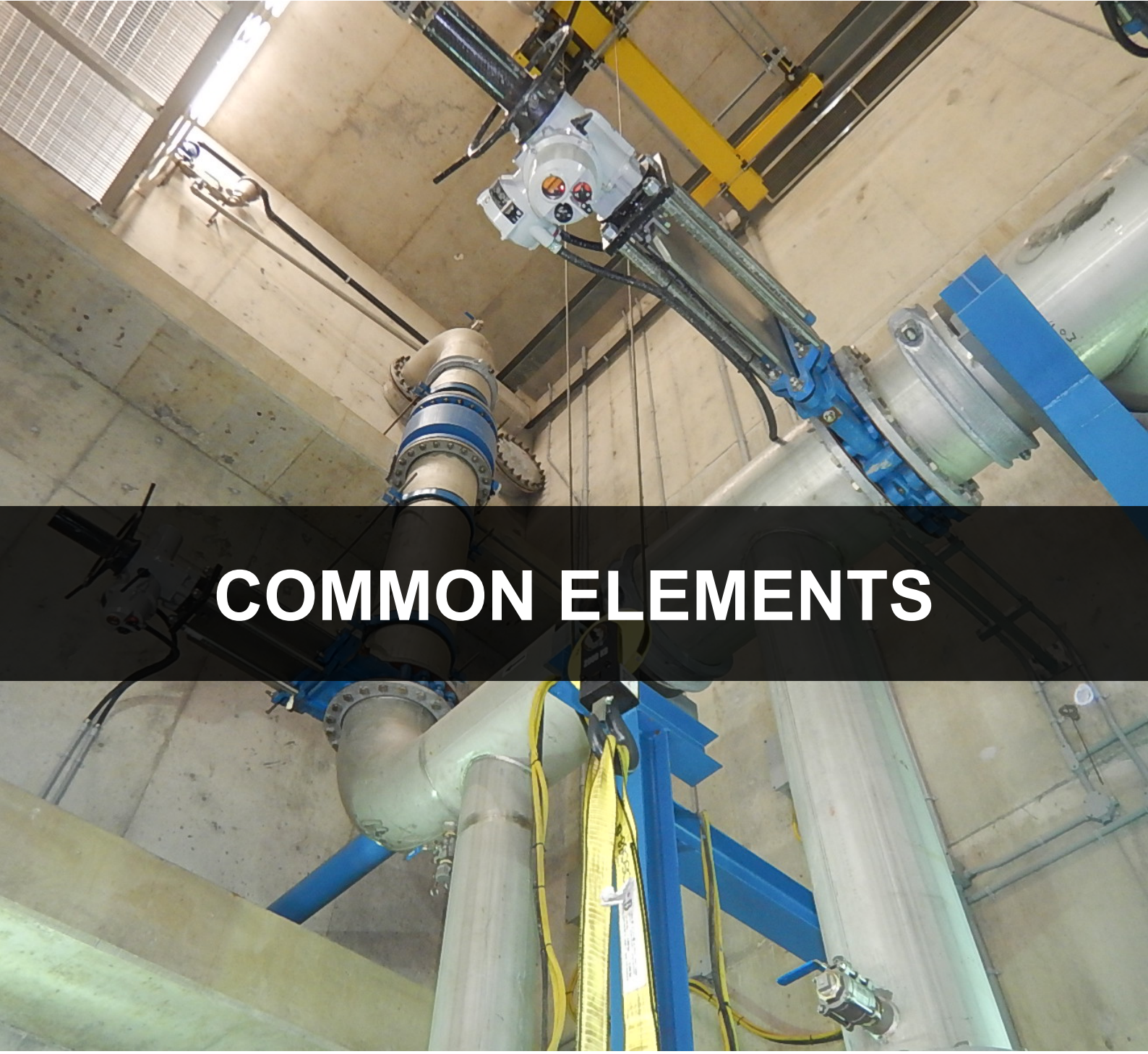

COMMON ELEMENTS

DESIGN AND CONSTRUCTION MANUAL

Vertical Municipal Infrastructure Standards

THE CORPORATION OF THE CITY OF BRANTFORD

V5- March 2024

REVISION TRACKING

EXISTING VERSION	VERSION NUMBER
March 2019	N: V1 - Original Final Submission
December 2020	V2
May 2022	V3
January 2023	V4
March 2024	V5

2024 REVISION SUMMARY

SECTION	MODIFICATION & COMMENTARY
9.10 Network Access Panel	New section
10.1 Site Security	Where applicable, design of site security for new facilities should take into consideration the principles of Crime Prevention through Environmental Design (CPTED) as explained in the City's Site Plan Manual, as well as adhere to the By-law & Security's Physical Security Standards.
10.2 Security Alarm System	Provide a vendor-specific security alarm system for all new facilities, installation to be located in the electrical room. The vendor control panel must be interfaced with the SCADA system via ~~BACnet communication protocal~~ hardwired dry contacts for monitoring. Provide illegal entry alarm contact switches for all building entry points including doors, windows, and hatches. Please reference The City of Brantford's By-law & Security's Physical Security Standards for specific ~~Wastewater alarming applications as it does not just pertain to security.~~ hardware and configuration requirements.

SECTION	MODIFICATION & COMMENTARY
10.3 Closed-Circuit Television Cameras	New buildings should be equipped with exterior and interior closed-circuit television (CCTV) cameras mounted at strategic locations and connected to the City's CCTV network. This includes but is not limited to perimeter monitoring, gate entry including plate detection specific cameras, public interaction areas, locations that provide a high likelihood of break-in. All CCTV cameras shall be equipped with day/ night vision. All CCTV cameras shall be IP/ Ethernet based and include all equipment to provide a functional system, power supplies, POE injectors, etc. CCTV cameras must be provided for confined spaces and restricted spaces where applicable, including wastewater wet wells, dry wells, and critical underground valve chambers, to reduce the need for personnel access. Provide appropriately classified CCTV cameras to suit rated spaces. It should be emphasized that the design of new facilities should eliminate the need for confined space entry as a general design principle. CCTV cameras must also be provided for interior spaces where applicable, including electrical & IT rooms, vestibules & entranceway, high traffic areas, pump gallery's, and other process areas. CCTV cameras to be integrated with building security systems, including alarm systems and access control systems. Please reference The City of Brantford's By-law & Security's Physical Security Standards for specific hardware and configuration requirements.
10.4 Fire Alarm System	Provide addressable heat and smoke detectors monitored by a vendor-specific fire alarm system that is also connected to the City's SCADA System via hardwired dry contacts for monitoring. The design of the fire alarm system shall conform to the OBC requirements.

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1.0 INTRODUCTION

1.1 Applicability

This section of the manual covers requirements related to common elements in the design of water, wastewater, and stormwater systems within the City of Brantford. This document should be read in conjunction with the **General Preface** section of the manual as well as the applicable Vertical Municipal Infrastructure Standards (Water, Wastewater, or Stormwater).

2.0 SUBMISSION REQUIREMENTS

2.1 Deliverable Format

All deliverables shall be submitted in a format that facilitates filing and data management by the City. Discuss and confirm with the City at the outset of the project the City's format requirements for deliverables not specified herein. All deliverables must be prepared in compliance with the Accessibility for Ontarians with Disabilities Act, 2005, S.O 2005, c. 11;

2.2 Hard Copies and Digital Copies of Deliverables

2.2.1 Reports, Memoranda, and Narratives

Submit the following of each deliverable:

- Three bound hard copy sets, printed double-sided and in colour
- Portable Document Format (.pdf) fully searchable digital file
- Microsoft Word (.docx) digital file
- All supporting spreadsheets, schedules, registers, and other files in their original production format (for example, Excel, Word, PowerPoint, Project, etc.)

2.2.2 Engineering Design Drawings

Submit the following:

- One full-size (ISO A1) and one half-size (ISO A2) hard copies are required for the Issued for Tender (IFT) drawings
- Portable Document Format (.pdf) fully searchable digital file for each design milestone
- AutoCAD 2019 (.dwg) at the Issued for Tender and As-Built submission stage

2.2.3 Specifications

Submit the specifications in the following format:

- One hard copy of the IFT and IFC contract documents and specifications printed double-sided on letter sized pages (8.5" x 11")
- Microsoft Word (.docx) digital file for each specification section, and front-end contract documents including IFT and IFC versions
- Portable Document Format (.pdf) fully searchable digital file of all contract documents including IFT and IFC versions

2.3 Existing Information

When projects involve retrofits or upgrades to existing City infrastructure, the City will provide available as-built drawings, operation manuals, and other documents in hard copy or digital format.

2.4 Preliminary Design

The following submittals are to be provided during the Preliminary Design:

- **Design Scoping Memorandum:** Submit a design scoping memorandum to confirm the scope of work and design criteria prior to the start of preliminary design. The project design memorandum shall be submitted after all background analysis has been completed, various alternative design solutions have been evaluated and final project direction has been concluded. Acceptance of the project design memorandum forms the basis to start preliminary design.
- **Preliminary Design Report (PDR):** The PDR shall address the following topics at a minimum:
  - Project objectives and basis of design
  - Site investigation summaries (i.e. condition assessments, topographic surveys, subsurface utility engineering investigations, designated substance survey, geotechnical investigations, hydrogeological investigations, tree inventory, species at risk and related studies)
  - Design criteria
  - Preferred process design solution including life cycle cost (LCC) analysis
  - Process equipment sizing for each major process system
  - English language description of the Process Control Narrative (PCN)
  - Building location, general layout, architectural design and proposed structural design criteria
  - Preliminary construction sequencing and implementation plan
  - Approvals register including list of anticipated permits and approvals
  - Capital cost estimate of the proposed works (Class D) including assumptions and a list of uncertainties and contingencies
  - Stakeholder register
  - Risk register
- **30% Preliminary Design Drawings:** Submit the preliminary (30%) design drawings with the PDR. The drawings shall include the following information as applicable:
  - Site verification of existing elevations and dimensions
  - Site Plan layout drawings including existing and proposed site plans, existing and proposed yard piping plans, and existing and proposed electrical site plans
  - Preliminary layout of all facilities
  - Preliminary building architectural views and elevations
  - Existing and proposed hydraulic profiles
  - Existing and proposed process flow diagrams
  - Preliminary process equipment, piping and valve plans
  - Electrical single line diagrams
  - SCADA network architecture for proposed facility

2.5 Detailed Design

Detailed Design submissions must highlight all changes to the design report and specifications in yellow to document changes to the previous submissions. The following deliverables to be submitted during the detailed design phase:

- **50% Detailed Design Submission**
  Draft Construction Sequencing and Implementation Plan

  1. Updated English Language Description of the PCN
  2. Updated Cost Estimate (Class C)
  3. Updated Stakeholder Register
  4. Updated Risk Register

- **50% Detailed Design Drawings:**
  General: Title sheet, drawing index, legends, and general notes
  - Civil: Preliminary site plan, yard piping, and grading design with considerations for drainage, retaining walls, and stormwater management
  - Architectural: General architectural plans, elevations, and cross sections
  - Structural: Foundation plan, floor and platform plans, and roof plan complete with cross sections
  - Process: All major process design items including pipe layout, sizing, configuration, valving, hydraulic profiles, and process flow diagrams
  - Building Mechanical: Preliminary layout of equipment, duct, piping, and space requirements including plumbing and ventilation schematics
  - Electrical: Preliminary electrical concepts, electrical site plan, and updated single line diagrams
  - Instrumentation: piping and instrument diagrams (P&IDs) and SCADA network and communication diagrams

- **75% Detailed Design Submission:**

  5. Final Design Report (FDR): Prepare and submit the FDR with the 75% drawings. The FDR should include updated information from the PDR based on the City's feedback and review of the 50% drawings
  6. Draft PCN complete with tag list
  7. Updated Cost Estimate (Class B)
  8. Updated Stakeholder Register
  9. Updated Risk Register

- **75% Detailed Design Drawings:**
  - General: Title sheet, drawing index, legends, and general notes
  - Civil: Updated site plan, yard piping, and preliminary grading design plan
  - Architectural: Floor plans, roof plans, elevations, building cross sections, and wall sections
  - Structural: Foundation plan, floor/ grating platform plans, roof plan, typical wall sections, and associated details
  - Process: Updated process equipment layout, sizing, configuration, valving, hydraulic profiles, and process flow diagrams
  - Building Mechanical: Updated layout of equipment, duct, piping, and space requirements including plumbing and ventilation schematics, preliminary HVAC schematics, and ventilation schedules including noise limits
  - Electrical: Electrical legend and notes, electrical site plan, single line diagrams, electrical room plan and sections, electrical panel wiring schematics, preliminary lighting layout, and lighting panel details
  - Instrumentation: Updated P&IDs and SCADA network and communication diagrams, proposed panel layout, bill of materials, detailed loop drawings, and Programmable Login Controller (PLC) panel power distribution.

2.5 Detailed Design (Cont'd)

- **90% Detailed Design Submission:**

1. Draft Contract Specifications (Construction Specifications Institute [CSI] Master Format 2020, 52 Divisions)
2. Summary of training requirements for operation and maintenance staff
3. Approvals Tracking Log
4. Updated PCN
5. Updated Construction Sequencing and Implementation Plan
6. Updated Cost Estimate (Class A
7. Updated Stakeholder Register
8. Updated Risk Register

- **90% Detailed Design Drawings:**
  - General: Title sheet, drawing index, legends, and general notes
  - Civil: Detailed site, yard, and grading plans, as well as civil details
  - Landscape: Preliminary landscape plan including vegetation schedules
  - Architectural: Detailed architectural plans, elevations, rendering drawings, architectural specifics, room finish schedules, and Ontario Building Code (OBC) building matrix
  - Structural: Structural notes, foundation, floor, and roof plans complete with sections, rebar sizing, and structural details
  - Process: Final process design details including pipe layouts, sizing, configuration, valving, hydraulic profiles, and process flow diagrams
  - Building Mechanical: Equipment plan and sections, duct, piping, and space requirements including final plumbing and ventilation schematics and equipment schedules
  - Electrical: Updated electrical single line diagrams, electrical room plans, and elevations with all proposed electrical equipment shown; starter wiring diagrams, panel layouts, lighting plans, and lighting panel details
  - Instrumentation: Final P&IDs and SCADA network and communication diagrams, proposed panel layout and bill of materials, detailed loop drawings, and Programmable Logic Controller (PLC) panel power distribution

- **Issued for Approval Drawings:** Following receipt of final comments from the City on the 90% drawings, update and issue the applicable drawings for regulatory approvals.

- **100% Detailed Design Submission:**

1. Updated Contract Specifications based on City feedback
2. Pre-Tender Capital Cost Estimate (Class A)
3. Final Construction Sequencing and Implementation Plan to be incorporated into the contract specifications
4. Final PCN including I/O list and alarm tables
5. Updated Risk Register
6. Draft Asset Inventory List
7. Updated Approval Tracking Log
8. Draft Operations & Maintenance Manual

- **100% Detailed Design Drawings:** Submit final drawings while incorporating comments from the City and regulatory review agencies.

- **Issued for Tender Drawings and Specifications:** Update, seal, and submit hard copies and digital copies of the IFT drawings and specifications within 30 days of receiving the City's final review comments on the 100% drawings and specifications.

- **Issued for Construction Drawings and Specifications:** Submit hard copies and digital copies of the IFC drawings and specifications that incorporate any changes provided in addenda during the tender stage within 14 days of the tender closing date.

- **Operations & Maintenance Manual:** Submit a digital copy of the Draft Operations & Maintenance Manual for City review with the 100% design submission. The Draft O&M Manual shall be broken up into sections to permit easy review. Submit an updated draft O&M Manual prior to training, and one hard copy and one fully searchable digital copy of the final Operations Manual with the close-out documents.

2.6 Risk Register

Develop and maintain a risk register throughout the duration of the project. The risk register is a living document that identifies, rates, and quantifies potential risk to the project, as well as identifies and tracks mitigation measures where applicable. The risk register must be tracked and updated regularly throughout the life of the project to ensure that the identified mitigation measures are addressed within the identified time frame.

2.7 HAZOP Review

Hazard and operability (HAZOP) review is a systematic study of a process design to identify potential safety hazards and operational risks. The main objective of a HAZOP review is to evaluate system vulnerabilities and safety risks to personnel or equipment. A HAZOP review is not intended to improve the constructibility of a design or optimize the cost of the project.

Undertake a HAZOP review of the project at the 90% detailed design stage of a project. The HAZOP review sessions must be completed by a qualified professional who has experience in the subject matter. The HAZOP review must be conducted in accordance with the latest edition of IEC/BS EN 61882 or equivalent guidelines.

2.8 Construction Sequencing and Implementation Plan

The Construction Sequencing and Implementation Plan is intended to convey the complexities and dependencies associated with the project, particularly those that impact critical system operations. The plan is not intended to dictate the construction means and methods.

2.9 Close-out Documents

In addition to close-out submittals by the Contractor, submit the following documents to the City:

- **Final Operations & Maintenance Manual:**
  Updated according to City feedback.
- **Equipment Details:** Provide equipment manufacturer details for all new equipment in digital format and ensure the format is compatible with the City's database.
- **Asset Inventory List:**
  Include digital files of all new assets to integrate into the City's Asset Management database and ensure the format of submission is compatible with the City's database. Asset list shall include asset tags for each piece of equipment, using the departments asset tagging registry. Include asset life expectancy, date of installation and replacement value.
- **As-Built Drawings:**
  Update IFC drawings according to field notes from the contractor, and construction management team to reflect the conditions and develop the as-built drawings accordingly. As-built drawings shall be submitted within three months of substantial performance of the project.

2.10 Close-out Meetings

Following substantial performance of the construction works, organize and lead the following debriefing sessions:

- **Post-Construction Meeting:**
  The purpose of this meeting is to discuss lessons learned with the construction team and to identify opportunities for improvements on future projects. This meeting provides the Contractor with an opportunity to provide constructive feedback to the Construction Management team for consideration on future projects. The Post-Construction meeting shall include the City, the Contractor, and the Proponent.
- **Proponent Debrief:**
  This meeting shall include the Proponent and the City to discuss lessons learned from the entire project including both the design and construction phases to identify opportunities for improvement.

2.11 Engineering Drawing CAD Requirements

All design and as-built drawings shall be submitted to the City in AutoCAD 2019 and in Portable Document Format (.pdf). Site drawings shall be in a grid scale with world coordinates matching the **Universal Transverse Mercator (UTM) Projection CSRA 1983 Zone 17 North (WKID EPSG:2958).**

Ground control points for site plans shall be shown in the drawing including the published geodetic point number, coordinates, and elevation. For layout and tie-in survey purposes, all drawing sheets will include ground scale dimensions to survey control points, monuments, or bars.

2.12 Commissioning Plan

The Contractor shall develop and submit the Final Commissioning Plan to the City prior to starting any equipment. Commissioning activities, in general, should not start on a Friday or within two days before a long weekend. The Proponent and Contractor shall work together to prepare a Commissioning Plan to be submitted to the City at least four weeks prior to the planned commissioning activities.

Commissioning activities shall include a Performance Period during which new processes are proven to function and operate continuously as intended. The Performance Period must be witnessed, signed off and accepted by the City and prior to abandoning and/or removing old processes and equipment.

2.13 Warranty Period

All City construction projects shall be specified with a 12-month warranty period from the date of substantial performance of the construction project or as identified in the Development Agreement.

2.14 Training Requirements

Following submission of 90% design and prior to developing the specifications, consult with City operations on the operator training requirements for all key systems proposed for the project. Similarly, discuss with the City the required spare parts for key equipment. Operator training by the equipment suppliers shall be:

- Reviewed by the Proponent;
- Include both classroom and field (hands-on) training; and,
- Accommodate multiple operator shifts.

3.0 SITE LAYOUT

3.1 Fencing and Gates

Provide appropriate security fencing around the site with consideration for aesthetics where potential public impacts are a concern. Provide secure and lockable gates for personnel, vehicle, and truck access to site.

3.2 Driveways and Parking Spaces

Paved surfaces shall be designed in accordance with the minimum pavement design requirements for heavy industrial property outlined in the City's Roads & Transportation Linear Municipal Infrastructure Standards. All road designs should be verified with a geotechnical engineering report.

The design of driveways and parking spaces shall take into consideration all potential vehicular access requirements including operations, maintenance, deliveries, construction, and emergencies, as well as accessibility requirements in accordance with the City's Facility Accessibility Design Standards and the Accessibility for Ontarians with Disabilities Act (AODA). Provision of parking spots shall be determined based on zoning by-law requirements and consultation with the City.

3.3 Protection Devices Around Structures

Consider the use of protective bollards or other suitable devices around structures that could inadvertently be damaged by vehicles or trucks.

3.4 Space for Expansion

Consider future expansions and property use when completing site layout design.

4.0 CIVIL

4.1 Yard Piping and Buried Utilities

Design of buried piping and utilities within the property boundary must comply with the City's Linear Municipal Infrastructure Standards.

4.2 Chemical Lines

The City's preference is for chemical lines not to be buried. However, if direct burial is required, then the pipe shall be double-walled and heat traced with applicable equipment and installed with tracer wire to assist with locating in the future. For critical chemical applications, consider using dedicated accessible trenches to house the chemical feed lines.

4.3 Wall Sleeves and Penetrations

All process pipe penetrations to buildings and structures shall be watertight and structurally designed with appropriate thrust restraint as required. Fire stops will be utilized as required.

4.4 Electrical and Instrumentation Buried Ducts

Buried conduits and ducts for electrical and instrumentation wiring shall be designed and constructed according to the City's Linear Municipal Infrastructure Standards.

Provide at least 50% spare conduits in all buried ducts equal to or greater than the size of the largest conduit. Where electrical duct banks cross driveways and access roads, provide concrete encasement around the conduits.

4.5 Stormwater Management

Design new facilities in accordance with the City's Vertical and Linear Municipal Infrastructure Standards, and in direct consultation with the City.

5.0 LANDSCAPE

Landscaping should be designed in accordance with the City's Site Plan Manual. Plantings that are indigenous to the area are encouraged. Consider the use of low-maintenance vegetation to reduce watering and maintenance costs.

6.0 ARCHITECTURAL

6.1 Design Objectives

All new buildings should be designed to:

- Match the aesthetic requirements of and fit with the surrounding neighbourhood
- Use water and energy efficiently
- Deter vandalism and unauthorized access

6.2 Building Layout and Elevations

The finished floor elevation of the main ground level of all new facilities shall be at least 300 mm above the regional flood elevation established by the Grand River Conservation Authority (GRCA) including all non-submersible electrical and instrumentation equipment.

6.3 Roofing Design

Design roofing systems for minimum 50-year life span. All roofing systems shall be warranted for 25 years non-prorated for both material and labour.

Pitched or sloped roofs shall be equipped with snow guards. Eavestroughs and downspouts shall discharge to the surface with precast splash pad underneath each downspout. Connection to either the wastewater or storm system is not permitted.

6.4 Cranes and Equipment Lifting Devices

Provide a permanent crane or other lifting device to suit equipment removal and transport offsite. The preference is for motorized cranes rated for the weight of the largest piece of equipment. Where installation of a permanent crane or lifting device is not practical due to space limitation or weight of a particular item, provide removable panels or slabs for equipment removal by a mobile crane or similar means. Provide lifting points, removable covers, and/or lifting devices above equipment where feasible.

6.5 Doors and Building Entry Points

Each exterior door shall be insulated hollow metal, equipped with a touch-bar exit device, a heavy-duty closer mechanism, and a kick plate.

All personnel doors shall be sized in accordance with the City's Facility Accessibility and Design Standards. Doors and frames should be ready to accept electrical swipe card access without modification or replacement. Locks and keys shall be what the applicable City Department currently utilizes.

Provide heavy-duty roll up doors where practical to allow room for equipment delivery and removal. All roll up doors shall be electrically powered unless they are located in classified areas where manual operation is acceptable. A personnel entry door shall be provided near each roll up door.

6.6 Building Signage

Provide signs outside new buildings that include the following information: City of Brantford, Public Works, street address, and contact telephone number (to be provided by the City). Do not identify the facility type or name.

6.7 Floor Plans and Door Signage

Provide a floor layout plan in a clearly visible area for all new buildings indicating all egress points for fire safety. Provide signage for each room door indicating the name of the room.

6.8 Windows and Skylights

New facilities should be designed with no windows on the ground floor for security purposes. Introduction of natural lighting should be set at least 3.0 m above the final building grade. Where windows are proposed by the Proponent, the exterior pane should be non-breakable.

Consider the use of skylights where practical to introduce natural daylight and reduce energy consumption. However, the design of the skylight should consider overall safety and security requirements for the building and site.

6.9 Wall Finishes

All interior walls shall be architecturally coordinated to provide a level of finish for the use or service intended. Additional consideration shall be given to humid environments typically encountered within water and wastewater facilities. Provide ceramic tile finishes on all walls for washroom facilities.

6.10 Floor Finishes

All floors shall be provided with non-slip floor finishes suitable for the working environment.

Concrete floors within process areas including chemical storage rooms shall be provided with a slip-resistant epoxy finish. Review chemical compatibility with the selected floor epoxy coating.

6.11 Access Hatches

All personnel and equipment access hatches shall be equipped with secondary safety gratings for fall protection. Provide hinged, pad lockable covers with lifting assists and hold-open arms. Each lock port shall be recessed and provided with a drain. All personnel access hatches shall be equipped with a personnel davit base and a grab bar. All access hatches supporting concrete curbs must be between 300 mm and 450 mm higher than the adjacent finished grade.

Access hatches shall be aluminum or stainless steel construction and shall be sealed to prevent ingress of insects or debris through key holes or other spacings.

6.12 Structural

All cast-in-place concrete water retaining structures shall be low-shrinkage concrete that complies with CSA Standard A23.1 complete with semi-permeable type 2 form liners. Water-retaining concrete structures shall be designed and constructed to hold water with no evidence of leakage as per the requirements of the project's leakage test. Application of coatings is not an acceptable means to control leaks.

7.0 PROCESS MECHANICAL

7.1 Piping

Unless process conditions require a higher rating, all piping and valving shall be designed for a minimum working pressure of 1034 kPa (150 PSI) and full vacuum. Hydrostatic test pressure shall equal working pressure and allowance for surge pressure shall be considered in pipe design. All process piping for water facilities shall be minimum 304L stainless steel. All process piping for wastewater facilities shall be minimum 316L stainless steel.

7.1 Piping (Cont'd)

All piping, valves, vessels, and other components used for compressed air service must be designed in accordance with the requirements of CSA B51/ASME B31.1.

All equipment, pipes, coatings, or materials in contact with potable water must be certified to ANSI/NSF 61.

Piping layout shall accommodate access to all critical components for operation and maintenance. Locate valves, equipment, and instruments in unhindered locations accessible from floors and platforms with sufficient clearance to complete maintenance.

Ensure that the failure or maintenance of any single segment of pipe (between two valves) does not result in a total shutdown of the facility.

The design of suction and discharge headers shall accommodate flange connection for future expansions.

Individual pipe sections between isolation valves shall be equipped with manual air vent ball valves and drain ball valves. Minimum valve sizes shall be 50 mm.

Evaluate pipe material, size, and schedule to suit the process requirements and the surrounding environment.

Piping shall be independently supported. Pipe sections shall not be supported by adjacent process equipment such as pumps. Design the piping system to accommodate thermal expansion and contraction using suitable couplings/fittings.

All pipes shall be colour-coded in compliance with the latest edition of the Ontario Design Guidelines for Drinking-Water Systems and the Ontario Design Guidelines for Sewage Systems respectively. Provide pipe labelling in accordance with ANSI/ASME A13.2 Pipe Labelling Standard.

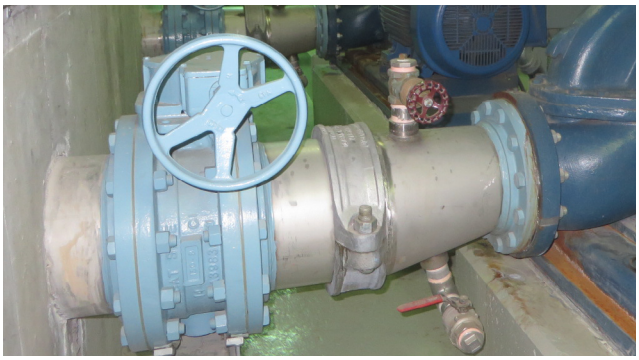
7.2 Couplings

Provide suitable restrained couplings within the piping system to facilitate:

- Removal of all valves and process equipment;
- Future maintenance and pipe dismantling;
- Installation tolerances; and,
- Thermal expansion and contraction.

7.3 Valves

Selected valve type shall suit the process fluid, operating conditions, and control philosophy. All valve components and coatings in direct contact with potable water must be certified to ANSI/NSF 61 and ANSI/NSF 372 Standards. All valves shall be stainless steel or fusion bonded epoxy for corrosion resistance, complete with stainless steel hardware.



7.4 Valve Automation

All valves shall be automation-capable whether they are automated or not. At a minimum, actuators shall be sized to the class rating of the valve with a safety factor of 1.5 for operational control service and a safety factor of 2 for modulating service. Review with the City the requirements for valve automation during a dedicated workshop. The decision for valve automation shall consider the following factors:

Valve accessibility (safety and practicality of manual operation);

- Maintenance requirements (valve size and cycling needs);
- Process needs (modulating versus isolating service);
- Status and Control feedback requirements to SCADA; and,
- Flow control requirements for process optimization.

7.5 Process Equipment Noise Level

Process equipment noise limits shall comply with Occupational Exposure Limits under the Ontario Occupational Health and Safety Act (OHSA).

7.6 Equipment Access and Maintenance Requirements

All rotating equipment shall be equipped with protective guards. All process equipment shall be mounted on individual concrete pads raised above the finished floor of the building. Provide a minimum of 1.0 m of clear, accessible space around all equipment for maintenance work.

All new equipment shall be provided with electrical and mechanical lock-out isolation devices.

In designing the layout of valves and equipment, allow provisions for their removal and maintenance.

7.7 Chemical Storage and Feed Systems

The design of chemical storage and feed systems shall minimize the risk of exposure to hazardous materials. Chemical storage facilities shall be equipped with a containment system to avoid an environmental spill in the event of failure of a storage component complete with sump and flood floats tied to SCADA. The volume of containment shall be equal to the total volume of all tanks plus 10%.

For all chemical systems, provide a minimum of two metering pumps. Metering pump sizing shall take into consideration both the maximum and minimum dosing requirements. The chemical pump feed rate speed and stroke shall be fully automated and controlled by the SCADA system.

All equipment and components (eg. gaskets, rings etc.) must be compatible with the chemical utilized.

Chemical storage tanks shall be made of materials that are compatible with the chemical being stored. Provide level-indicating transmitters and flow meters connected to SCADA for monitoring levels and flow rates, respectively. Provide piping for manual calibration of the metering pumps.

For chemicals that have the potential to release gases, provide air scrubbers for chemical storage areas to suit the type and size of the chemical stored and in accordance with the Ontario Design Guidelines for Drinking Water Systems and the Ontario Design Guidelines for Sewage Works.

Provide clear identification for all chemical rooms, fill ports, and storage areas according to the Workplace Hazardous Materials Information System (WHMIS) and the Globally Harmonized System (GHS) of Classification and Labelling of Chemicals.

8.0 BUILDING MECHANICAL

8.1 Ventilation Systems

The ventilation system for process and chemical storage areas shall be designed in accordance with the Ontario Design Guidelines for Drinking Water Systems, Ontario Design Guidelines for Sewage Works, and NFPA 820 area classification where applicable. It is preferred to de-rate spaces by area separation and not by ventilation.

Ventilation system intakes shall be located at a sufficient distance from chemical tank vents, parking bays, and other nearby sources of emissions. Consider the prevailing wind direction and surrounding operations when designing the air intake and exhaust locations.

The ventilation system for administrative and office spaces shall be designed in accordance with the requirements of the OBC and ANSI/ASHRAE 62.1.

8.2 *Ventilation System Control*

The ventilation system shall be controlled by a vendor-specific control panel or building automation system to interface with the SCADA system via BACnet protocol for alarm monitoring.

8.3 *Space Heating*

All process areas must be designed to maintain temperatures above 8 degrees Celsius at all times. Areas periodically occupied by operations staff should be designed for an ambient temperature of 20 degrees Celsius. Automatic reduction of the heating demand when spaces are unoccupied should be considered in the design. Provide the most efficient and lowest LCC heating system.

8.4 *Cooling and Dehumidification Systems*

Supply and exhaust fans should be considered as a primary means of cooling spaces. For process areas, design ventilation systems to achieve a maximum building temperature of 5 degrees Celsius below outdoor temperature.

Provide cooling and dehumidification systems for critical electrical and instrumentation systems, including server rooms, to suit the anticipated cooling and dehumidification loads. Air conditioning should be provided for all office and control areas designed for continuous human occupancy. Assess the need for dehumidification systems for process areas to control condensation and control corrosion from a LCC cost perspective.

8.5 *Plumbing*

A potable water service line shall be provided to all facilities in accordance with the Linear Municipal Infrastructure Standards, and Ontario Building Code (OBC). All plumbing lines shall be insulated and labelled with the type of service and flow direction in accordance with ANSI/ ASME A13.1 Standards.

Provide hot water tank(s) sized for the facility's hot water needs and at least one universally accessible washroom for new facilities. Washroom design shall comply with the City's Facility Accessibility Design Standards.

Provide a hands-free wash sink, a hands-free soap dispenser, and a hands-free paper towel dispenser. Provide a separate custodial room with a slop sink and/ or service sink. A hot water recirculation system to large installations is required to provide hot water to sinks in a timely manner. Provide an emergency eye wash station supplied with tepid water for all process areas with chemicals or wastewater.

9.0 ELECTRICAL

9.1 *Design Drawings*

Field-verify the latest single line diagrams provided by the City prior to their use as the basis of design for any proposed modification or upgrade to an existing electrical system. Following completion of the electrical works, submit a record drawing of the updated single line diagrams of the entire operational system.

All as-built single line drawings shall be printed on ISO216 A1 or appropriately sized water-resistant lamacoid plaques and installed at a conspicuous location inside the electrical room.

9.2 Safety Requirements

600 V Motor Control Centres (MCC) and motor starter panels shall be separated from low voltage control panels (120 VAC or less).

Emergency stop buttons shall be provided for all moving/rotating equipment in the field. Provide an additional emergency stop button at the MCC. Where equipment extends multiple levels (such as an extended shaft), provide additional E-Stop buttons at each access level.

9.3 Arc Flash Risk Mitigation

The electrical system design should eliminate or reduce the risk of arc flash by reducing the likelihood of exposure, reducing the magnitude of severity of exposure, and enabling achievement of an electrically safe work condition. Complete an arc flash risk assessment according to CSA Z462 - *Workplace Electrical Safety* for new installations. All new work shall include a complete Arc Flash analysis, labelling and documentation.

9.4 Investigations and Studies

When variable frequency drives (VFDs) are being used, the completion of a harmonics study by a qualified specialist firm shall be provided.

A Short Circuit, Arc Flash Hazard, and Protective Device Evaluation and Coordination Study must be completed for every project when a modification to the electrical system is proposed, unless otherwise indicated by the City. The study must be completed and implemented in accordance with the Ontario Electrical Safety Code.

9.5 Utility Power and Power Distribution

Consult with the City, GrandBridge Energy Inc. on the source and preferred location of the power meter for the construction of all new facilities. For highly critical facilities, consider two separate utility feeds to the facility with a tie breaker. Each feed shall be sized to power a minimum of 75% of the facility's total load.

Electrical utility boxes shall be compact and low profile to complement the aesthetics of the location. A separate power monitor shall be provided for each utility feed. The power monitors shall be connected to the SCADA system.

When a new utility power service or an existing utility service is being modified or upgraded, a transient voltage surge suppression and lightning arrester system shall be provided in conjunction with the harmonic study, provide adequate harmonic mitigation as required.

9.6 Automatic Transfer Switch

A free-standing automatic transfer switch shall be provided for all facilities with standby power generators. A resistive load bank connection shall be installed for all future generator installs.

All equipment, ATS and generator shall be Ethernet capable and connected to SCADA. Hardwired controls are still required. The Ethernet communication will supply additional analytics and data. Communication protocal should be Native Allen-Bradley.

9.7 Motor Control Centre (MCCs)

MCCs and all components shall be designed, manufactured, and tested in accordance with NEMA Standards. All compartmentalized vertical sections shall be provided with common power bus bars. Each vertical section of the MCC shall be designed to permit the removal or addition of motor starters and control units as required.

MCCs shall be floor-mounted, freestanding, dead front, completely enclosed control assembly and should accommodate front mounting combination starters and circuit breakers. Cubicles housing the service entrance main breaker shall be compartmentalized and provided with a full-width front door complete with locking handle. Evaluate the cost and benefit of NEMA 4X outdoor enclosures for MCCs on a project-specific basis.

Panels shall have adequate ventilation to limit internal temperature rise. Provide a continuous ground bus with accessible external connection for bonding to the ground. All indicating light lamps shall be LED type. All lights shall be push-to-test type.

9.8 Motor Starters

Provide reduced voltage soft starters unless operation requires variable speed operation, in which case VFDs are to be utilized. Soft starters and VFDs shall be equipped with keyed bypasses to permit across-the-line start if necessary.

9.9 Motor Specifications and Protection

All electric motors greater than 7.5 kW (10 hp) shall be high efficiency motors. For motors greater than 89.5 kW (120 hp), the minimum efficiency shall not be less than 94% at full load. Final motor selection shall be determined based on LCC analysis.

A motor protection relay system must be provided for all motors equal to or greater than 89.5 kW (120 hp) in size.

All motors greater than 89.5 kW (120 hp) shall be equipped with the following resistance temperature detectors (RTDs):

- RTD connections for windings, one per phase
- RTD for motor inboard and outboard bearings (where applicable)
- RTD for pump inboard and outboard bearings (where applicable)

All motors greater than 7.5 kW (10 hp) but less than 89.5 kW (120 HP) shall be provided with thermistors tied to the motor starter for protection.

All submersible motors, regardless of size, shall be equipped with built-in thermal and moisture/leakage sensors tied to trip the circuit and alarm.

All motors shall be factory-tested in accordance with NEMA MG-1 and applicable Institute of Electrical and Electronics Engineers (IEEE) Standards.

9.10 Network Access Panel

Provide a dual hinged sealed network cabinet with a minimum 21U spacing to allow for various network installations. Network cabinet to be sufficiently strong enough to withhold all network equipment including but not limited to, fibre splicing, Ethernet patching, network switch and firewall, power supplies, UPS backup with spare battery, and AC unit. Network cabinet to be supplied with sufficient means of ventless cooling, providing a sealed network cabinet with regulated temperature. Network hardware to suit the latest SCADA Standards in conjunction with IT standards for their specific hardware requirements. Network Ethernet wiring to utilize shielded cable (STP) throughout the entire facility, including patch cables within the network cabinet.

9.11 Electrical Panel Location and Access

All electrical control equipment must be located outside of process, chemical, or other hazardous areas whenever possible. The electrical design should reduce the operator risk of arc flash hazards by reducing or eliminating the need to be near high voltage electrical equipment during normal operations. Cabinets and panels can be sized to permit safe maintenance work.

All electrical motors must be located above the maximum anticipated water or flood level with a minimum of 300 mm freeboard whenever possible. If not possible, motors must be at least IP68 immersion rated or fully submersible.

All electrical panels, installed indoors or outdoors, shall be mounted on designated equipment pads. Provide a minimum 500 mm wide clearance from the panel exterior to the edge of the concrete where practical.

9.12 Equipment and Wiring Identification Requirements

All electrical equipment must be identified with clear lamacoid nameplates that are adequately fastened to the exterior of the panels regardless of the voltage level.

All electrical wiring must be clearly identified with permanent identifying markings at both ends. All work shall comply with the Ontario Electrical Safety Code. Tagging must conform to the City's SCADA Standards.

9.13 Lighting

Provide sufficient lighting to facilitate safe and clear operation and maintenance by the City as outlined in the City's Roads and Transportation Linear Municipal Infrastructure Standards. Outdoor exterior lighting must be provided at all facilities in accordance with the City's Site Plan Manual. A photometrics plan is required for all outdoor exterior lighting designs.

Conduct a photometric assessment to confirm the necessary number of light fixtures and optimum locations for new facility design. A photometric assessment of existing facilities is not required unless requested by the City.

The luminaire type for indoor and outdoor applications shall be LED. Photocell control for all outdoor lighting applications must be provided. Avoid locating light fixtures on high ceilings or in areas that may be difficult to access for maintenance purposes. Consider wall-mounted LED lights. Provide access for servicing light fixtures that must be located at high ceilings. Provide occupancy sensors for indoor lighting to enhance energy savings. Emergency lighting shall also be provided for all buildings.

10.0 SECURITY AND SAFETY SYSTEMS

10.1 Site Security

Where applicable, the design of site security for new facilities should adhere to City Security Standards, and take into consideration the principles of Crime Prevention through Environmental Design (CPTED) as explained in the City's Site Plan Manual, as well as adhere to the By-law & Security's Physical Security Standards.

10.2 Security Alarm System

Provide a vendor-specific security alarm system for all new facilities, installation to be located in the electrical room. The vendor control panel must be interfaced with the SCADA system via hardwired dry contacts for monitoring. Provide illegal entry alarm contact switches for all building entry points including doors, windows, and hatches. Please reference The City of Brantford's By-law & Security's Physical Security Standards for specific hardware and configuration requirements.

10.3 Closed-circuit Television Cameras

New buildings should be equipped with exterior and interior closed-circuit television (CCTV) cameras mounted at strategic locations and connected to the City's CCTV network. This includes but is not limited to perimeter monitoring, gate entry including plate detection specific cameras, public interaction areas, locations that provide a high likelihood of break-in. All CCTV cameras shall be equipped with day/night vision. All CCTV cameras shall be IP/ Ethernet based and include all equipment to provide a functional system, power supplies, POE injectors, etc.

CCTV cameras must be provided for confined spaces and restricted spaces where applicable, including wastewater wet wells, dry wells, and critical underground valve chambers, to reduce the need for personnel access. Provide appropriately-classified CCTV cameras to suit rated spaces. It should be emphasized that the design of new facilities should eliminate the need for confined space entry as a general design principle.

CCTV cameras must also be provided for interior spaces where applicable, including electrical & IT rooms, vestibules & entranceways, high traffic areas, pump gallery's, and other process areas. CCTV cameras to be integrated with building security systems, including alarm systems and access control systems. Please reference The City of Brantford's Bylaw & Security's Physical Security Standards for specific hardware and configuration requirements.

10.4 Fire Alarm System

Provide addressable heat and smoke detectors monitored by a vendor-specific fire alarm system that is also connected to the City's SCADA system via hardwired dry contacts for monitoring. The design of the fire alarm system shall conform to the OBC requirements.

10.5 Hazards Warning Signage

Provide clear signs identifying anticipated hazards including, but not limited to, chemicals, noise, arc flash, confined spaces, pinch points, rotating equipment, heat, and fall hazards.

11.0 STANDBY POWER

11.1 Facility Requirements and Sizing Criteria

All water, wastewater, and stormwater facilities shall be equipped with permanent on-site standby power generators to operate in the event of a utility power failure. All standby power generators must be equipped with a standard Ethernet connection. A resistive load bank connection shall be installed for all future generator installs. Standby power generators shall be sized as follows:

- **Water Treatment Plant:** Provide standby power to maintain the rated capacity of the Water Treatment Plant according to the Drinking Water Works Permit (DWWP).
- **Water Pumping Station and Booster Station:** Provide standby power to meet the full load capacity of the facility.
- **Wastewater and Stormwater Pumping Station:** Provide standby power to meet the full load capacity of the facility.
- **Wastewater Treatment Plant:** Provide standby power to maintain the peak flow rate of the Wastewater Treatment Plant per the Environmental Compliance Approval (ECA).

11.2 Generator Layout and Location

The City's preference for generators is pre-packaged, stand-alone systems consisting of a liquid-cooled, closed-loop, diesel-powered engine in a self-contained, sound-attenuating, outdoor enclosure.

Outdoor generators shall be installed on a dedicated concrete pad above the regional flood elevation.

11.3 Noise and Emissions Control Requirements

Provide site-specific noise and emission attenuation measures to minimize impact to neighbouring communities where deemed necessary by the City.

11.4 Fuel Tank Requirements

Diesel is the preferred fuel source for emergency standby power. Diesel storage tanks shall be sized based on the greater of:

- 24 hours of full load of operation starting from a 75% full tank; or,
- 48 hours of operation at the facility's firm capacity starting from a 75% full tank.

Provide a double-walled storage tank. A fuel level-indicating transmitter, a low and high float switch, a fuel leakage alarm wired to SCADA, and a vent whistle shall be provided. Where practical, a tank rupture/ leak alarm switch wired to SCADA and a visual vacuum gauge shall be provided within the double-walled tanks. All fuel tank, piping, and associated systems shall be designed to comply with the latest requirements of the TSSA and CSA B139.

The fuel tank shall be equipped with an analog level indicator to read and monitor diesel fuel level in SCADA. In addition, a passive (non-electronic) means of reading the fuel level shall be provided.

11.4 Fuel Tank Requirements (Cont'd)

Where more than one fuel tank is provided, each tank must be vented separately to the exterior. Each tank supply fuel line shall be provided with a manual shut-off valve for isolation. Direct cross-connection between tanks is not permissible. Fuel lines shall be installed in dedicated and sealed floor trenches equipped with a flood switch connected to SCADA for monitoring fuel leaks.

11.5 Air Intake and Ventilation

The generator system shall be designed complete with fans, dampers, and other ancillary systems to meet the required air intake volume for engine combustion and ventilation requirements. The engine ventilation system shall be designed to operate with or without local utility power. In the event of a malfunction, intake dampers shall open on loss of power in a fail-safe manner.

Combustion Air Ventilation dampers must be fully open before the diesel engine is permitted to start. Obtain variance from the TSSA at critical stations where it is necessary for the generator to start even if the damper fails to open. All louvres shall be acoustical style and equipped with an aluminum insect screen.

11.6 Battery System

Diesel engine shall be started by an electrical cranking motor with power provided from storage batteries, which may either be a 12- or 24-Volt system.

The system shall include a fully automated battery charger to maintain the battery in a fully charged state, with an alarm to SCADA in the event of malfunction or low battery voltage. Provide sufficient amperage for three cranking cycles of 15 seconds duration.

The generator set shall be provided with a microprocessor-based control system compatible with the automatic transfer switch and designed to provide automatic starting, monitoring, and control functions. The generator status signals shall be connected to and monitored by the SCADA system.

11.7 Grid Synchronization and Peak Shaving

Standby power systems are intended to provide backup power in the event of an emergency when utility power fails. It is not the intent of the standby power system to provide peak shaving and synchronize with the grid during normal operation.

11.8 Generator Testing

All generators shall be engineer witnessed factory tested. All Factory Acceptance Testing (FAT) and Site Acceptance Testing (SAT) must be completed with mandatory Reactive Load Bank. Only when a generator has passed the factory test can it be shipped to site. Following installation and pre-commissioning checks, the generator system must be tested continuously for a minimum period of four hours at full load. Complete acoustical field testing of the generator equipment to confirm compliance with the specified noise limits. All generator alarms are to be tested and verified during SAT tests to ensure they alarm out to SCADA.

12.0 INSTRUMENTATION AND CONTROLS

12.1 Instruments and Devices

Review process operating conditions to determine the most suitable instrument technology. All instruments shall be installed in locations that are safe for workers and easily accessible. Instruments shall be suitable for their intended service, easily serviceable, and calibrated.

Field instrument enclosures shall be rated in accordance with the area classification. Locate instrument displays and transmitters in accessible locations and away from confined spaces or other hazardous locations. Avoid installing instruments in hazardous areas when non-hazardous alternative locations are available.

All instruments mounted outdoors shall be in NEMA 4X enclosures and should be suitable for operating temperatures of -30 to +50 degrees Celsius. Provide a heater complete with thermostat where required. In general, valves must be installed on all instrument lines to allow for calibration and removal without disruption to the process. Block and bleed valving configurations should be used wherever possible. Electrical switches must be located near the equipment to allow for isolation while servicing or installing instruments. City of Brantford SCADA Standards must be fully adhered to.

12.2 Device Connectivity

All instruments and devices connected to SCADA shall also be capable of integration through the Industrial Internet of Things (IIoT) system. All devices that offer Ethernet connection as an option shall be included and connected to SCADA as required (i.e flow, level, etc).

12.3 Lamacoid Tags

Provide lamacoid tags for all supplies, instruments and equipment. Each lamacoid tag must include the equipment's tag number and service description.

12.4 Instrument Loops

All analog instrumentation loops shall be 4-20 mA current loops (and two wires wherever possible). Direct-current (DC) power supplies within the PLC panel shall be provided with power to the transmitters via fused terminal blocks or mini-circuit breakers. The power supplies shall be rated at no greater than 50% load to allow for future expansion.

The signal cables should be shielded twisted pairs and should run through a metal conduit which is not located near high voltage power cables. The shields should be terminated and grounded to a dedicated instrument ground bar at the PLC panel end only.

When field instruments such as analyzers require a 120 VAC power supply, this must be run in a separate conduit from the signal cables. There should be a switch at the instrument which allows the 120 VAC power to the instrument to be shut off. The output of the transmitter must be 4-20 mA and electrically isolated from the power supply. The 120 VAC shall be supplied by a UPS protected circuit.

All instruments must include Ethernet capabilities where ever possible and connected to SCADA.

12.5 Local Control Panel Requirements

Local control panels (LCP) shall be in a dedicated electrical room for new construction whenever feasible. Each LCP shall be connected to the SCADA system for monitoring and remote control. Develop detailed loop drawings for all signals to and from each LCP to the central PLC as part of the tender package. Typical loop drawings are not acceptable.

12.6 Control Philosophy

The PLC shall be used as a centralized control point to monitor and control all process and non-process parameters for the facility. Under normal operating conditions, all unit processes shall be operated in “remote-automatic” mode using the control logic of the SCADA system.

Individual unit processes shall be equipped with LCPs to control the operation of units locally by operators. Incorporate hardwired and software interlocks as required by the process to ensure redundancy of operation and safety of personnel and equipment. Any personnel or equipment safety interlocks must be protected by means of hardwired interlocks, which will interrupt operation of the equipment until the condition is reset in the field.

12.7 Central PLC Panel Requirements

New control panels shall be housed in floor-mounted enclosures with a NEMA rating appropriate for the environment. Electrical power for the PLC panel shall be provided with a minimum of three 120 VAC, 15 A lighting panel supplies from the same phase. Conduits and wiring should be installed from the panel to the PLC cabinet location. Provide an uninterruptable power supply (UPS) unit sized for 30 minutes complete with Ethernet connection, and alarm monitoring to SCADA upon loss of power as well as UPS fault.

The front face of the PLC panel shall be equipped with an HMI touch panel and a folding table for laptops. An auxiliary Ethernet port and a 120 VAC power outlet shall also be provided. The detailed design drawings shall include dimension layout drawings of new PLC panels with full legend plate and bill of material information for internal and panel-mounted equipment.