accordance with drawings and specifications.
- .6 Vents and Drains
 - .1 Valved process vents shall be provided at high points of pipelines and equipment. Equipment vents may be located in overhead piping, provided no valves or blinds are located between vent connections and vessels.

- .2 Valved drains shall be provided at low points to empty pipe lines or equipment.
- .3 Process vent, drain and sample connections shall be a minimum of NPS 3/4 size. For lines smaller than NPS 3/4, vent, drain and sample connections are to be line size.
- .4 Vents and drains shall consist of a branch connection with a nipple, a valve and a plug. Nipple length shall be equal to the insulation thickness plus three inches.
- .5 Any additional vents or drains which may be required strictly for hydrostatic tests are not shown on the drawings. Contractor shall provide hydrostatic vents in welded pipe as required, which shall be plugged and backwelded after the test. Hydrostatic vents in nonwelded pipe shall be plugged. On insulated lines, the length of the plug will be sufficient to protrude through the insulation. In the event a drain is installed for hydrotesting, it shall be provided with a valve which will be retained as a drain valve after the test.
- .6 Process line vent, drain, and sample valves must be plugged, capped, or flanged, unless piped to receptacles.
- .7 Drains emptying into open receptacles or floor drains shall terminate a minimum of 50mm above the receptacle and be visible from the drain valve.
- .7 Provide clearance for installation of insulation and access for maintenance of equipment, valves and fittings.
- .8 Connect equipment in accordance with manufacturer's instructions unless otherwise indicated.
- .9 Cap open ends of piping during installation.
- .10 Revisions to location of piping require approval of Departmental Representative.
- .11 Provide flanged unions in compressed air piping before

and after pressure regulators, rotometers or other equipment requiring regular maintenance.

- .12 Install piping, joints, fittings, valves and other items in accordance with manufacturer's recommendations, except where there is conflict between Contract Documents and manufacturer's recommendations, in which case Departmental Representative will decide.
- .13 Become informed of installation requirements and dimensions of equipment required to be connected to piping. Where piping is to be connected to equipment, preliminary dimensions have been shown which are not warranted and should be confirmed by Contractor prior to bidding. Contractor shall install and fabricate piping to suit equipment as selected.
- .14 Contractor shall install all control devices for Division 44 work in the piping. Connection size and type to match requirements of equipment. Device locations to be as per control manufacturers directions or as indicated by Departmental Representative.
- .15 All piping components including pipe, couplings (flanges, mechanical grooved end couplings, bolting, nuts, etc.) supports, valves and valve actuators submerged in liquids shall be stainless steel.

3.2 FABRICATION

Piping and piping components shall be fabricated and tested in accordance with ASME B31.1 for compressed air systems, and the T.S.S.A., "Boiler and Pressure Vessels Act". Other piping systems shall be fabricated and tested in accordance with ASME B31.3 (for Normal Fluid Service) and manufacturer's recommendations.

- .1 Welding
 - .1 Welding procedures and welders shall be qualified in accordance with Section IX of the ASME Boiler and Pressure Vessel Code, CSA B51, and T.S.S.A. Boiler and Pressure Vessels Act.
 - .2 Welding procedures and welder qualifications shall be submitted to the Departmental Representative for review and approval prior to start of fabrication. GMAW (MIG) welding using the short

circuiting arc mode of transfer is limited to welds that will be backgouged and backwelded and to minor structural welds.

- .3 All austenitic stainless steels, and nickel-based and other non-ferrous alloy piping shall be welded using the GTAW (TIG) weld process on the root pass with argon gas back purge.
- .4 To ensure weld quality, GTAW (TIG) welding is recommended for the root pass of all carbon and low alloy steel piping less than or equal to 50mm nominal diameter. SMAW (stick) welding is acceptable only if the welder can demonstrate either through test pieces or radiography that he can produce satisfactory welds in small diameter pipe.
- .5 Changes in size of "threaded lines" shall be made with reducing bushings, reducing couplings, reducing tees or swaged nipples.
- .6 Preheating before welding shall be in accordance with the applicable section of the ASME/ANSI Code B31.1. Post weld heat treatment, when required by the ASME/ANSI B31.1 Code, shall be in accordance with the applicable section of the ASME/ANSI Code B31.1.
- .7 If threaded fittings are backwelded, each leg of the fillet shall be equal to or greater than the thickness of the "female" section.
- .8 Piping shall be cleaned externally and internally to remove slag and other surface defects.
- .9 Unless noted otherwise, all temporary lugs shall be the same material as the pipe. After removal, the surface shall be ground flush and smooth without reducing wall thickness.
- .10 Branch connections using integrally reinforced fittings shall be such that the hole in the main line matches ID of the fitting.
- .11 Backing rings are not allowed for any weld.
- .12 All pipe welds shall be stenciled to identify the

welder. Punch marks are not permitted.

- .13 After fabrication, immerse all pipe assemblies in pickling solution in manufacturer's plant. Scrub and wash until discolourization and possible iron picked up from manufacturing process is removed.
- .14 Field welds - treated with pickling pasts, scrubbed and washed with stainless wire brushed until clean. Use stainless steel brushes.
- .15 Completed pipe lines - washed with steam or hot water to remove any dirt picked up during transport to construction site.
- .16 During fabrication and installation, avoid contact of stainless steel pipe with structural steel, chain, wire-ropes, steel tools, cement, other building materials, etc. as the contamination of the stainless steel may lead to marks due to rusting or imbedded material.

.2 Flanges

- .1 Pressure rating and facing of all flanges NPS24 and smaller shall be in accordance with ANSI B16.5.
- .2 All flange bolt holes shall straddle the vertical centerline or the established north-south centerline noted on the drawings, unless noted otherwise.
- .3 Flange face shall be free from weld splatter, mars, and scratches.
- .4 Slip-on flanges shall be continuously welded both inside and outside. The inside fillet weld shall be built up to the pipe wall thickness and shall conform to Fig. 328.5.2B, Detail 1 of 2 of ASME/ANSI B31.3 (1989) Revision).
- .5 Orifice flange taps shall be installed in the exact orientation shown on the drawings. The orifice flanges shall be weld neck type with 300# ANSI Rating (Minimum), and bored to match pipe.

.3 Pipe

- .1 Reinforcing pads shall be used only where called for in the specification or as required by B31.1. Material shall be the same as the pipe, unless otherwise approved. Refer to Branch Connections Section.
 - .2 All attachments to stress relieved piping shall be welded before stress relieving is performed. If welding is performed on stress relieved piping, local stress relieving is required per the applicable section of the ASME/ANSI Piping Code, B31.1.
 - .3 Thermometer and thermocouple weld connections shall be installed in accordance with drawings and/or specifications.
 - .4 If at all possible, welds should not rest on pipe supports. If it is not possible, then welds which interfere with movement of lines on supports shall be ground flush.
 - .5 Root pass require full uniform penetration without weld shrinkage, porosity or incomplete penetration and provide uniform reinforcement smoothly blended into parent metal surfaces. After each pass, remove slag and flux from each by chipping before proceeding. Thoroughly clean complete bead or layer by chipping and wire brush using only stainless steel tools and brushes. Remove weld splatter from pipe ends and weld surfaces before laying down the next successive bead or layer. Grind away any cracks or blow holes that appear on the surface of any bead of welding before depositing the next successive bead. Finished welds shall have full penetration with no shrinkage or porosity.
- .4 Threaded Joints
- .1 In order to make tight screwed joints, the threads of pipe and fittings are to be cut with sharp dies and tools and wiped clean. The screwed joint is to be made up with a thread lubricant applied to the male thread. Approved compounds are:
PTFE Tape - any screwed pipe joint (up to 260°C)
PTFE Liquid or Paste - any screwed pipe joint (up

to 260°C)
Threaded connections which are to be backwelded shall be made up dry.

.5 Branch Connections

- .1 All lines which connect to another line or header, including instrument connections, vents and drains are considered branch connections. Reinforcement at branch connections shall meet:
- Pressure/temperature limitations as stated at ANSI/ASME B31.1, Power Piping.
 - External loading determined by pipe stress analysis.
- .2 All size-to-size branch connections shall be tees in all pressure classes.
- .3 Reinforcement will be as shown in the Branch Connections Tables. When pad reinforcement is specified in the Tables, the minimum pad width shall be as shown below. The pad thickness shall be no less than the header wall thickness.

Branch Size NPS	2	3	4	6	8
Pad Width mm	25	38	50.8	76	102

- .4 When a line of lower pressure rating connects to a line of higher pressure rating, the higher pressure rating shall determine the piping up to and including the first shut-off valve in the line carrying the lower pressure rating.
- .5 Vents, drains, instrument connections and short extensions subject to mechanical damage shall use 'olets.
- .6 The following Branch Connection Tables indicate

the type of construction requirements:

.1 Branch Connections

Table I - For Carbon Steel Piping

Symbols

P - Reinforcing Pad

T - Tee

X - Threaded or Socket Integrally Reinforced Fitting (threadolet or sockolet)

W - Integrally Reinforced Fitting (weldolet)

Notes:

For size-to-size connections - use tees. For NPS 1-1/2 and smaller branches - use reinforcement. NPS 2 and larger branches - use reinforcement, only if required; stub-in connections are permitted if branch connections have adequate strength in accordance with para. 3.2.5.1.

Branch (across in Inches) by Header (Down in Inches)

	1/2	3/4	1	1.5	2	3	4	6	8
1/2	T								
3/4	T	T							
1	T	T	T						
1.5	T	T	T	T					
2	X	X	X	X	T				
3	X	X	X	X	W	T			
4	X	X	X	X	W	W	T		
6	X	X	X	X	W	W	W	T	
8	X	X	X	X	W	W	W	W	T

.2 Branch Connections

Table II - For Stainless Steel Piping

Symbols

T - Tee

X - Threaded or Socket "Half" Couplings

*W - Integrally Reinforced Fittings (Weldolet)

P - Reinforcing Pad

* Integrally reinforced fittings for use on schedule 10S (or lighter) shall be "light weight" fittings.

Notes:

For size-to-size connections - use tees. For NPS 3/4 and smaller branches - use reinforcement. For NPS 1 and larger branches - use reinforcement, only if required; stub-in connections are permitted if branch connections have adequate strength in accordance with para. 3.2.5.

Branch (across in Inches) by Header (Down in Inches)

	1/2	3/4	1	1.5	2	3	4	6	8
1/2	T								
3/4	T	T							
1	X	X	T						
1.5	X	X	W	T					
2	X	X	W	W	T				
3	X	X	W	W	P	T			
4	X	X	W	W	W	P	T		
6	X	X	W	W	W	W	P	T	
8	X	X	W	W	W	W	W	P	T

.6 Fabrication Tolerances

The following dimensional tolerances for fabrication shall be adhered to and linear tolerance shall not be cumulative:

- .1 Length and other linear dimensions
 - 3.2mm dia. up to NPS10
 - 4.8mm NPS 12 dia. to NPS 24 dia.

- .2 Flattening
 - a) Piping subject to internal pressure
 - 8% of nominal pipe size
 - b) Piping subject to external pressure
 - 3% of nominal pipe size

- .3 Flange Face Alignment
 - a) Flange to Flange 1.2mm per 300mm or 0.8mm
Whichever is greater
 - b) The plane across the gasket seating surface shall be perpendicular to the theoretical centerline of the pipe within:
 - 1.2mm per 300mm or 0.8mm
 - Whichever is greater

- .4 Bolt hole location deviation from centerline
 - 1.6mm

- .5 In line pipe joint alignment: maximum permissible parallel misalignment
 - 1.6mm

- .6 Placement of branch connection form indicated
 - Same as 3.2.6.1.

3.3 CLEANING

- .1 The Contractor will internally clean and, if necessary, flush all piping to remove all large debris prior to turning over the systems to the Departmental Representative. Following hydrostatic test and flushing contractor shall blow out piping using plant compressed air supply to remove all moisture and other debris.

3.4 INSPECTION AND TESTS

.1 General

- .1 Perform examinations and test by specialist qualified in accordance with CSA W178.1 and CSA W178.2 and approved by Departmental Representative. Personnel qualification shall be in accordance with SNT-TC-1A, Recommended Practice for Non-Destructive Testing Personnel Qualification and Certification. Contractor shall provide written verification of radiography technicians qualifications.
- .2 To ANSI/ASME Boiler and Pressure Vessels Code, Section V, CSA B51 and requirements of T.S.S.A.
- .3 Hydrostatically test all welds to requirements of ANSI/ASME B31.1 for compressed air, B31.3 for other piping and ANSI/ASME Boiler and Pressure Vessels Code. Where welds can not be hydrostatically tested, provide non destructive testing per ANSI/ASME B31.1, B31.3 and ANSI/ASME Boiler and Pressure Vessels Code.
- .4 Defects causing rejection shall be determined as described in ANSI/ASME B31.1, B31.3 and ANSI/ASME Boiler and Pressure Vessels Code.
- .5 Repair of welds which failed tests shall be reinspected and retested at Contractor's expense. If any welds fail radiograph tests, tests shall be extended to all welds made by the welder responsible and at the contractor's expense.
- .6 Claims against Departmental Representative for delays in completion of project will not be entertained for reasons of failures of welds to pass examinations.
- .7 The Departmental Representative shall have the right to select the welds to be radiographed, unless waived in writing.
- .8 Formulate "Inspection and Test Plan" in cooperation with Departmental Representative.
- .9 Do not conceal welds until they have been

inspected, tested and approved by the inspector.

.10 Contractor shall provide inspector and pay for all costs of testing and inspection.

.2 Inspections

.1 All piping shall be subject to the visual examination requirements of the ASME/ANSI Code B31.1 and B31.3. A minimum sample of 5% of all welds shall be non-destructively examined as per requirements of ASME/ANSI B31.3 Normal Fluid Service.

.2 Upon failure of a weld by visual examination, perform additional testing as directed by Owner of a total of up to 10% of all welds, selected at random by Departmental Representative by radiographic test.

.3 All phases of shop and field pipe fabrication shall be subject to inspection by the Departmental Representative. Dimensional accuracy shall be subject to check against the drawings and the tolerances specified in the specifications, or the drawings, whichever are more stringent. Responsibility for dimensional accuracy lies with the erection contractor.

.4 The Departmental Representative may, at his expense, radiograph any weld. Repair of any faulty weld and subsequent radiography of any required weld shall be at contractor's expense.

.5 Failure of radiographic tests:

.1 If any weld fails tests, tests shall be extended to all welds made by the welder responsible and at the cost of the contractor.

.6 Certifications and Records. The examiner shall be assured, by examination of certifications, records, and other evidence, that the materials and components are of the specified grades and that they have received required heat treatment, examination, and testing. The examiner shall provide the Inspector with a certification that all the quality control requirements of the Code

and of the Engineering design have been carried out. Radiograph films shall become the property of the Departmental Representative upon completion.

.3 Testing

All piping shall be hydrostatically pressure tested in the field after erection in accordance with the applicable ASME/ANSI Code B31.1 for compressed air piping, B31.3 for other piping and as modified by specification section 44 01 27, Field Pressure Testing of Piping.

3.5 RECORDS

.1 The records outlined below shall be kept by the Contractor/Vendor and be ready for correlation between test records and item tested and for Departmental Representative's review (such as radiography of a weld).

- .1 Material Certification Reports
- .2 Mill Test Report(s)
- .3 Welding Procedure(s)
- .4 Welders Qualification Record(s)
- .5 Hydrostatic or Pneumatic Test Record(s)
- .6 Non-Destructive Examination Record(s)
- .7 Heat Treatment Record(s) including charts showing time and temperature of heat treatment

3.6 PAINTING

.1 Contractor shall clean and apply required coatings to all carbon steel and stainless steel piping and pipe supports in accordance with specification Section 44 01 46, Field Painting.

SIZE (mm)	SPECIFICATION	RATING	ENDS TYPE	DESCRIPTION
65-300	CAJHA	250 CWP	FLANGED	OPEN STEM AND YOKE GATE VALVE, CAST IRON CONSTRUCTION, RESILIENT WEDGE. ENDS STYLE TO BE FLANGED ANSI CLASS 125. CAST IRON, ASTM A126, CLASS B BODY. CAST IRON SBR COATED COATED A126 CLASS B, BRONZE STEM ASSEMBLY B584/B21, BUNA-N O-RING AND STEM O-RING, GRAPHITE IMPREGNATED PACKING, CAST IRON PAKCING GLAND A126 CLASS B, CAST IRON BONNET A126 CLASS B, CAST IRON HANDWHEEL ACTUATOR. VALVES TO BE ULC LISTED/FM APPROVED. SUPERVISED VALVES SHALL BE SUPPLIED WITH TWO SPDT PRE-WIRED SWITCHES RATED AT 10A @ 125 VAC AND 0.5A @125 VDC. SWITCH 1 SUITABLE FOR CONNECTION TO A SUPERVISORY CIRCUIT OF A UL LISTED ALARM CONTROL PANEL AND SWITCH 2 THAT MAY BE CONNECTED TO AUXILARY DEVICE. SUPERVISORY SWITCH TO MONITOR VALVE IN NORMAL POSITION.
100-300	CEGGT	175 CWP	GROOVED	ECCENTRIC PLUG VALVE, CAST IRON CONSTRUCTION, RESILIENT FACED PLUG. ENDS STYLE TO BE FLEXIBLE GROOVED ENDS (STYLE 31). 316 STAINLESS STEEL ASTM A743 GRADE CF-8M BODY . 316 STAINLESS STEEL PLUG. 316L STAINLESS STEEL BODY BEARING. PACKING TO BE BUNA (NITRILE BUTADIENE) FILED TFE U-RING SEAL. NEOPRENE (CHLOROPRENE) PLUG FACING. HANDWHEEL GEAR ACTUATOR. GREASE FITTING IN BODY AND BONNET. C/W EXTERNALLY ADJUSTABLE PACKING.
50-600	RVFLT	150 CWP	LUG STYLE BODY	KNIFE GATE VALVE, 304SS VALVE BODY AND GATE, EPDM RESILIENT SEALS, LUGGED BODY TO FIT ANSO B16.5 CLASS 150, VALVES 200 AND SMALLER PROVIDE HANDWHEEL ACTUATOR, VALVES 250 AND LARGER PROVIDE FULLY ENCLOSED GREASE PACKED BEVEL GEAR ACTUATOR COMPLETE WITH 90 DEGREE MITRE WITH 50 NUT AND HANDWHEEL. MAXIMUM OPERATING RIM PULL ON THE MANUAL OPERATOR AT 340 KPA PRESSURE DIFFERENTIAL SHALL NOT EXCEED 180N.
50-250	CBHHB	200 CWP	FLANGED	GLOBE VALVE, CAST IRON CONSTRUCTION, ENDS STYLE TO BE FLANGED ANSI CLASS 125/150. CAST IRON, ASTM A126, CLASS B BODY. BRONZE TRIM, BRONZE DISC,
50-500	CHGLT	175 WOG	LUG STYLE BODY	RESILIENT SEATED BUTTERFLY VALVE WITH OFFSET DISC AND LUG STYLE BODY. CAST IRON, ASTM A126 CLASS B BODY. 316 STAINLESS STEEL, ASTM A743, GRADE CF-8M DISC. 316 STAINLESS STEEL, ASTM-A276 SHAFT. EPDM SEAT. PTFE STAINLESS STEEL COATED BEARING, EPDM SHAFT SEAL. 316 S/S TRIM. ANSI CLASS 125 LUGGED END CONNECTIONS. LEVER (10 POSITION) ACTUATOR FOR SIZES UP TO NPS 2 1/2. MANUAL GEAR ACTUATOR FOR SIZES NPS 3 AND ABOVE.
65-200	CCEFT	CLASS 125	FLANGED	CHECK VALVE FOR LOW LIFT APPLICATIONS. IRON BODY, BOLTED COVER, SWING CHECK, WEIGHT AND LEVER TYPE WITH STAINLESS STEEL SHAFTS, DOUBLE "O" RING PACKINGS WITH GREASE FITTINGS.
250-600	CCEHA	CLASS 125	FLANGED	AIR CUSHIONED SWING CHECK VALVE. CAST IRON BODY, CAST IRON DISC FACED WITH A RENEWABLE EPDM RESILIENT SEAT RING, STAINLESS STEEL SEAT, WEIGHT AND LEVER TYPE WITH STAINLESS STEEL SHAFT C/W STUFFING BOX AND ADJUSTABLE PACKING.

SIZE (mm)	SPECIFICATION	RATING	ENDS TYPE	DESCRIPTION
12-50	BFFAT	CLASS 150	THREADED	BALL VALVE, BRONZE BODY, CHROME PLATED STAINLESS STEEL BALL, PTFE TEFLON ADJUSTABLE PACKING, BRASS GLAND AND PTFE TEFLON BUNA N SEAT. SCREWED ENDS, STEEL LEVER HANDLE.
12-50	BCFAB	CLASS 150	THREADED	CHECK VALVE, BRONZE BODY, ASTM B62, THREADED BONNET, INTEGRAL SEAT, RENEWABLE DISC, SWING TYPE, BRONZE TRIM
50-500	CUEHA	CLASS 125	FLANGED	SILENT GLOBE CHECK VALVE, CAST IRON BODY ASTM A126 CLASS B, BRONZE ASTM 5884 SEAT AND PLUG, STAINLESS STEEL T302 ASTM A313.5 SPRING, BRONZE ASTM B584, 300 PSI RATING, FM APPROVED.
12-50	BFOAB	300# @ 250 F	THREADED	BALL VALVE, BRASS BODY, BRASS BALL AND STEM, B30 ALLOY 857, OR B16, BLOW-OUT PROOF STEM, 2 PIECE BODY WITH FASTENERS OR ONE PIECE BODY WITH INSERT, PTFE SEATS AND SEALS, LEVER OPERATED.
12-250	TFFFT	CLASS 150	FLANGED	BALL VALVE, CAST 316SS BODY, ASTM A351 GR. CF8M, 316SS BALL AND STEM, BLOW-OUT PROOF STEM, REINFORCED PTFE SEATS, PTFE SEAL, 75 LEVER OPERATED, 100 AND LARGER GEAR OPERATED. PROVIDE 120V ON/OFF ELECTRIC ACTUATOR WHERE INDICATED.
300-500	TFFFT	CLASS 150	FLANGED	BALL VALVE, CAST 316SS BODY, ASTM A351 GR. CF8M, 316SS BALL AND STEM, BLOW-OUT PROOF STEM, REINFORCED PTFE SEATS, PTFE SEAL, GEAR OPERATED. PROVIDE 120V ON/OFF ELECTRIC ACTUATOR WHERE INDICATED.
12-50	TNUAT	6000#	THREADED	NEEDLE VALVE, 316SS BODY, BONNET & STEM, PTFE PACKING, THREADED ENDS
12-50	8FFCO	CLASS 150	SOCKET WELD	BALL VALVE, PVC BODY, TRUE UNION, PTFE SEATS, VITON SEALS, NPS 1 AND SMALLER OVAL OR ROUND HANDLE OPERATED, NPS 1 1/2 AND LARGER LEVER OPERATED.
75-150	8FFCO	CLASS 150	SOCKET WELD	BALL VALVE, PVC BODY, TRUE UNION, PTFE SEATS, VITON SEALS, NPS 1 AND SMALLER OVAL OR ROUND HANDLE OPERATED, NPS 1 1/2 AND LARGER LEVER OPERATED.
12-50	88FCO	CLASS 150	SOCKET WELD	CHECK VALVE, BALL TYPE CHECK, PVC BODY AND BALL, UNION BODY, VITON SEALS
75-150	88FCO	CLASS 150	SOCKET WELD	CHECK VALVE, BALL TYPE CHECK, PVC BODY AND BALL, UNION BODY, VITON SEALS
12-50	8FFAO	CLASS 150	THREADED	BALL VALVE, PVC BODY, TRUE UNION, PTFE SEATS, VITON SEALS, NPS 1 AND SMALLER OVAL OR ROUND HANDLE OPERATED, NPS 1 1/2 AND LARGER LEVER OPERATED.
12-50	8FFVO	CLASS 150	SOCKET WELD X THREADED	BALL VALVE, PVC BODY, TRUE UNION, PTFE SEATS, VITON SEALS, NPS 1 AND SMALLER OVAL OR ROUND HANDLE OPERATED, NPS 1 1/2 AND LARGER LEVER OPERATED.

NOTES: 1. All valve actuators 2100mm and above their intended operational level shall be provided with chain operators.

PART 1 - GENERAL

1.1 RELATED SECTIONS

- .1 Section 01 33 00 - Submittals
- .2 Division 26 - Electrical
- .3 Section 26 29 20 - Variable Frequency Drives
- .4 Section 44 04 00 - Process Piping

1.2 SUBMITTALS

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittals.
- .2 Indicate:
 - .1 Manufacturer's data, including materials of construction, equipment weight, connections, fittings and ancillaries. Identify whether factory or field assembled.
 - .2 Wiring and schematic diagrams.
 - .3 Dimensions and recommended installation.
 - .4 Data regarding pump and motor characteristics and performance inclusive of guaranteed performance curves showing that the equipment meets the specified requirements of head, capacity and horsepower.
 - .5 Motor data.
 - .6 Provide characteristic curves for variable speed pumps for both actual maximum pump speed and for speed required to obtain minimum pump flow specified.
 - .7 Use Tag numbers for all equipment as indicated and specified.
 - .8 A copy of this specification with addenda updates, and all referenced sections with addenda updates, with each paragraph check marked to show specification compliance or marked to show deviations.
- .3 The pump supplier shall review the contract drawings and specifications to ensure the pump application and sizing is acceptable and notify the Engineer immediately regarding any concerns.

1.3 MAINTENANCE DATA

- .1 Provide maintenance data for incorporation into manual specified in Section 01 33 00 - Submittals.
- .2 Data to include:
 - .1 Manufacturers name, type, model, capacity, head, serial number and performance curves.
 - .2 Applicable operation and maintenance information as specified in section 01 33 00.
 - .3 Installation certification form.
 - .4 Training Certification form.

PART 2 - PRODUCTS

2.1 General

- .1 The pumps shall be either a vertical turbine or propeller, product lubricated, open lineshaft pump. Each unit shall include a bowl assembly, suction strainer, column and open lineshaft, discharge head, sealing assembly and driver. The pump shall include a flow sleeve.
- .2 All pumping equipment furnished under this Section shall be of a design and manufacture that has been used in similar applications, and it shall be demonstrated to the satisfaction of the Owner that the quality is equal to equipment made by that manufacturer specifically named herein.
- .3 Pumps, complete with motor, necessary guards and all other specified accessories and appurtenances shall be furnished by the pump manufacturer to insure compatibility and integrity of the individual components, and provide the specified warranty for all components.
- .4 The vertical turbine pump(s) specified in this section shall be furnished by and be the product of one manufacturer.

- .5 Pumps are to be engineered and manufactured under a written Quality Assurance program. The Quality Assurance program is to be in effect for at least ten years, to include a written record of periodic internal and external audits to confirm compliance with such program.
- .6 Pumps are to be engineered and manufactured under the certification of ISO-9001:2000, shall be of stainless steel construction and be NSF 61 Certified.

2.2 Performance

- .1 The pumps shall be designed for continuous operation and will be operated continuously under normal service via an integral Variable Frequency Drive of the same manufacturer.
- .2 Operation Criteria

	Flow (L/s)	TDH (m)	Max. Pump Speed (RPM)	Max. Solids Passage	Max. Shutoff Head (m)	Max/Min Submergence (m)
Service Water Pumps (P101, P102)						
Duty Point 1	5	6.6	3450	14 mm	60	2.3/1.0m
Duty Point 2	10	6.97	3450	14 mm	60	2.3/1.0m
Duty Point 3	16	7.76	3450	14 mm	60	2.3/1.0m
Duty Point 4	21	8.7	3450	14 mm	60	2.3/1.0m

- .3 Total dynamic head shall be as measured at the discharge of the pump and shall include velocity head and vertical static head from the minimum water level to the centerline of the pump discharge.
- .4 Minimum water level shall be at elevation 98.00m. The finished floor elevation of the wet well housing the pumps is 96.70m. The elevation of the intake screen is 300mm above the wet well floor and the maximum water level is 99.60m.
- .5 Pumps should be suitable for VFD operation and shall be incorporated into the process control through

external 4-20mA signal to the VFD. The maximum pump speed shall not exceed 3450RPM.

- .6 The driver size for the Service Water pumps shall be limited to 5 HP maximum. The liquid to be pumped is primary treated raw water with a maximum temperature of 30°C.

2.3 PUMP CONSTRUCTION

- .1 Design:
 - .1 Rotation: The pump will be counterclockwise rotation when viewed from the driver end looking at the pump.
 - .2 Impeller
 - .1 The impeller shall be of stainless steel construction conforming to AISI 304. They shall be of one-piece construction, single suction, enclosed radial flow design. The waterways through the impeller shall have extremely smooth contours, devoid of sharp corners, so as to promote maximum efficiency.
 - .2 The impeller is to be balanced and secured to the shaft by means of a stainless steel drive collet.
 - .3 The casing shall be hydrostatically tested to 1.5 times the design head or 1.25 times the shutoff head whichever is greater.
- .3 .1 The pump discharge will incorporate a priming screw to prevent dry running.
 - .2 The pump discharge will include a spring assisted check valve in the valve casing preventing back flow in connection with pump stoppage. The valve closing time will be minimized to prevent water hammer
- .5 Wear Rings (Service Water Pumps Only)
 - .1 Wear rings shall be provided on both the impellers and bowls

.2 Impeller wear rings shall be of the radial-type.

.4 Wear rings shall be attached to the impellers and bowls using an interference fit and Loctite.

.5 Wear rings shall be bronze conforming to ASTM, B505 C93200.

.6 Column

.1 Refer to the process drawings to determine the total length of the discharge column.

.2 The column pipe shall be not less than 80mm inside diameter

.3 The threaded column sections shall be connected with threaded, sleeve-type couplings.

.9 Vibration Limitations (Field)

.1 The limits of vibration as set forth in the standards of the Hydraulic Institute shall govern.

.10 Motor

.1 The motor shall be a IP68, fully sealed, non-contact, canned type, with liquid lubricated bearings and pressure-equalizing diaphragm, squirrel cage induction full voltage starting, inverter duty, powered by an electrical service rated at 575 volts, 60 hertz, 3 phase. Motors shall be compatible with VFD operation. Each motor shall be capable of driving the pump under all head conditions without exceeding the rated capacity of the motor. Motor shall have class F insulation, 1.15 service factor. Motor shall be supplied with a non reverse ratchet. Motor shall conform to AIEE and NEMA standards. Motor design shall be premium efficiency style and include built-in temperature and leak detection transmitter, integral thermal protection.

.2 Thermal and Leak Detection relays to be supplied loose for installation by Div. 26.

- .1 Service water pumps (P101, P-102) shall be:
 - .1 300S50-1 vertical single stage submersible pumps as supplied by Grundfos.
 - .2 Approved equivalent

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Follow the manufacturer's recommended installation details and procedures supplemented by details on the drawings.
- .2 Install in a neat, workmanlike manner so that connections and disconnections can be easily made with parts accessible for inspections, maintenance and repairs.
- .3 Install at correct elevations, true, square, plumb and level and provide all shims required.
- .4 Apply protection so that anchor bolts, shims and miscellaneous metals are fully corrosion protected.
- .5 Contractor shall install pumping equipment on concrete pad and make final alignments thereon.
- .6 Contractor shall prove the pump's discharge port connections to process lines are made in a free supported state without need to apply vertical or horizontal pressure to align piping with pump nozzles.
- .7 The installation and initial operation of all components shall be certified in accordance with Section 01 80 50 - Equipment.

3.2 Testing

- .1 A certified factory hydrostatic and performance test shall be performed on each bowl assembly in accordance with Hydraulic Institute Standards, latest edition. Tests shall be sufficient to determine the curves of head, input horsepower, and efficiency relative to capacity from shutoff to 150% of design flow. A

minimum of six points, including shutoff, shall be taken for each test. At least one point of the six shall be taken as near as possible to each specified condition.

- .2 Results of the performance tests shall be certified by a Registered Professional Engineer and submitted for approval before final shipment.

END OF SECTION

Appendix 1
**Landmark Municipal Services: Joyceville GAC
Inspection and Report**



Joyceville GAC Inspection & Report
Project #40750-92431
February 18, 2015

February 25, 2015

Correctional Service Canada

Ontario Region Technical Services
443 Union Street West
Kingston, ON. K7L 2R8

Attn: **Corinna Dally-Starna, MES**
Regional Coordinator, Environmental Programs

Email: Corinna.Dally-Starna@CSC-CSCC.GC.CA

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LMS Job # LM5005: Joyceville WTP GAC Tank Inspection
Project Number: 40750-92431

On February 18th 2015 an inspection of the granular activated carbon (GAC) tanks at the Joyceville Correctional Institute was performed.

The two cylindrical GAC tanks, which are located inside the water treatment plant, measure 13 ft in height and 9 ft in diameter. Inside there is a ½ inch thick steel baffle plate supported 18 inches above the floor, and this supports the carbon GAC media. There are 96 plastic strainers mounted into the plate that allow water to flow into the chamber below while filtering out the GAC above.

The objective of this inspection was to examine the coatings and linings of the tank, as well as the steel condition. The ability of the plastic strainers to keep GAC media out of the lower chamber was to be determined as well.

With careful planning and preparation, condition surveys provide valuable information about the causes of deterioration and distress. The appropriate remedy can only be applied when the problem is identified.

Observations

Overall Structure:

The GAC tanks themselves appear to be in excellent condition, with no visible distortions or mechanical issues. The interior of the building itself is neat, orderly and well lit. The concrete floors are free of any visible spalling or large cracks, and the formed concrete bases under the tanks are in excellent condition (*photo 2, 5, 6*).

Operational Characteristics:

Although the GAC tanks have been performing as designed during the filtering process, it was communicated by operating staff that the backwashing process has resulted in some undesirable mechanical characteristics, namely that the tank was observed to be lifting up off the floor by up to 2 inches on some occasions, although not every time. The requirement of manually operating the valves for the backwash during construction has meant a variable flow rate upon initial opening, depending on who was doing the operating.

During the interior inspection, it was noted that approximately 60 lbs, or 2 cubic feet of GAC media had made its way through the strainers and into the lower chamber (*Photo 21 to 24*). From the description of timelines and operational events given, I surmised that this loose media was becoming suspended during the backwash process. The suspended media was then flowing into the back of the strainers and plugging them, which in turn caused an increase in pressure within the lower chamber and thus forced the floor plate to balloon downwards. This diaphragm action would in turn lift the sides of the tank.

During the course of the inspection, most of the GAC media in the lower chamber was manually removed. This will hopefully prevent any further distortion of the floor in the future, as this movement puts a tremendous strain on the floor-to-wall weld.

Tank Exterior:

These tanks are coated with an aliphatic urethane over an epoxy primer which is in excellent condition. There is some light corrosion on the lower edge of the floor plate where it meets the floor (*Photo 17*), where water has been allowed to pool. The sheen level is good, and there are no signs of blistering, de-lamination or surface corrosion.

Tank Interior:

The interiors of these tanks are lined with an epoxy type of system. The epoxy in both tanks is in poor condition, with osmotic blistering and delamination in some areas (*Photo 20*). The lower chamber of tank #2 is exhibiting rust around the stainless steel bolts where breaks in the coating during assembly have caused galvanic corrosion, exacerbated by the proximity of dissimilar metals (*Photo 21 to 26*). The flat flange area around the rectangular hatch has some substantial metal loss around the edges (*Photo 18, 19*).

Above the GAC media there is loss of coating and general surface corrosion, this being the 'vapour zone' where water vapour containing chlorine and oxygen is concentrated (*Photo 14 to 16*). The inlet weir box (*Photo 11, 12*) and backwash trough (*Photo 13 to 15*) have some localized corrosion on edges and seams.

Steel Condition:

Ultrasonic thickness measurements were made over many representative areas of the tank shell and all were between 3.9mm and 4.9mm, which, taking into account the original 6mm specification minus the original blast profile, indicates no signs of interior metal loss due to large scale corrosion.

Appurtenances

The stairs, landings and catwalks around the tanks and their neighboring filtration/settling chambers are in excellent condition, with all handrails intact (*Photo 8*).

All stainless steel piping appears to be in good condition, although there is some surface corrosion on certain areas because of the chlorine gas that is in the air at all times (*Photo 5, 6*).

Both plastic tank covers are in good condition (*Photo 10*).

Recommendations:

It is recommended that both of these tanks have their interior linings removed via abrasive metal blasting to SSPC-SP10 Near-White Metal Clean, and re-coated with 10 to 12 mils DFT of NSF 61 approved epoxy as per manufacturer's directives.

This process can be performed with the tanks in situ, but the filter plate and all removable supporting beams should be removed completely and re-finished using the same process.

Upon re-assembly, all stainless fasteners should be electrically isolated with appropriate insulators and washers. Future abrasion and coating damage between the steel filter plate and its supporting beams could be minimized by sandwiching 1/16" thick neoprene or nylon strips between load bearing surfaces.

Budget pricing for re-lining of both GAC tanks is **\$70,000.00**, including weld repairs, not including new strainers or base sealing as suggested below.

The 96 plastic strainers should be replaced at this time as well.

The corroded edges of the access hatch should be repaired by puddle welding and then grinding down to the correct profile before blasting and re-painting.

The joint between the tank lower edge and the concrete base should be sealed, first by flooding the existing hidden corrosion with a 100% solids creeping epoxy and then filleting the joint to increase its surface area using a mesh-impregnated urethane elastomeric caulking. This will prevent spilled water from getting trapped under the tank and causing corrosion from below.

Stainless steel piping can be buffed to a higher sheen, this will prevent chlorine precipitate concentration and subsequent corrosion.

Should you have any questions or comments regarding the content of this report, please contact us at 905 319 7700. We look forward to the opportunity of further interaction with Correctional Service Canada, and we thank you for your business.

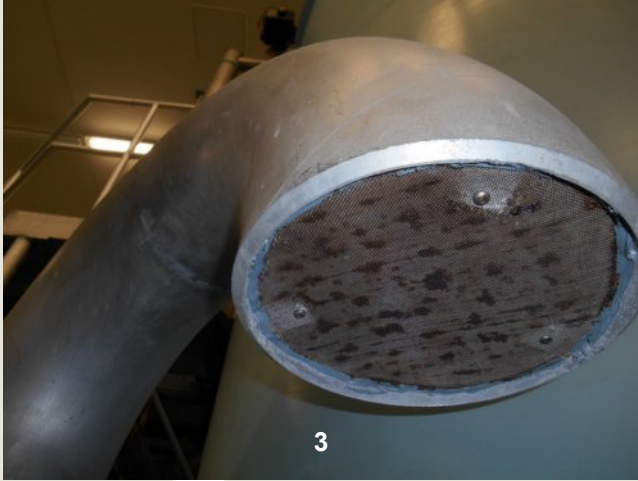
Yours sincerely,

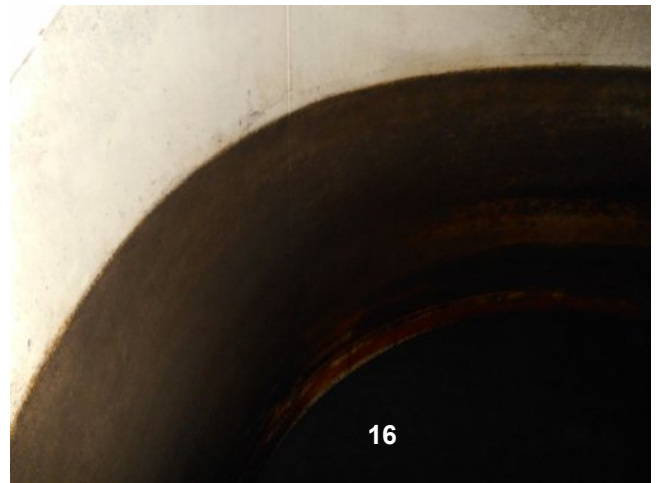
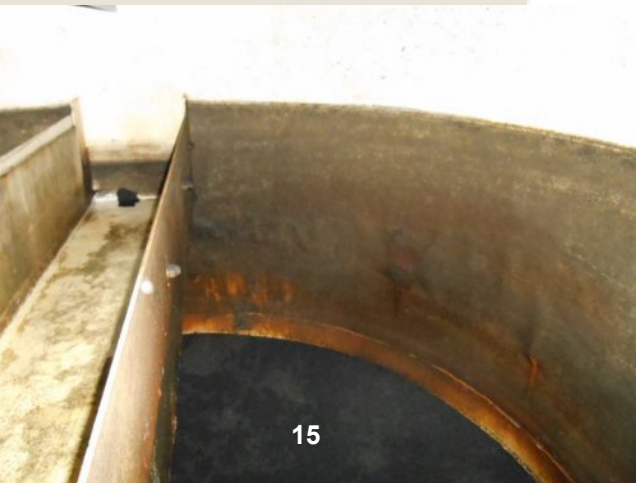
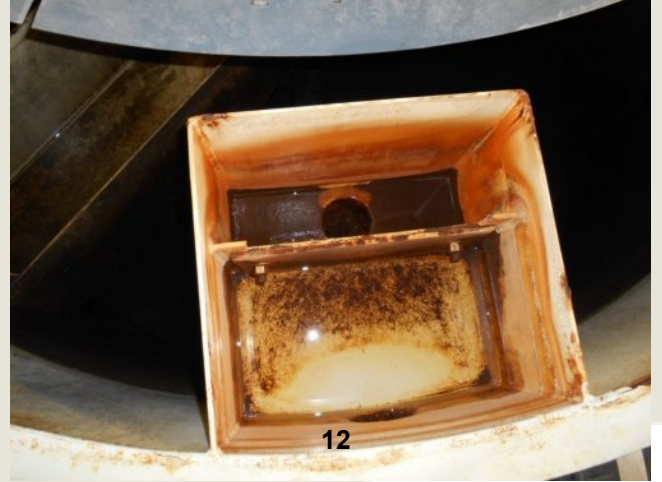
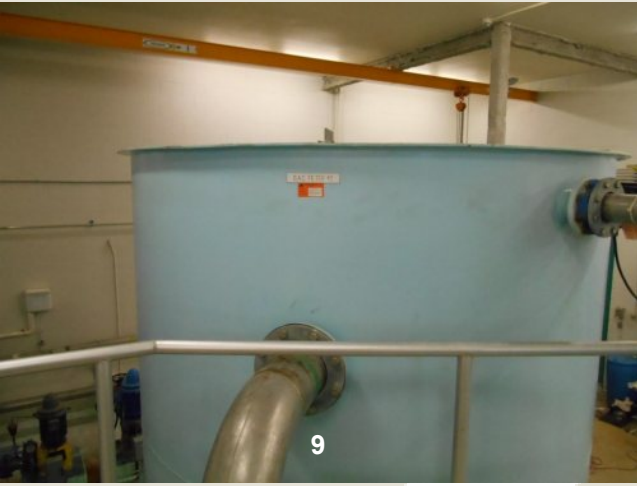
LANDMARK MUNICIPAL SERVICES

A handwritten signature in black ink, appearing to read 'D. Baker', with a long horizontal stroke extending to the right.

David Baker

NACE Certified Coating Inspector – Level 2, CIP No. 36124









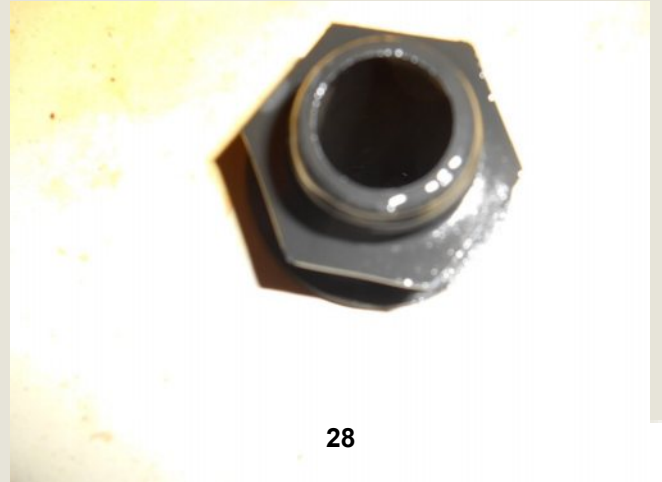
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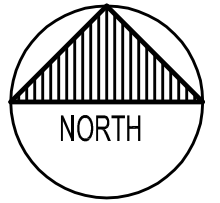


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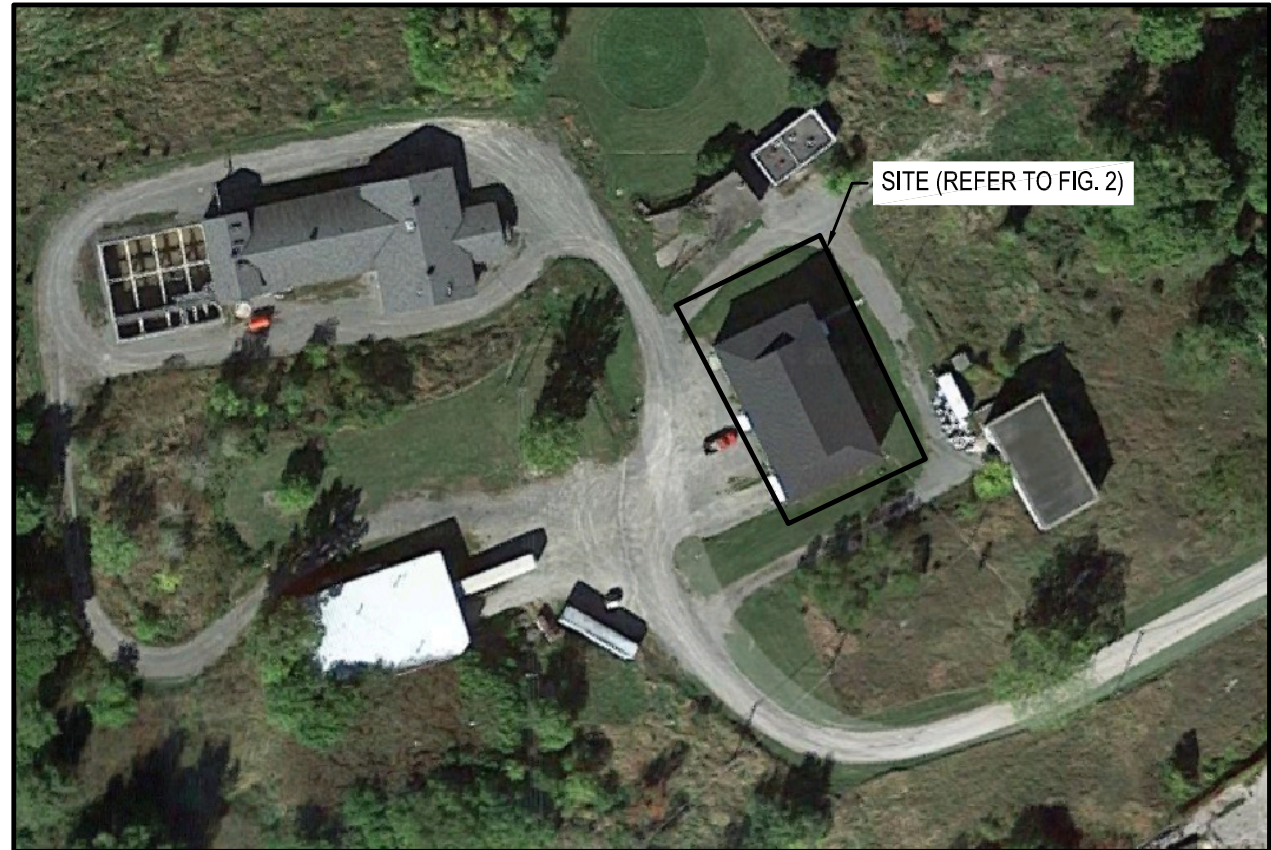
Appendix 2 Figures

LIST OF FIGURES

- FIG.1 Key Plan
- FIG.2 Filter and GAC Layout
- FIG.3 Legend
- FIG.4 GAC Tanks (1 &2) Plan and Section
- FIG.5 Cover Support Frame
- FIG.6 Strainer Plate Support Ring



KEY PLAN
SCALE: N.T.S.



SITE PLAN
SCALE: N.T.S.



PROJECT:

JOYCEVILLE WTP
GAC TANK REPAIRS

TITLE:

KEY AND SITE PLANS

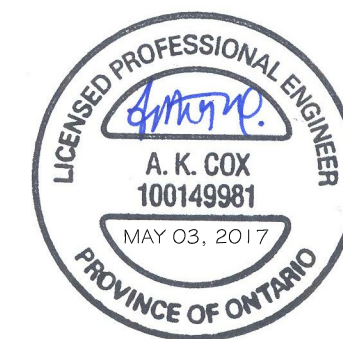
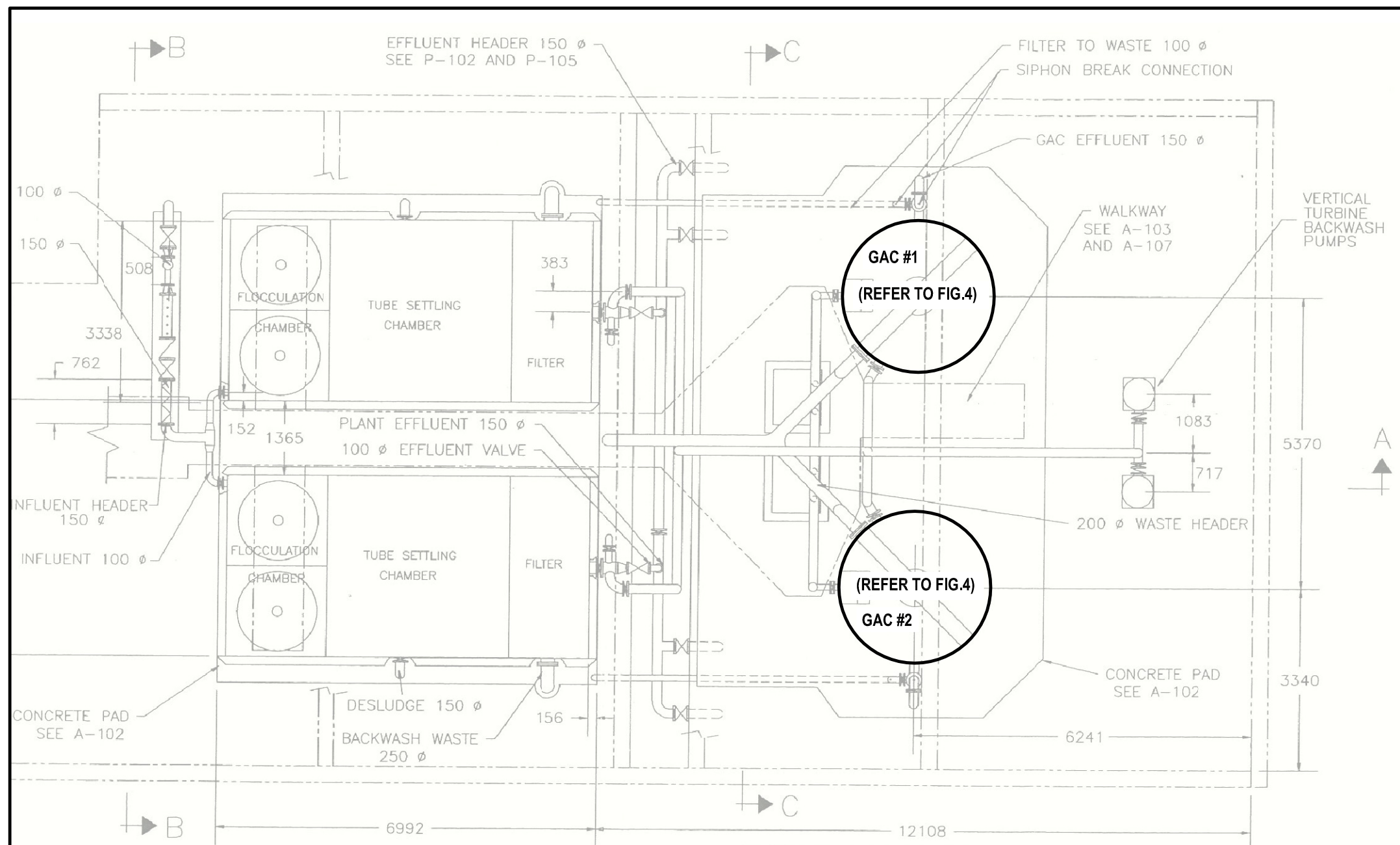
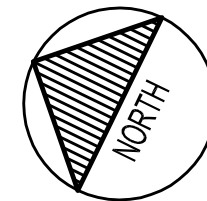
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DATE:
SEPTEMBER 2016

PROJECT NO:
161-10630-00

DRAWING NO:

FIG.1



PROJECT:

JOYCEVILLE WTP
GAC TANK REPAIRS

TITLE:

FILTER AND GAC LAYOUT

SCALE:
N.T.S.
DATE:
SEPTEMBER 2016
PROJECT NO:
161-10630-00
DRAWING NO:

FIG.2

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LEGEND

- 1 EMPTY ALL SECTIONS OF EACH GAC TANK.
- 2 REMOVE COVER (3mm PANEL). RE-INSTALL WHEN WORK ON TANK IS COMPLETE.
- 3 REMOVE FILTER PLATE AND ALL REMOVABLE BEAMS.
- 4 REMOVE TANK INTERIOR LININGS (INCLUDING ALL PAINTED COMPONENTS) USING METAL BLASTING TO SSPC-SP10 NEAR WHITE METAL CLEAN.
- 5 RE-COAT INTERIOR OF TANKS AND RELATED COMPONENTS WITH 12mils DFT OF NSF61 APPROVED EPOXY AS PER MANUFACTURER'S INSTRUCTIONS.
- 6 RE-INSTALL FILTER PLATE AND ALL REMOVABLE BEAMS. RE-USE EXISTING STAINLESS STEEL BOLTS. INSTALL $\frac{1}{8}$ " THICK NEOPRENE GASKETS BETWEEN LOAD BEARING SURFACES AND LOADING ELEMENT.
- 7 ELECTRICALLY ISOLATE ALL STAINLESS FASTENERS WITH APPROPRIATE INSULATORS AND WASHERS.
- 8 PUDDLE WELD CORRODED EDGES OF THE ACCESS HATCH THEN GRIND DOWN TO CORRECT PROFILE THEN BLAST AND REPAINT.
- 9 REMOVE LIGHT CORROSION ON LOWER EDGE OF DOLLAR PLATE AND REPAINT TO MATCH EXISTING
- 10 SEAL JOINT BETWEEN TANK LOWER EDGE AND CONCRETE BASE BY FLOODING EXISTING HIDDEN CORROSION WITH 100% SOLIDS CREEPING EPOXY. THEN FILLET JOINT USING A MESH-IMPREGNATED URETHANE ELASTOMETRIC CAULKING.



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PROJECT:

JOYCEVILLE WTP
 GAC TANK REPAIRS

TITLE:

LEGEND

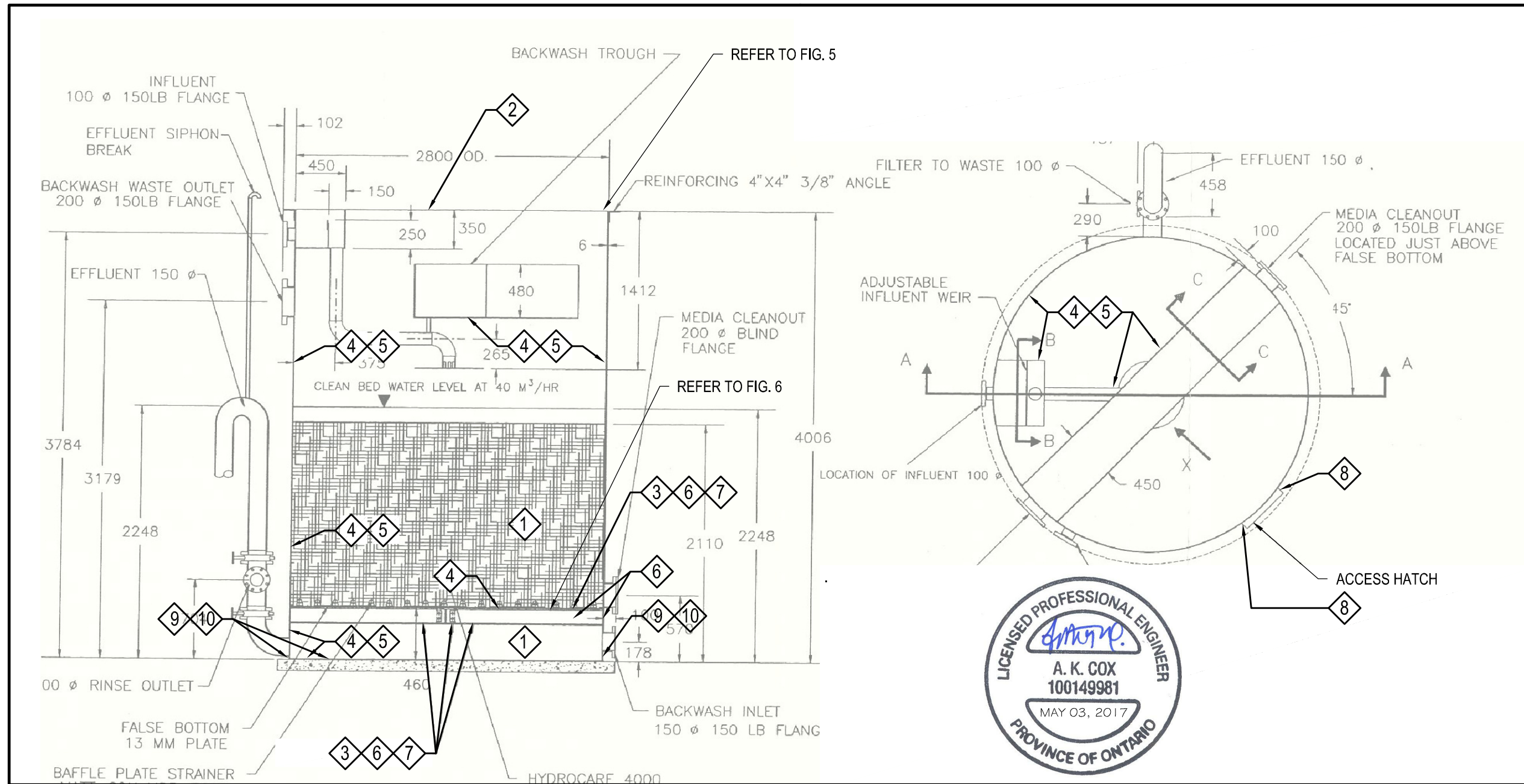
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 N.T.S.

DATE:
 SEPTEMBER 2016

PROJECT NO:
 161-10630-00

DRAWING NO:

FIG.3



◊ - REFER TO LEGEND (FIG.3)



PROJECT:

JOYCEVILLE WTP
GAC TANK REPAIRS

TITLE:

GAC TANKS (1 & 2) PLAN & SECTION

SCALE:
N.T.S.

DATE:
SEPTEMBER 2016

PROJECT NO:
161-10630-00

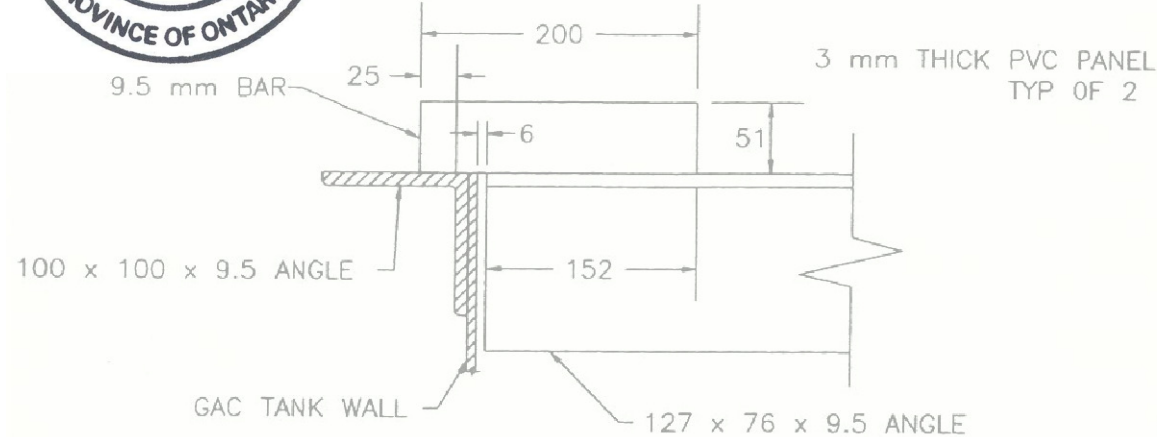
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FIG.4

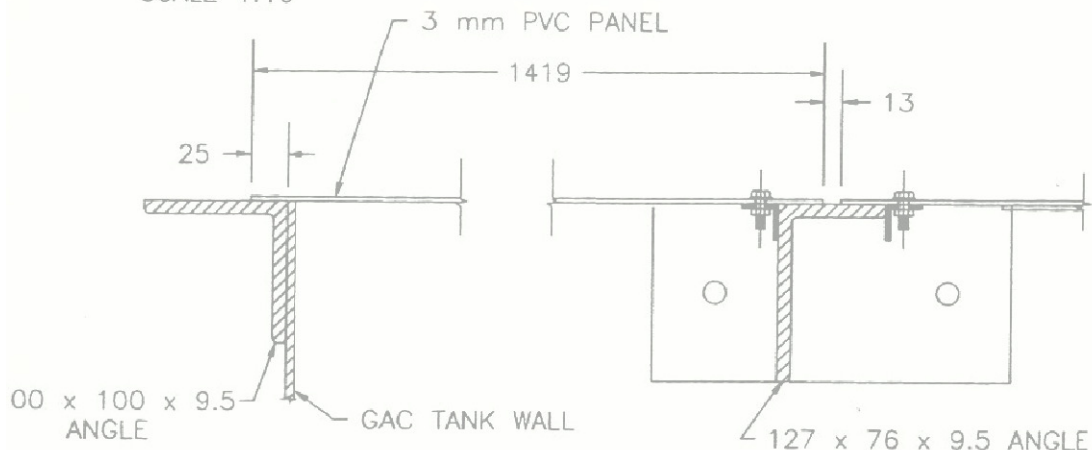
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SECTION A-A DETAIL
SCALE 1:5

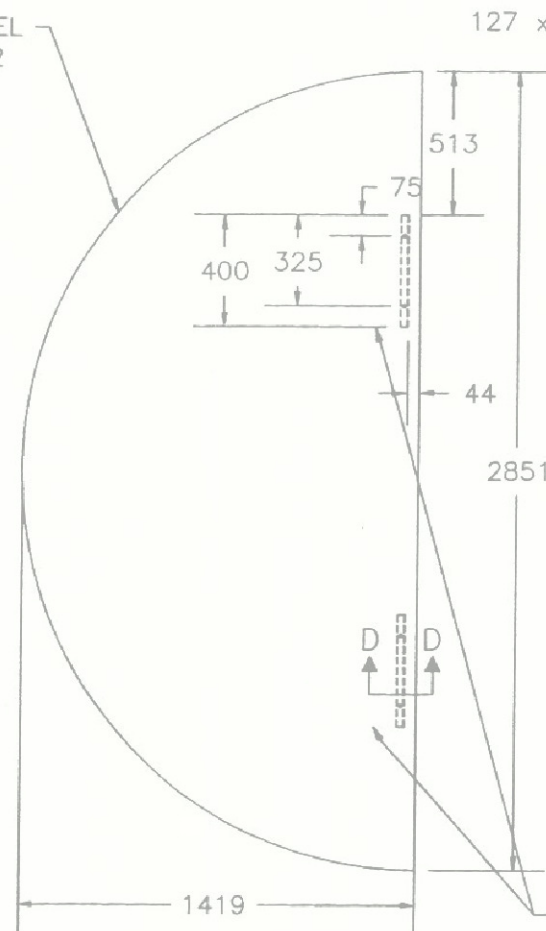


DUST COVER PVC PANEL DETAIL - ELEVATION VIEW
SCALE 1:10



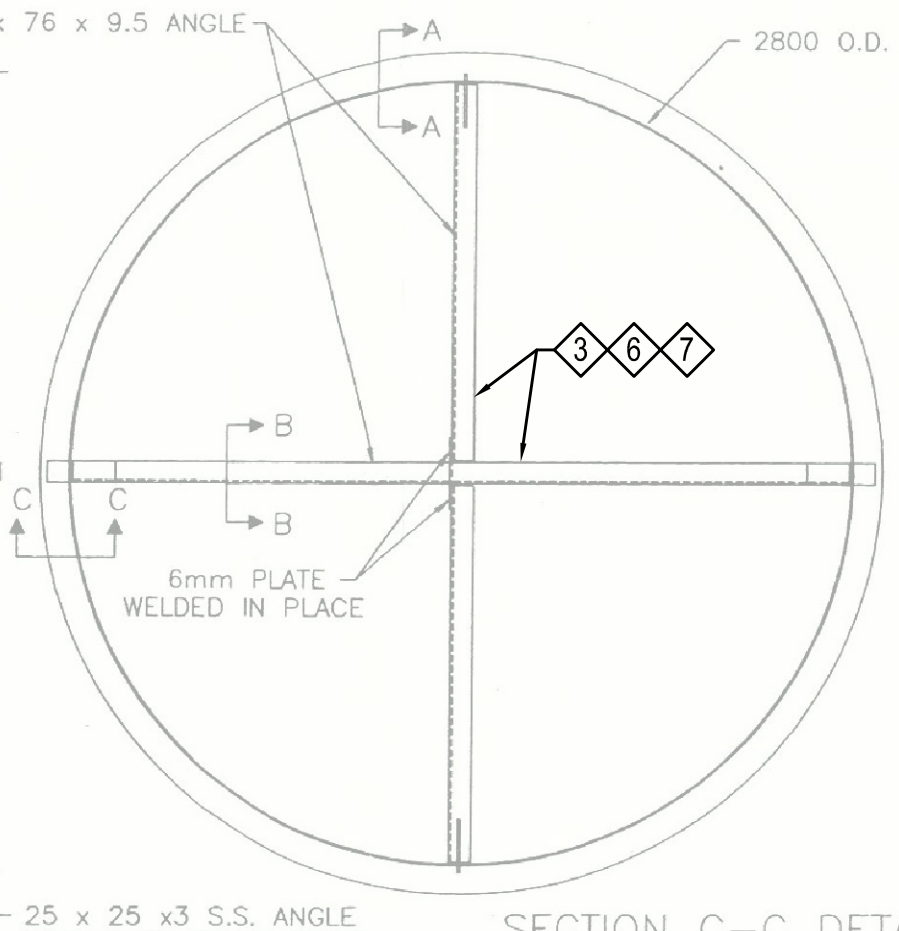
SECTION B-B DETAIL

DUST COVER PANEL
SCALE 1:20



SECTION D-D DETAIL

DUST COVER SUPPORT FRAME
SCALE 1:20



SECTION C-C DETAIL
SCALE 1:5

◇ - REFER TO LEGEND (FIG.3)



PROJECT:

JOYCEVILLE WTP
GAC TANK REPAIRS

TITLE:

GAC TANK COVER SUPPORT FRAME

SCALE:
N.T.S.

DATE:
SEPTEMBER 2016

PROJECT NO:
161-10630-00

DRAWING NO:

FIG.5

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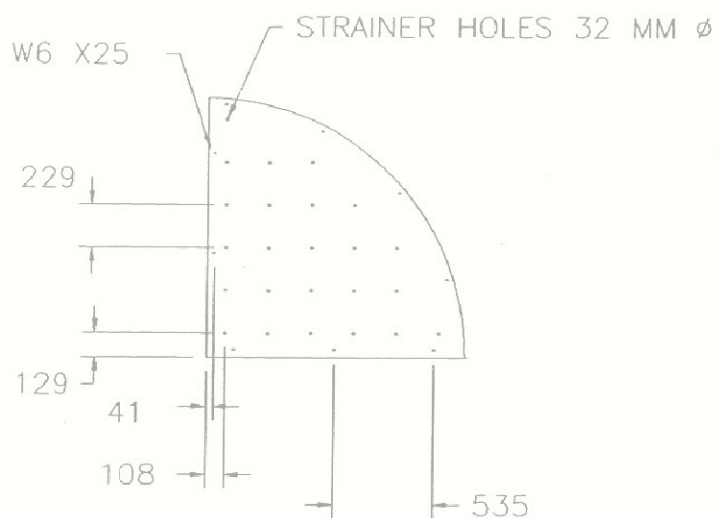
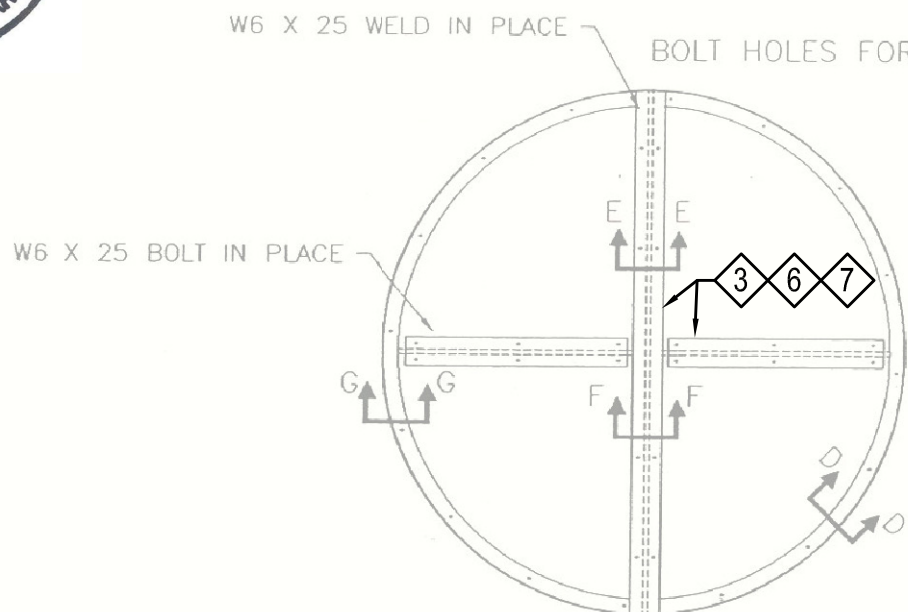


STRAINER HOLE LOCATION

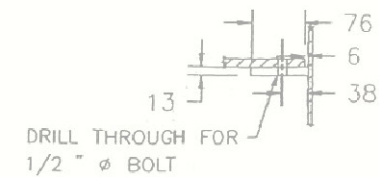
PLAN VIEW

STRAINER PLATE SUPPORT RING
(PLATES NOT SHOWN)

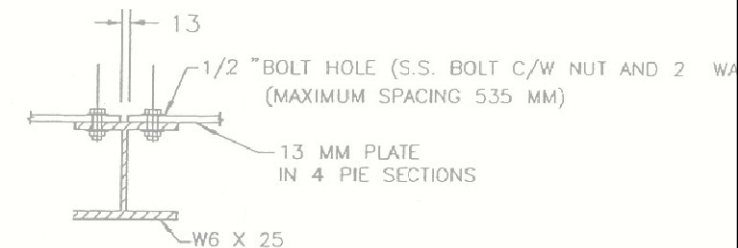
STRAINER PLATE
USE 13 MM PLATE (1 OF 4)



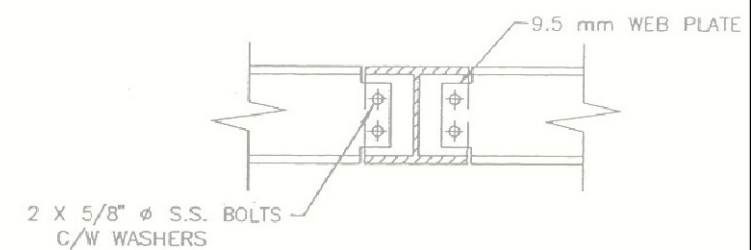
SECTION D-D



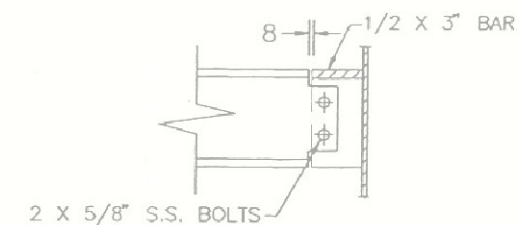
SECTION E-E



SECTION F-F



SECTION G-G



- NOTES: 1) ALL STRAINER HOLES 229 MM APART.
2) BOLT HOLES TO MATCH THOSE ON SUPPORT FRAME.

◇ - REFER TO LEGEND (FIG.3)



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PROJECT:

JOYCEVILLE WTP
GAC TANK REPAIRS

TITLE:

GAC STRAINER PLATE SUPPORT RING

SCALE:
N.T.S.

DATE:
SEPTEMBER 2016

PROJECT NO:
161-10630-00

DRAWING NO:

FIG.6

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Appendix 3
Photolog:

PHOTO LOG



Photo 1: GAC tank #1 and platform



Photo 2: Top Section of GAC Tank #2



Photo 3: GAC tank cover



Photo 4: Cover partially opened showing cover frame and adjustable influent weir



Photo 5 – Adjustable influent weir



Photo 6: Backwash trough



Photo 7: Tank base (1)



Photo 8: Tank base – (2)



Photo 9 – Tank base (3)



Photo 10 – Tank (4)

