INFRASTRUCTURE ONTARIO

2017 BUILDING SYSTEMS DESIGN GUIDELINE

This document is intended for use by:

Property Land Management Service Provider
Project Management Service Providers
Vendors including Design Consultants
And Commissioning Authorities

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INTRODUCTION

1 Infrastructure Ontario (IO) oversees the execution of ministry funded and capital projects that deliver the Ontario Government's needs for infrastructure investment, maintenance and renewal across the portfolio.

2 IO has contracted with Project Management Service Providers (PMSPs) for the project management of certain construction and construction-related services. IO provides project oversight and project management advisory services over the Project Management Service Providers. IO also directly delivers specialty projects on behalf of its clients.

3 IO has adopted sustainable and smart green design strategies which establish a basis for incorporating the principles of environmental stewardship, energy efficient and resource conservation into the design of new retrofit or renovation projects. IO is committed to a resource and energy conservation program based on continual improvement in the design and construction of new buildings and major renovations.

PURPOSE

1 The purpose of the IO Building Systems Design Guidelines is to standardize design and construction objectives and technical requirements across the full portfolio of IO buildings. This will result in higher performing building designs in accordance with the Smart Green Portfolio strategy and consistency for the IO portfolio.

2 This in turn will help our organization and our partners achieve:

2.1 Better occupant comfort and satisfaction

2.2 Savings through improved operational performance and optimized life expectancy

2.3 Energy Management Conservations efficiency

2.4 The provisioning of technologies and tools to efficiently monitor, control and manage building systems

THE SMART GREEN PORTFOLIO STRATEGY

1 The Smart Green Portfolio Strategy is a high performance building portfolio strategy that utilizes advanced automation and integration to measure, monitor, and control building systems in order to optimize operations and maintenance at the lowest cost.

2 The Strategy involves integrating relevant building systems including, but not limited to, HVAC, Lighting, Security, Generators, UPS, Elevators, Fire Protection and Life Safety where possible, to reduce energy consumption in a facility.

3 The Strategy includes the infrastructure required for centralized remote monitoring of building systems. The combination of integrated automation with centralized monitoring will allow for:

3.1 All relevant building system information to be available to a supervisor for alarm and event management, trouble shooting, dispatch for service or repair, historical record keeping, network security and utility metering including sub-metering for individual tenants.

3.2 Faster response times, consistent implementation of policies and procedures, improved operational performance, and continuous energy efficiency optimization.

THE GUIDELINE CONTENT AND ORGANIZATION

1 The Guideline organizes Building Systems components into the following five Divisions, per the 2012 CSI Master-Format practice:

1.1 Division 21 Fire Suppression

1.2 Division 22 Plumbing

1.3 Division 23 HVAC

1.4 Division 25 Integrated Automation

1.5 Division 26 Electrical

2 Users shall need to refer to multiple Divisions for details on a particular sub system.

3 The organization of each Section is aligned with the 2012 CSI Master-Format and includes the Section Names and Numbers for each Division by Construction Specification Canada (CSC).

GENERAL REQUIREMENTS

1 Commissioning Agent and Project designer shall review Project Justification and all attachments for project details.

2 The Owner's Project Requirements (OPR) shall be developed by the Commissioning Agent on the project and shall include:

2.1 Project Justification (PJ) document for the project

2.2 Attachments to the project PJ, such as studies, recommendations

2.3 Charter for project as agreed with owner

3 Physically review condition and integration of related or peripheral equipment not being replaced/renewed to ensure final system as left by project, will be able to operate in efficient manner and have a life expectancy of 10 years or more. If not, report findings prior to submitting 33% to IO and its representatives.

4 Allow for a 2 hour presentation session with building operation staff, when design is 99% complete, including detailed sequence of operation. Schedule the time at least 5 working days (excluding weekends and holidays) prior to the session. This makes the operating

staff aware of any upcoming projects and staff may know of problems in the project area that could affect the performance of the design intent.

5 Design to be based on the most efficient technology readily available and serviceable for the systems being altered (e.g. replace a non-condensing boiler with a condensing unit or heat pump. Like for like is not acceptable.). Design must adhere to project original budget, any additional budget shall be approved in writing by IO

6 All equipment that requires maintenance must be accessible for service and maintenance, including equipment mounted in ceiling spaces.

7 Furnishings layout to provide access to all mechanical equipment such as, but not limited to, perimeter heating units, and isolation valves typically located at/below exterior windows.

8 When replacing existing systems, ensure that all overarching systems (e.g. Backbone network, lighting controls), where they point, how they collect information, control existing systems must be fully functional during construction and after.

9 Any new systems with new features or functions installed that can be monitored, measured, or controlled shall be integrated into the BAS. Any additional space or control points needed for the BAS shall be discussed and approved with IO. Lighting controls is an exception and its integration requires a discussion with IO and PLMS.

10 It is mandated for coordination of all trades to ensure service and program continuity. End-users will be consulted and communicated with, before changes occur.

11 Contemplated Change Orders affecting the scope or quality of the equipment provided shall be reviewed and acknowledged by the facility manager.

12 The site and the site conditions must be investigated thoroughly prior to any study, design or construction begins.

13 All permits, MOPs, Lock-out/Tag-out procedures, escorting, security requirements, logistics, safety features shall be included in the project scope of work and costing.

14 The consultant is responsible to collect, integrate and approve all shop drawings, red line redactions, and implied design in a stamped Final Drawing set to be issued prior to substantial completion. The consultant is responsible to ensure all changes comply with original tender documents. This drawing is mandatory prior to the substantial complete walkthrough.

15 Mechanical Insulation shall be installed by qualified certified insulators. The insulators contracted by Infrastructure Ontario shall be eligible to conduct mechanical insulation work in the Province of Ontario.

16 Water Treatment shall be considered in all major HVAC upgrades. This includes to not limit to all Chiller, Boiler and water distribution upgrade projects.

SYSTEM REQUIREMENTS

1 Automation/Control Software

1.1 Licensing:

1.1.1 Provide or upgrade all licensing for all software packages all workstations

1.1.2 No restrictions shall be placed on the licensing including expiry dates or times.

1.1.3 All software and hardware licenses and associated administrative rights must be assigned to IO's designated PLMS representative (Facility Manager).

1.2 Software Tools

1.2.1 Provide or upgrade all tools needed for full administrative use, including programming of controllers, network management and expansion, and graphical user interface use and development, of the BAS described within the specifications shall be provided to the owner and his designated agent on the system server and laptops used by building operating personnel.

1.3 Software manuals

1.3.1 Provide or upgrade all manuals that describe system overview, programming and testing. The manuals shall include a detailed description of each software feature including editing and writing control programs, reading or modifying printout and logs, adding, deleting and modifying user password, creating and modifying graphics. Soft copy of the Software Manuals shall be provided.

1.4 Project- specific software and documentation shall become IO's property. This includes, but is not limited to:

1.4.1 Graphics;

1.4.2 Record drawings;

1.4.3 Database; and

1.4.4 Application programming code.

1.5 Operator Interface:

1.5.1 All operator interfaces, programming environment, networking, database management, and any other software used by the Contractor to install the system or needed to operate the system to its full capabilities shall be licensed and provided to Infrastructure Ontario (IO).

2 The lighting Control installations and retrofit shall be separated from the Building Automation System except integration on the field level (When occupancy sensors can be utilized for controlling the light and HVAC. No interface integration is needed), integration between Lighting Control and Building Automation System (BAS) shall be approved by IO.

3 All lighting retrofits shall consider and address the lighting control needs within the project unless approved by IO and PLMS. The lighting control shall address the operational, energy and environmental needs. Lighting control strategies shall include Occupancy control, dimming capabilities, Day time light harvesting and diagnostics for faults on the system.

4 All lighting retrofit projects shall include a lighting redesign unless approved by IO.

THE METHODOLOGY IN STEPS

For Mechanical, Electrical and Envelop projects, Project Management Service Provider (PMSP) Project Manager shall maintain appropriate communications during the lifetime of the project. IO Project Review account (Project.Review@InfrastructureOntario.ca) will be the communication tool for IO Technical team until the bid documents are fully developed and reviewed by stakeholders. All communications shall indicate the project number in the Subject line of the communication. Final Tender Document and issued Addenda to be sent to same account.

1 Step 1: Before or During Charter Meeting

1.1 PMSP Project Manager will initiate the process by requesting the applicable sections of the IO Design Guidelines from IO Property and Land Management Service Provider (PLMSP). Failure to receive feedback does not absolve the need for the use of the Design Guideline, the PMSP shall assume that all sections are applicable.

1.2 The PMSP provides the selected sections of the Design and Commissioning Guideline and this Methodology Guideline to the Designer and Commissioning.

2 Step 2: At 33% Design

2.1 PMSP, Designer and Commissioning Agent shall discuss the application of the IO Design Guideline sections by acknowledging by returning a signed copy of the design guidelines with their feedback.

2.2 Documents for review shall include:

2.2.1 A summary report from the initial site visit (date, equipment reviewed, pictures)

2.2.2 Basis of Design along with Schematic Design including any Life Cycle Cost Analysis (LCCA)

2.2.3 All assumptions for the basis of design and modelling

2.2.4 Design Calculations in case of Change of Use or major equipment replacements (e.g. Chillers, Boilers, Air Handling Units, etc.,)

2.2.5 A concept sequence of operations, logistics of project

2.2.6 Initial expected drawing list

2.2.7 A list of concerns, questions, clarifications about the scope, OPR or logistics

2.2.8 Draft commissioning plan (1-pager)

2.2.9 Draft application for incentives, if applicable

2.3 PMSP reviews the design criteria with IO and PLMS

2.4 Consensus is required in order to proceed with the rest of the design. The designer is to provide feedback to comments and supporting data.

3 Step 3: At 66% Design

3.1 Draft Specifications with all sections completed.

3.2 Complete drawings.

3.3 Commissioning plan with logistics, testing, training and special requirements (e.g. Permit-to-Work/Change Request).

3.4 Testing and balancing scope requirements shall be submitted by the Commissioning Agents.

3.5 Acknowledgement of the incentives submitted to the local distribution company, as applicable.

3.6 Consensus is required in order to proceed with the rest of the design. The designer is to provide feedback to comments and supporting data.

4 Step 4: At 99% Tender Document (including detailed Specifications)

4.1 PMSP shall deliver the Project bid documents (Specifications including PMSP and consultant general requirements, drawings, commissioning Req., ext.) to the IO Project Review account (Project.Review@InfrastructureOntario.ca).

4.2 Detailed and complete commissioning plan and schedule in order to schedule site staff and manage Ministry program interruptions.

4.3 Approved incentive application, if applicable.

4.4 Consensus is required in order to proceed with the construction. The designer is to provide feedback to comments and supporting data.

APPLICATION AND LIMITATIONS

1 PMSP Project Manager shall coordinate concurrent and future projects in order to optimize capital spend.

2 Any designs deviating from the intent of the Design Guide must be discussed and accepted by IO and its representatives prior to implementation.

3 All installed systems shall be integrated to existing buildings as function of the whole for optimal performance.

DESIGN OPTIONS

1 For many projects, multiple design solutions are available and should be evaluated during the early stages of design to determine the optimum solution for the project.

2 On this basis, IO requires the Designer to identify Design Options and evaluate them accordingly. The analysis shall include capital cost, life cycle cost, energy efficiency and performance advantages and disadvantages.

IO COMMISSIONING GUIDELINES

The Guideline includes references to the IO Commissioning Guidelines for each Division. The IO Commissioning Guideline describes the commissioning process required for the entire project life beginning with project identification; program planning, execution and final close out. The Commissioning Plan for each project will be customized to suit the specific project in accordance with the Commissioning Guideline.

CONTACT INFORMATION

Should you have any questions about the IO Building Systems Design Guideline, please contact:

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21 01 00 OPERATION AND MAINTENANCE OF FIRE SUPPRESSION

1 Operation and Maintenance

1.1 All systems installed must be readily accessible, able to be isolated and replaced with the need for demolition or assisted lifts.

21 05 13 COMMON MOTOR REQUIREMENTS FOR FIRE SUPPRESSION EQUIPMENT

1 Common Motor Requirements

1.1 Motors shall be squirrel-cage induction motors, built to CEMA and NEMA motor and generator standards.

1.2 Three phase motors shall be minimum CEMA Design B; Class B insulated for maximum 40°C (104°F) ambient.

1.3 Motors 44.7kW (60 HP) and over shall be inherent overheat protection, consisting of thermistors embedded in each phase of the stator winding and wired to the motor conduit box.

1.4 Motors 0.75kW (1 HP) to 373kW (500 HP) shall be three phase, and equal or exceed motor efficiency levels as tested to CSA-C390-M or the nominal efficiency noted in Table 10.8 of SB-10 in the OBC.

1.5 Motors to be approved under Canadian Electrical Safety Code.

1.6 Provide explosion-proof motors in locations subject to explosive or flammable environments and as required by code.

1.7 Motors driven by Variable Frequency Drives (VFD's) shall be NEMA 31 design, have class F insulation, and be rated for inverter duty.

1.8 Motor enclosures shall be as follows:

1.8.1 If protected from the weather and entraining moisture, use open drip-proof, service factor 1.15.

1.8.2 Motors located in air streams shall be selected to operate satisfactory at maximum temperature and moisture levels of surrounding air. Use drip-proof motors with encapsulated windings and weatherproof terminal box.

1.8.3 For all other locations, use totally enclosed, service factor 1.0.

21 05 19 METERS AND GAUGES FOR FIRE SUPPRESSION SYSTEMS

1 Meters

1.1 Provide a fire pump test meter on the discharge side of the pump for accurate flow measurements.

2 Pressure Gauges

2.1 Provide one pressure gauge with piping and isolation valves in locations where measurements are required at the inlet and outlet of equipment to remove calibration errors between readings.

2.2 Provide pressure gauges at:

2.2.1 Suction and discharge of all pumps

2.2.2 Incoming fire line service

2.2.3 Inlet and outlet of alarm check valve

21 05 23 GENERAL DUTY VALVES FOR WATER BASED FIRE SUPPRESSION PIPING

1 Valves

1.1 Valves used on the fire protection system shall be approved by Underwriters Laboratories of Canada or Associated Factory Mutual Fire Assurance companies and shall bear identifying mark or label such as F.M., U.L.C., and I.A.O.

1.2 Provide valves on all mains and sub-mains and at the base of each riser to completely control, shut off and drain the system. Arrange piping and valves to allow for each zone or riser to be isolated without reducing the fire protection capability of surrounding systems.

1.3 Main shut-off valves shall be supervised O.S. &Y. gate valves.

1.4 Check valves on Fire Department connection to have rubber faced disc.

1.5 Install supervisory switches on all system shut-off valves, suitable for operation with building fire alarm system.

21 05 29 HANGERS AND SUPPORTS FOR FIRE SUPPRESSION PIPING AND EQUIPMENT

1 Hangers and Supports

1.1 All supports, anchors, hangers, braces and methods of holding any piping, conduits or any other electrical equipment shall be designed and certified by a professional engineer taking into account the location and current conditions of the structure it is loading.

21 05 33 HEAT TRACING FOR FIRE SUPPRESSION PIPING

1 Heat Tracing

1.1 Provide electric tracing for the following services:

1.1.1 All fire standpipe and wet sprinkler lines in unheated spaces.

1.1.2 Drum drips on the dry sprinkler system.

1.2 Design a complete cUL Listed, CSA Certified, or FM approved system of heating cables, components, and controls to provide freeze protection piping.

1.3 Provide thermostatic control of heat trace systems using line sensing thermostats with an ambient sensing thermostat shutoff override when ambient temperature is above freezing.

21 12 00 FIRE-SUPPRESSION STANDPIPES

1 Fire Extinguishers

1.1 Provide fire extinguisher as required to meet coverage and maximum travel distance requirements per the Ontario Fire Code.

1.2 Provide multipurpose dry chemical fire extinguisher with ABC rating in the mechanical rooms, electrical room, diesel room, U.P.S. battery room, switchgear room, and transformer vault. Mount extinguisher near the door with an approved aluminum wall bracket.

1.3 Provide standard dry chemical fire extinguisher, with BC rating in the parking garage.

1.4 Provide class ‘K’ extinguisher with BC rating complete with wall bracket for kitchen areas.

1.5 Where feasible, install fire extinguishers equipped with remote monitoring capabilities including ultrasonic interference detectors and dry contacts.

21 13 00 FIRE-SUPPRESSION SPRINKLER SYSTEMS

1 Sprinkler System General

1.1 Sprinkler layout drawings shall take into consideration, architectural, structural, mechanical, and electrical layouts of the building and sprinkler mains and branches must be arranged to not interfere with any of the aforementioned.

21 22 00 CLEAN AGENT FIRE EXTINGUISHING SYSTEM

1 Clean Agent Fire Extinguishing System

1.1 Clean agent fire suppression systems must be evaluated to protect areas with sensitive electrical equipment and valuable data such as server rooms, data storage rooms, computer rooms, UPS rooms and security equipment rooms.

1.2 Clean agent system will be complete with storage tanks, piping, dispersion nozzles, control panel with 24 hour battery backup, smoke detectors, manual pull stations, warning labels and visual and audible alarms. Connect to the fire alarm system.

1.3 Provide cross-zoned smoke detector arrangement to minimize potential for false alarm.

22 05 23 PLUMBING VALVES

1 Valves – General

1.1 Each valve type of the same size shall be of one manufacture and shall have the manufacturer's name and pressure ratings clearly marked on body.

1.2 Valves shall be located in such a manner that the top works, operators, and bonnets may be easily maintained or removed.

1.3 Provide drain valves at all low points. Drain valves shall be ball or gate valves, complete with cap and chain.

2 Gate Valves

2.1 Provide gate valves:

2.1.1 On all branch lines.

2.1.2 As isolation of each floor for all services.

2.1.3 At the base of all risers.

3 Globe Valves

3.1 Provide globe and/or eccentric plug valves:

3.1.1 On all bypass systems.

3.1.2 Where required for throttling control.

4 Check Valves

4.1 Provide check valves:

4.1.1 On the discharge of all pumps.

4.1.2 On the discharge of multiple equipment.

5 Ball Valves

5.1 Install ball valves in the following locations:

5.1.1 At each single plumbing fixture.

5.1.2 At each single item of equipment.

5.1.3 For pipe sizes DN50 (2") and smaller, ball valves may be substituted for gate and globe valves.

22 05 33 ELECTRIC PIPE TRACING

1 Electric Pipe Tracing

1.1 Provide electric tracing for the following services:

1.1.1 All domestic water piping (cold, hot, hot recirculation), including humidification make-up, cooling tower make-up, and irrigation supply in unheated areas or outside the building.

1.2 Provide thermostatic control of heat trace systems using line sensing thermostats with an ambient sensing thermostat shutoff override when ambient temperature is above freezing. Where a BAS system exists, provide line sensing temperature input to BAS system.

22 05 53 IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

1 Identification

1.1 After finished painting is complete, identify each pipe with stencils and stencil paint. Alternatively, use SMS Coil-Mark or adhesive style building service pipe markers.

1.2 Color coding shall be in conformance with CAN/CGSB-24.3 and ANSI A131 as follows:

Pipe and Valve Identification				
Pipe Marker Legend	**Valve Tag Legend**	**CGSB Hazard Classification**	**Background Colour**	**Text Colour**
Raw Water	**RAW**	**Low**	**Green**	**White**
River Water	**RIV.W**	**Low**	**Green**	**White**
Sea Water	**SEA W**	**Low**	**Green**	**White**
City Water	**CI.W**	**Low**	**Green**	**White**
Cold Water	**C.W.**	**Low**	**Green**	**White**
Distilled Water	**DI.W**	**Low**	**Green**	**White**
Demineralized Water	**DE.W**	**Low**	**Green**	**White**
Condenser Water Supply	**COND.W.S.**	**Low**	**Green**	**White**
Condenser Water Return	**COND.W.R.**	**Low**	**Green**	**White**
Chilled Water Supply	**CH.W.S.**	**Low**	**Green**	**White**
Chilled Water Return	**CH.W.R.**	**Low**	**Green**	**White**
Chilled Water	**CH.W.**	**Low**	**Green**	**White**
Domestic Cold Water Supply	**D.W.S.**	**Low**	**Green**	**White**
Domestic Hot Water Supply	**D.H.W.S.**	**Low**	**Green**	**White**
Domestic Hot Water	**D.H.W.R.**	**Low**	**Green**	**White**

Recirc.				
Hot Water Heating Supply (up to 120° C)	**H.W.H.S.**	**Hazardous**	**Yellow**	**Black**
Hot Water Heating Return (up to 120°C)	**H.W.H.R**	**Hazardous**	**Yellow**	**Black**
High Temp. Hot Water Heating Supply (above 120°C)	**H.T.W.S.**	**Hazardous**	**Yellow**	**Black**
High Temp. Hot Water Heating Return (above 120°C)	**H.T.W.R**	**Hazardous**	**Yellow**	**Black**
Make-up Water	**M.U.W.**	**Low**	**Green**	**White**
Boiler Feed Water	**B.F.W.**	**Hazardous**	**Yellow**	**Black**
Condensate Return - Gravity	**C.R.G**	**Hazardous**	**Yellow**	**Black**
Condensate Return - Pumped	**C.R.P.**	**Hazardous**	**Yellow**	**Black**
Blow Off	**B.O.**	**Hazardous**	**Yellow**	**Black**
Treated Water	**T.W.**	**Low**	**Green**	**None**
Brine	**B.**	**Low**	**Green**	**None**
Waste Water	**W.W.**	**Low**	**Green**	**None**
Storm Sewer	**S.S.**	**Low**	**Green**	**None**
Sanitary Sewer	**SAN.S.**	**Low**	**Green**	**None**
Combination Sanitary Storm Sewer	**C.S.S.S.**	**Low**	**Green**	**None**
Acid Drain	**A.D.**	**Hazardous**	**Yellow**	**Black**
Isotope Drain	**I.D.**	**Hazardous**	**Yellow**	**Purple**
Refrigerant Suction (include refrigerant No.)	**REF.S. (No.)**	**Hazardous**	**Yellow**	**Black**
Engine Exhaust	**E.E.**	**Hazardous**	**Yellow**	**Black**
Fuel Oil (show type No.)	**F.P. (No.)**	**Hazardous**	**Yellow**	**Black**
Steam (indicate pressure)	**S. kPa(psig)**	**Hazardous**	**Yellow**	**Black**

Lube Oil	**L.O.**	**Hazardous**	**Yellow**	**Black**
Hydraulic Oil	**H.O.**	**Hazardous**	**Yellow**	**Black**
Instrument Air	**I.A.**	**Hazardous**	**Green**	**White**
Gasoline	**G.**	**Hazardous**	**Yellow**	**Black**
L.P. Gas	**L.P.G.**	**Hazardous**	**Yellow**	**Black**
Natural Gas	**N.G.**	**Hazardous**	**Yellow**	**Black**
Chlorine	**CHLOR.**	**Hazardous**	**Yellow**	**Black**
Nitrogen Pressure 700 kPa and lower	**NIT.**	**Low**	**Green**	**White**
Oxygen (not med gas)	**OXY.**	**Hazardous**	**Yellow**	**Black**
Vacuum (not med gas)	**VAC.**	**Low**	**Green**	**White**
Compressed Air – indicate pressure (700 kPag and lower)	**C.A. kPa**	**Low**	**Green**	**White**
Compressed Air – indicate pressure (over 700 kPag)	**C.A. kPa**	**Hazardous**	**Yellow**	**Black**
Fire Protection Water	**F.P.W.**	**Fire Protection**	**Red**	**White**
Sprinkler Water	**S.W.**	**Fire Protection**	**Red**	**White**
Carbon Dioxide (fire protection)	**CO**	**Fire Protection**	**Red**	**White**
Vent (plumbing)	**V.P.**	**Low**	**Green**	**White**
Vent	**V.**	**Hazardous**	**Yellow**	**Black**

1.3 Supply and attach to pumps, valves and other equipment a lamacoid tag with equipment numbers that correlates to the plumbing design.

1.4 All control, drain, and test connection valves shall be provided with signs indicating their purpose.

22 05 76 CLEANOUTS

1 Cleanouts

1.1 Provide cleanouts on all drainage and waste systems as required by the Local Plumbing Code.

22 11 16 DOMESTIC WATER PIPING

1 General

1.1 All piping systems and components and methods of holding any piping or any other mechanical equipment shall be designed and certified by a professional engineer taking into account the location and current conditions of the structure it is loading.

2 Domestic Water Pipe – General

2.1 All welding and fabrication shall be to the requirements of the ANSI/ASME B31.9 code for pressure piping and CSA standard B51 code for the Construction and Inspection of Boilers and Pressure Vessels.

2.2 PEX tubing and fittings shall carry a twenty-five (25) year non-prorated warranty against failure due to defect in material or workmanship.

2.2.1 Unburied Water Pipe Mechanical couplings (e.g. Victaulic) shall be permitted for domestic cold water, hot water and hot water recirculation systems.

2.2.2 Sterilize domestic hot and cold water piping. Provide chemical and bacteriological test data to prove that sterilization has been carried out.

22 11 19 DOMESTIC WATER PIPING SPECIALTIES

1 Unions, Flanges, Di-Electric Couplings

1.1 Provide unions or flanges at all connections to equipment of fixtures requiring servicing or replacing.

1.2 Install approved dielectric isolation at the transition between noble materials such as copper, brass bronze, high alloy castings, or stainless steel and low alloy ferrous materials such as black iron, galvanized iron, or cast iron. These dielectric isolators must be installed in such a way that they are not shorted out by accidental contacts to process equipment, building steel, instrumentation tubing, or electrical neutrals. Ensure that dielectric unions are constructed of materials that are compatible galvanically with the systems to which they are connected, e.g. a dielectric union for installation between copper and iron must be constructed with a body of iron and a tailpiece of copper or brass.

2 Shock Absorbers

2.1 Provide shock absorbers on both hot and cold water systems. Install in an upright position at all quick closing valves, solenoids, groups of plumbing fixtures and isolated fixtures. Locate and size as required and in accordance with the plumbing and drainage institute standard No. WH201 P.D.I. and as per manufacturer's instruction.

3 Backflow Preventers

3.1 Provide backflow preventers for all potential cross connections, including domestic water connections to all heating, cooling and refrigeration equipment, to irrigation system, and as required by Provincial Plumbing code and local authority having jurisdiction. As a

minimum standard, installation shall be in conformance with CAN/CSA-B64.10-01. All backflow preventers must be of testable type.

4 Hose Bibbs

4.1 Provide combination cold and hot water hose bibs in mechanical rooms and garbage rooms. DN15 (1/2") with DN20 (3/4") hose end vacuum breaker.

4.2 Provide outside wall hydrants around perimeter of new buildings adjacent to doorways. Hydrants shall be non-freeze flush type with stainless steel box, polished nickel bronze hinged locking cover and key and integral vacuum breaker.

5 Pressure Reducing Valves

5.1 Provide pressure reducing valves to ensure the domestic water pressure at any plumbing fixture does not exceed 550 kPa (80 psi).

5.2 Valves shall regulate accurately throughout the range of pressures and flow conditions selected, function quietly, and shut tight on a dead end shut-off. Flanged ends, disc and diaphragms of hycar material. No springs to be in the path of the water and no stuffing of boxes. All parts must be easily accessible without removal of the valve from the line. Provide Type 'Y' Strainer (Suffix 'S') in front of PRV. Tested and certified to ASSE Std. 1003.

6 Water Meter

6.1 Provide water meter to the requirements of the Local Authority.

6.2 Provide 3-valve by-pass around meter and drain valve.

6.3 Provide remote reading totalizer complete with wiring and plastic conduit.

7 Kitchen and Other Owner's Equipment

7.1 Provide complete roughing-in and final connections for kitchen, laboratory, and other Owner's equipment.

7.2 Provide vacuum breaker on each domestic water connection serving each laboratory fixture.

22 11 23 DOMESTIC WATER PUMPS

1 Domestic Hot Water Recirculating Pump

1.1 Pump shall be bronze fitted.

2 Domestic Water Booster System

2.1 Pumps shall be split-coupled vertical in-line design. Pump casing shall be ductile iron, bronze fitted suitable for the maximum working pressure at 65.6°C (150°F).

22 13 16 SANITARY WASTE AND VENT PIPING

22 13 19 SANITARY WASTE PIPING SPECIALTIES

1 Unions, Flanges, Di-Electric Couplings

1.1 Provide unions or flanges at all connections to equipment of fixtures requiring servicing or replacing.

1.2 Install approved dielectric isolation at the transition between noble materials such as copper, brass bronze, high alloy castings, or stainless steel and low alloy ferrous materials such as black iron, galvanized iron, or cast iron. These dielectric isolators must be installed in such a way that they are not shorted out by accidental contacts to process equipment, building steel, instrumentation tubing, or electrical neutrals. Ensure that dielectric unions are constructed of materials that are compatible galvanically with the systems to which they are connected, e.g. a dielectric union for installation between copper and iron must be constructed with a body of iron and a tailpiece of copper or brass.

2 Traps

2.1 Provide every fixture and floor drain with traps in accordance with local regulations. Provide each trap with its own brass plug and ferrule cleanout.

2.2 For traps located in ceilings, provide access doors.

2.3 For drains in apparatus casings or air plenums, provide deep seal trap. For drains in outside air plenums, provide running trap located indoors as far as possible from drains.

2.4 For traps for floor and hub drains, provide an automatic trap primer.

2.5 If required by authorities having jurisdiction, provide building traps complete with cleanout and fresh air inlet.

3 Drains

3.1 In all areas with seamless flooring and plastic terrazzo finishes provide special flanges to maintain watertight integrity of floor system.

4 Mechanical Rooms, Plenums and Unfinished Area Floor Drains

4.1 Cast iron body floor drain, flashing clamp with weep holes, adjustable top and 200mm (8”) diameter, heavy duty, nickel bronze grate.

5 Mechanical Rooms and Unfinished Areas with Floating Floor Drains.

5.1 Cast iron body floor drain, flashing clamp with weep holes, adjustable top and 216mm (8-1/2”) diameter, heavy duty, cast iron grate with movement compensator and vibration isolator.

6 Finished Area Floor Drains

6.1 Cast iron body floor drain, reversible flashing clamp with weep holes, adjustable top and 125mm (5") diameter, nickel bronze, 6mm (1/4") thick secured strainer, full 100mm (4") throat opening. For quarry or mosaic tiled areas provide 125mm x 125mm (5" x 5") square nickel bronze strainer.

7 Finished Area (Heavy Duty) Floor Drains

7.1 Cast iron body floor drain, reversible flashing clamp with weep holes, adjustable top and 125mm (5") diameter, nickel bronze, 12mm (1/2") thick secured strainer, full 100mm (4") throat opening.

8 Electrical Rooms, Transformer Vault and Switchgear Room Floor Drains

8.1 Same as mechanical room floor drain but with backwater valve.

9 Garbage Room, Loading Area Floor Drains

9.1 Cast iron body drain, flashing clamp with weep holes, adjustable top, 280mm x 280mm (11" x 11") hinged, vandal proof, cast iron bar grate, and 100mm (4") deep, slotted sediment bucket.

10 Cooling Tower Drains

10.1 Cast iron body drain, 215mm (8-½") dia., combined flashing clamp and gravel stop, under deck clamp, sump receiver, solid extension, cast iron dome and 50mm (2") overflow dam.

11 Pool Deck Drains

11.1 Duco coated cast iron body with reversible flashing clamp with seepage openings and adjustable 150mm x 150mm (6" x 6") square secured stainless steel strainer. Provide lug in drain body for grounding wire.

12 Funnel Floor Drains

12.1 Provide funnel floor drains to collect equipment drains and condensate drains.

12.2 Provide cast iron funnel in unfinished areas and nickel bronze funnel in finished areas.

13 Planter Drains

13.1 Cast iron body planting area drain with galvanized dome strainer covered with stainless steel mesh.

14 Parking Drains

14.1 Cast iron body floor drain, flashing clamp with weep holes, sediment bucket and 300mm x 300mm (12" x 12") heavy duty galvanized ductile iron hinged grate.

15 Catch Basins (Interior)

15.1 Extra heavy cast iron trench drain with 50mm (2") thick grating complete with angle frames. Install goss-gulley trap.

16 Inspection Pits

16.1 Install checkered steel cover plate with access manhole and anchor frame on inspection pits. Covers shall be sealed and gasketed.

17 Trap Primers

17.1 All traps for floor drains shall be protected with trap primers.

18 Grease Interceptors

18.1 Provide a grease interceptor sized in accordance with the requirements of the OBC.

18.2 Grease interceptor shall be epoxy coated steel construction with removable baffles, gasketed aluminum cover, flow-control device, and deep seal trap with cleanout.

22 13 29 SANITARY SEWAGE PUMPS

1 Submersible Sump Pumps

1.1 High water level switch with alarm buzzer and additional contact for remote signaling via the control system.

1.2 Railing system with chain for pump removal.

1.3 Provide a non-slam check valve in each discharge pipe above the cover plate and pipe to gravity drain.

22 14 16 STORM DRAIN PIPING

1 Buried and Unburied Storm Drains

1.1 Tracer for the buried storm drain shall be installed with all PVC pipe.

2 Testing

2.1 After all pipes have been placed in position and all branches installed, test the tightness of all joints and the soundness of all pipes.

2.2 Securely close all openings in pipe ends throughout the work by means of approved plugs and fill the entire piping system, including stacks, branches to drain and all horizontal runs with water, up to highest opening and let this water stand at this level for not less than two (2) hours. Perform another test after the fixtures are set, connected, and connections are made to all equipment. Test by running water into all pipes, drain, and apparatus in order to detect and repair any imperfect material or workmanship. Where it is impossible to test the whole system at one time, divide into parts.

22 14 26 STORM DRAINS

1 Unions, Flanges, Di-Electric Couplings

1.1 Provide unions or flanges at all connections to equipment requiring servicing or replacing.

1.2 Install approved dielectric isolation at the transition between noble materials such as copper, brass bronze, high alloy castings, or stainless steel and low alloy ferrous materials such as black iron, galvanized iron, or cast iron. These dielectric isolators must be installed in such a way that they are not shorted out by accidental contacts to process equipment, building steel, instrumentation tubing, or electrical neutrals. Ensure that dielectric unions are constructed of materials that are compatible galvanically with the systems to which they are connected, e.g. a dielectric union for installation between copper and iron must be constructed with a body of iron and a tailpiece of copper or brass.

2 Sand Interceptor and Inspection Pits

2.1 Install checkered steel cover plate with access manhole and anchor frame on sand interceptor and inspection pits.

3 Scupper Drains

3.1 Cast iron body flush scupper drain, flashing clamp, 45° threaded outlet and secured, vandal proof, nickel bronze flush grate.

4 Exterior Planter Drain

4.1 Cast iron body planting area drain with galvanized dome strainer covered with stainless steel mesh.

5 Flow Control Roof Drain

5.1 Cast iron body control flow roof drain, 387mm (15-¼") dia., under deck clamp, solid extension and sump receiver, flashing clamp with weep holes and 280mm (11") dia. secured cast iron dome with 150mm (6") high flow control weir.

6 Conventional Flow Large Roof Area Drain

6.1 Cast iron body roof drain, 387mm (15-¼") dia., under deck clamp, solid extension and sump receiver, flashing clamp with weep holes and 280mm (11") dia. secured cast iron dome.

7 Conventional Flow Small Roof Area Drain

7.1 Cast iron body roof drain, 216mm (8-½") dia., under deck clamp, solid extension and sump receiver, flashing clamp with weep holes and low profile secured cast iron dome.

8 Area Well Drain

8.1 Cast iron body floor drain, flashing clamp with weep holes, low profile cast iron dome grate secured with stainless steel screws.

9 Large Area Promenade Drain

9.1 Dura-coated 387mm (15-¼") dia. cast iron body drain, flashing clamp with weep holes, under deck clamp, solid extension, sump receiver, and 356mm x 356mm (14" x 14") square secured nickel bronze grate.

10 Parking Area Trench Grate and Frame

10.1 Cast iron body floor drain, flashing clamp with weep holes, sediment bucket and 300mm x 300mm (12" x 12") heavy duty galvanized ductile iron hinged grate.

11 Parking Area Trench Grate and Frame

11.1 Dura-coated cast iron, heavy duty, trench grate and frame, 300mm x 600mm (12" x 24") sections with anchoring frame. Trench width 250mm (10"). Drain on bottom of trench with secured, 216mm (8-½") dia. cast iron dome.

22 31 00 WATER SOFTENING SYSTEMS

1 Water Softeners

1.1 Provide water softening system for the following applications:

1.1.1 Domestic hot water when the domestic water supply hardness exceeds 100 mg/L.

1.1.2 Steam Boiler feed water.

1.1.3 Laundry water supply.

1.1.4 Water supply for specialty equipment.

1.1.5 Install water softening equipment in accordance with manufacturer's recommendations.

1.1.6 Provide Material Safety Data Sheet for each chemical and testing reagent.

22 33 00 ELECTRIC DOMESTIC WATER TANK HEATERS

1 Electric Domestic Water Heaters

1.1 Provide electric domestic hot water heaters under the following conditions:

1.1.1 In building where natural gas or LPG are not available.

1.1.2 For distributed low load (<10kW) locations. i.e., remote sink location.

1.1.3 Water heaters shall meet or exceed the standby loss requirements of ASHRAE Standard 90.1-2016.

1.1.4 Tanks shall have a working pressure of 1,035 kPa (150 psi), and shall be completely assembled.

22 34 00 FUEL FIRED DOMESTIC WATER HEATERS

1 Gas-Fired Domestic Hot Water Heaters

1.1 Water heater shall meet or exceed the minimum energy performance requirements of the current OBC.

1.2 Water heater shall include 3-year warranty against tank leaks, advanced electronic control with LCD display, diagnostics and connection of remote monitoring, leak detection and fault alert.

1.3 Flush and clean boilers on completion of installation, according to manufacturer's written instructions.

22 35 00 DOMESTIC WATER HEAT EXCHANGERS

1 Plate and Frame Domestic Water Heat Exchanger

1.1 Heat exchanger shall be of plate and frame design in accordance with ASME and provincial pressure vessel regulations.

1.2 Provide pressure gauge with piping and isolation valves to measure inlet and outlet pressure of heat exchanger.

1.3 Provide drain valves on inlet and outlet for draining and cleaning of heat exchanger.

2 Brazed Plate Domestic Heat Exchanger

2.1 Double wall heating plates, with vented air gap, shall be fabricated through a customized single stamping process, producing perfectly fitted chevron patterns and minimal air gap for excellent thermal performance.

2.2 Provide pressure gauge with piping and isolation valves to measure inlet and outlet pressure if heat exchanger.

2.3 Provide drain valves on inlet and outlet for draining and cleaning of heat exchanger.

22 40 00 PLUMBING FIXTURES

1 Fixtures – General

1.1 Supply and install all hangers, supports, brackets, reinforcement, steel back-up plates, etc. for the proper installation of fixtures and supply fittings.

2 Toilet – Wall Hung Flush Valve

2.1 Toilet, vitreous china, elongated syphon jet action bowl, 6L flush. Flush Valve, C.P. low consumption, quiet action diaphragm type, with vacuum breaker, seat bumper on angle stop, pressure loss check and with non-hold open feature. Seat, elongated heavy-duty solid plastic open front less cover, with check hinges and chromated steel posts, washers and nuts. Carrier, with block base feet, rear anchor support, factory assembled, bolts, cap nuts, adjustable nipple, gasket, test plug and protection cap.

3 Urinal – Wall Hung Flush Valve

3.1 Urinal, vitreous china, syphon jet 3.8L flush. Flush valve, C.P. low consumption, quiet action diaphragm type, with vacuum breaker, angle stop, and pressure loss check and

non-hold open feature. Urinal Wall Access Cleanout, with round stainless steel face and v.p. screw. Carrier with steel pipe legs, block base feet supports and bearing plates.

4 Basin – Counter Mounted

4.1 Basin, vitreous china, front overflow, self-rimming with sealant. Faucet, C.P. Solid cast brass lead free body, with ¼ turn ceramic disc cartridges, vandal-proof 8L flow aerator outlet and cast metal lever handles. Drain, C.P. open grid. C.P. "p" Trap, 17 gauge (1.5 mm) 32 mm and escutcheon. C.P. rigid horizontal with V.P. loose key angle stops, escutcheons and flexible risers.

5 Janitor Mop Sink Floor Mounted (Square Unit)

5.1 Mop Sink, 610 mm x 610 mm x 254 mm deep, floor mounted, precast terrazzo and Integral Drain with strainer. Hose Faucet, C.P. wall mounted, solid cast brass lead free body with ¼ turn ceramic disc cartridges, cast metal lever handles, body mounted vacuum breaker, integral stops, 1,220 mm hose and hanger, "p" Trap 75 mm.

6 Toilet – Wall Hung Flush Valve (Barrier Free Design)

6.1 Toilet, vitreous china, elongated syphon jet action bowl, 1.3 gal. (6L) flush. Flush Valve, C.P. low consumption, quiet action diaphragm type with vacuum breaker extended seat bumper on angle stop, pressure loss check and with non-hold open feature. Seat, elongated heavy duty solid plastic open front with cover, check hinges and chromated steel posts, washers and nuts. Carrier, with block base feet, rear anchor support, factory assembled, bolts, cap nuts, adjustable nipple, gasket, test plug and protection cap. Mount fixture (406 mm to OBC) or (as required by local codes) above finished floor rim of toilet.

7 Basin – Counter MTD. (Barrier Free Design)

7.1 Basin, 102 mm centers, 533 mm x 445 mm x 127-175 mm deep, vitreous china, rear overflows, self-rimming with sealant. Faucet, free body with ¼ turn ceramic disk cartridges, vandal-proof 8L flow aerator outlet and cast metal lever handles. Drain, C.P. offset open grid. C.P. "p" Trap, 17 gauge 14.5 mm, 32 mm and escutcheon. Supplies, C.P. short rigid horizontal with V.P. loose key angle stops, escutcheons and braided flexible risers. Provide insulted covers to exposed piping as per local codes.

23 01 00 OPERATION AND MAINTENANCE OF HVAC SYSTEMS

1 Operation and Maintenance

1.1 All systems installed must be readily accessible, able to be isolated and replaced with the need for demolition or assisted lifts.

23 05 13 COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

1 Common Motor Requirements

1.1 Motors 0.75kW (1 HP) to 373kW (500 HP) shall be NEMA certified Premium Efficiency Motors.

1.2 Motors driven by Variable Frequency Drives (VFD's) shall be NEMA Frequency Drive Rated.

23 05 19 METERS AND GAUGES FOR HVAC PIPING

1 Pressure Gauges

1.1 Provide pressure gauges at:

1.1.1 Suction and discharge of all pumps

1.1.2 Inlet and outlet of all coils in air handling units

1.1.3 Inlet and outlet of all heat exchangers

1.1.4 Inlet and outlet of all boilers

1.1.5 Connection to expansion tank

1.1.6 Inlet and outlet of chiller evaporators and condensers

1.2 Provide one gauge with piping and isolation valves at inlet and outlet of equipment to measure pressures. This eliminates calibration errors between inlet and outlet readings.

2 Temperature gauges

2.1 Provide temperature gauges at:

2.1.1 Inlet and outlet of all coils in air handling units

2.1.2 Inlet and outlet of all heat exchangers

2.1.3 Inlet and outlet of all boilers

2.1.4 Inlet and outlet of chiller evaporators and condensers

3 Meters

3.1 Provide energy meters to measure peak load and consumption of the following systems:

3.1.1 Hot water heating plant

3.1.2 Chilled water cooling plant

3.1.3 Steam heating plant

3.1.4 Natural Gas systems (heating boilers, domestic hot water heaters, kitchen equipment)

23 05 23 GENERAL-DUTY VALVES FOR HVAC PIPING

1 Valves – General

1.1 Valves shall be installed in such a manner that is accessible, maintainable and replaceable.

1.2 Stems of valves shall be positioned for maximum ease in use, but in no event in a manner causing a hazard, or with stem down.

1.3 Provide drain valves at all low points of system. Drain valves shall be ball or gate valve with cap and chain.

1.4 Provide chain wheel operators and operating chain for all valves located more than 2.1m (7 ft.) above floor or walkway

2 Gate and Butterfly valves

2.1 Provide gate and/or butterfly valves:

2.1.1 Entering and leaving all equipment and terminal units.

2.1.2 On all branches.

2.1.3 As isolation of each floor.

2.1.4 At the base of all risers.

2.2 Gate valves to be rising stem type.

3 Globe Valves

3.1 Provide globe valves:

3.1.1 On all bypass systems.

3.1.2 Where required for throttling control.

4 Ball Valves

4.1 For pipe sizes DN50 (2") and smaller, ball valves may be substituted for gate and globe valves.

5 Check Valves

5.1 Provide check valves:

5.1.1 On the discharge of all pumps (silent check).

5.1.2 On the discharge of multiple equipment.

6 Drain Valves

6.1 Install 20mm (¾") dia. drain valves at all down-fed terminal heating and/or cooling units.

6.2 Install 40mm (1-½") dia. or line size valves at low points and other drain points on system.

6.3 Install 40mm (1-½") dia. valves for flushing purposes.

6.4 Provide drain valves at inlet and outlet of all major pieces of equipment including boilers, chillers, heat exchangers and coils for draining and flushing of equipment.

7 Circuit Balancing Valves

7.1 Provide circuit balancing valves as follows:

7.1.1 In return branch mains and branch connections to return mains.

7.1.2 In each return riser.

7.1.3 In return piping connections to air handling unit heating and cooling coils, fan coil units, heat pump units, reheat coils in air terminal control units, and any other similar equipment.

7.1.4 Locate balancing valves a minimum of five pipe diameters downstream of any piping fitting, and a minimum of ten pipe diameters from any pump.

7.1.5 Maintain two pipe diameters downstream of any balancing valves free of any fitting.

23 05 29 HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

1 Hangers and Supports

1.1 All supports anchors, hangers, braces and methods of holding any piping, conduits or any other electrical equipment shall be designed and certified by a professional engineer taking into account the location and current conditions of the structure it is loading.

23 05 33 HEAT TRACING FOR HVAC PIPING

1 Heat Tracing

1.1 Provide a complete system of heating cables, components, and controls to provide freeze protection of piping.

1.2 Provide electric tracing for the following services:

1.2.1 Cooling tower make-up water line and make-up valve.

1.2.2 Cooling tower overflow and bleed-off lines, spray water pumps and piping, exposed on roof.

1.2.3 All heating water lines in unheated areas, except glycol heating system.

1.2.4 Heating cable circuit shall be protected by a ground-fault device for equipment protection. This requirement is in accordance with section 427-22 of the NEC-1996.

1.3 Apply “Electric Traced” labels to the outside of the thermal insulation.

1.4 Provide thermostatic control of heat trace systems using line sensing thermostats with an ambient sensing thermostat shutoff override when ambient temperature is above freezing.

23 05 36 MOTOR STARTERS AND MCCS

1 Motor Starters

1.1 All motors above 14 HP shall be equipped with a soft starter or Variable Frequency Drive

23 05 53 IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

1 Identification

1.1 Color coding to be as per Table 23.1. For all other services, provide color coding in conformance with CAN/CGSB-24.3 and ANSI A131. Provide a valve chart and co-ordinate valve numbers with the "As-built" plan and schematic drawings. If existing valve number and chart are existing, update to suit the deletions and additions. All control, drain, and test connection valves shall be provided with signs indicating their purpose.

Pipe and Valve Identification				
Pipe Marker Legend	**Valve Tag Legend**	**CGSB Hazard Classification**	**Background Colour**	**Text Colour**
Raw Water	**RAW**	**Low**	**Green**	**White**
River Water	**RIV.W**	**Low**	**Green**	**White**
Sea Water	**SEA W**	**Low**	**Green**	**White**
City Water	**CI.W**	**Low**	**Green**	**White**
Cold Water	**C.W.**	**Low**	**Green**	**White**
Distilled Water	**DI.W**	**Low**	**Green**	**White**
Demineralized Water	**DE.W**	**Low**	**Green**	**White**
Condenser Water Supply	**COND.W.S.**	**Low**	**Green**	**White**
Condenser Water Return	**COND.W.R.**	**Low**	**Green**	**White**
Chilled Water Supply	**CH.W.S.**	**Low**	**Green**	**White**
Chilled Water Return	**CH.W.R.**	**Low**	**Green**	**White**
Chilled Water	**CH.W.**	**Low**	**Green**	**White**
Domestic Cold Water Supply	**D.W.S.**	**Low**	**Green**	**White**
Domestic Hot Water	**D.H.W.S.**	**Low**	**Green**	**White**

Supply				
Domestic Hot Water Recirc.	**D.H.W.R.**	**Low**	**Green**	**White**
Hot Water Heating Supply (up to 120° C)	**H.W.H.S.**	**Hazardous**	**Yellow**	**Black**
Hot Water Heating Return (up to 120°C)	**H.W.H.R**	**Hazardous**	**Yellow**	**Black**
High Temp. Hot Water Heating Supply (above 120°C)	**H.T.W.S.**	**Hazardous**	**Yellow**	**Black**
High Temp. Hot Water Heating Return (above 120°C)	**H.T.W.R**	**Hazardous**	**Yellow**	**Black**
Make-up Water	**M.U.W.**	**Low**	**Green**	**White**
Boiler Feed Water	**B.F.W.**	**Hazardous**	**Yellow**	**Black**
Condensate Return - Gravity	**C.R.G**	**Hazardous**	**Yellow**	**Black**
Condensate Return - Pumped	**C.R.P.**	**Hazardous**	**Yellow**	**Black**
Blow Off	**B.O.**	**Hazardous**	**Yellow**	**Black**
Treated Water	**T.W.**	**Low**	**Green**	**None**
Brine	**B.**	**Low**	**Green**	**None**
Waste Water	**W.W.**	**Low**	**Green**	**None**
Storm Sewer	**S.S.**	**Low**	**Green**	**None**
Sanitary Sewer	**SAN.S.**	**Low**	**Green**	**None**
Combination Sanitary Storm Sewer	**C.S.S.S.**	**Low**	**Green**	**None**
Acid Drain	**A.D.**	**Hazardous**	**Yellow**	**Black**
Isotope Drain	**I.D.**	**Hazardous**	**Yellow**	**Purple**
Refrigerant Suction (include refrigerant No.)	**REF.S. (No.)**	**Hazardous**	**Yellow**	**Black**
Engine Exhaust	**E.E.**	**Hazardous**	**Yellow**	**Black**

Fuel Oil (show type No.)	**F.P. (No.)**	**Hazardous**	**Yellow**	**Black**
Steam (indicate pressure)	**S. kPa(psig)**	**Hazardous**	**Yellow**	**Black**
Lube Oil	**L.O.**	**Hazardous**	**Yellow**	**Black**
Hydraulic Oil	**H.O.**	**Hazardous**	**Yellow**	**Black**
Instrument Air	**I.A.**	**Hazardous**	**Green**	**White**
Gasoline	**G.**	**Hazardous**	**Yellow**	**Black**
L.P. Gas	**L.P.G.**	**Hazardous**	**Yellow**	**Black**
Natural Gas	**N.G.**	**Hazardous**	**Yellow**	**Black**
Chlorine	**CHLOR.**	**Hazardous**	**Yellow**	**Black**
Nitrogen Pressure 700 kPa and lower	**NIT.**	**Low**	**Green**	**White**
Oxygen (not med gas)	**OXY.**	**Hazardous**	**Yellow**	**Black**
Vacuum (not med gas)	**VAC.**	**Low**	**Green**	**White**
Compressed Air – indicate pressure (700 kPag and lower)	**C.A. kPa**	**Low**	**Green**	**White**
Compressed Air – indicate pressure (over 700 kPag)	**C.A. kPa**	**Hazardous**	**Yellow**	**Black**
Fire Protection Water	**F.P.W.**	**Fire Protection**	**Red**	**White**
Sprinkler Water	**S.W.**	**Fire Protection**	**Red**	**White**
Carbon Dioxide (fire protection)	**CO**	**Fire Protection**	**Red**	**White**
Vent (plumbing)	**V.P.**	**Low**	**Green**	**White**
Vent	**V.**	**Hazardous**	**Yellow**	**Black**

1.2 Identify all fans, pumps, air handling equipment, boilers, chillers, controls, starters, switches, pushbuttons, and all other equipment as to service by lamacoid engraved nameplate.

23 05 93 TESTING ADJUSTING & BALANCING FOR HVAC

1 Quality Assurance

1.1 Testing, adjusting and balancing work shall be performed by a specialist company, who is a member of good standing of the AABC (Associated Air Balance Council) or the NEBB (National Environmental Balancing Bureau) or approved by IO.

1.2 Measurement, testing, adjusting, and balancing of HVAC systems and reporting shall be in compliance to ANSI/ASHRAE Standard 111-2008. For system balancing and testing, the technician/balancer/tester shall be NEBB or AABC certified and hold a currently valid certification.

1.3 Testing, adjusting and balancing work shall be performed by an independent testing and balancing agency having successfully completed testing, adjusting and balancing work for a minimum of five (5) projects of similar size and scope during the last five (5) years.

2 Testing Adjusting and Balancing Work

2.1 All mechanical systems to be tested, adjusted and balanced must be maintained in full, normal operation during each day of testing, adjusting and balancing that the building is occupied so that the building tenant is not inconvenienced.

2.2 Balance all systems with due regard to potential objectionable noise issues which may be a factor when adjusting fan speeds and performing terminal work such as adjusting grille and diffuser air quantities.

2.3 Check all air handling system mixing plenums for stratification, and where the variation of mixed air temperature across coils is found to be in excess of plus or minus 5% of design requirements, report to the Consultant.

2.4 Perform testing, adjusting and balancing to within plus or minus 5% of design values, and make and record measurements using instruments with minimum accuracy of within plus or minus 2% of required values.

2.5 Wherever possible, lock all balancing devices in place at the proper setting and permanently mark settings on all devices.

3 Testing, Adjusting and Balancing Report

3.1 Prepare the report using standard AABC, NEBB or equal forms to indicate all measurements required by the referenced balancing standard. Include static pressure readings wherever a change in pressure reading may affect the results, if a verification measurement check is done at a later date.

3.2 Include for each system to be tested, adjusted and balanced, a neatly drawn, identified (system designation, plant equipment location and area served) schematic “as-built” diagram indicating all equipment and accessories.

4 Commissioning of Testing, Adjusting and Balancing Report

4.1 In addition to spot checking equipment performance, a minimum of 15% of all terminal equipment will be checked.

4.2 Failure of the performance of the above point shall trigger re-balancing and re-testing of 100% of all systems.

23 07 00 MECHANICAL INSULATION

1 Insulation - General

1.1 All insulation system materials must meet the requirements of ASHRAE 90.1.

1.2 PVC recovery jackets shall be 0.51mm (0.020") thick with longitudinal slip joints and 0.51mm (0.020") thick one piece premolded PVC fittings, off-white in color. Provide PVC jacket for exposed conditions. Aluminum recovery jackets shall be 0.4mm (26 ga.) thick smooth aluminum jackets with longitudinal slip joints with 0.5mm (24 ga.) thick preformed fittings with factory attached protection liner on interior surface. Provide aluminum jacket for exposed locations outdoors.

1.3 Aluminum recovery jackets shall be 0.4mm (26ga.) thick smooth aluminum jackets with longitudinal slip joints with 0.5mm (24ga.) thick preformed fittings with factory attached protection liner on interior surface. Provide aluminum jacket for exposed locations outdoors.

2 Removable Insulation

2.1 Provide removable insulation on pipe, equipment, valves and fittings that require regular service. Removable insulation shall be provided for the following:

2.1.1 Valves 50mm (2”) and larger in heating and cooling systems

2.1.2 Steam systems including traps, valves, PRV stations, boiler feed pumps, deaerators, flash tanks

2.1.3 At unions connecting pipe to equipment

2.1.4 At meter assemblies

2.1.5 Removable insulation covers shall comprise a mat insulation composed of 100% select grade type ‘E’ glass fibers in a mat form and contained within a jacket of Teflon coated fiberglass cloth that is custom formed to suit the equipment being insulated.

23 09 00 CHILLER PLANT OPTIMIZATION SYSTEM (CPOS)

1 General

1.1 The CPOS shall target an annual operating plant performance of 0.50 kW/ton or better for water cooled chillers using continuous and automatic measures directly integrated into the Building Automation Systems, no external 3rd party module shall be used.

1.2 All points controlling the Chiller Plant Optimization System shall be visible and adjustable through the Building Automation System.

23 20 00 HVAC PIPING AND PUMPS

23 21 13 HYDRONIC PIPING

1 Hydronic Piping - General

1.1 Layout piping, valves, fittings and cleanouts to facilitate easy maintenance.

1.1.1 Do not locate any valves, couplings, or flanged/union connections directly above electrical panels, motor starters or MCC's.

1.2 Grade piping and/or add additional valved and capped drain points to permit complete drainage of entire system.

1.3 Provide di-electric connections for cathodic protection wherever pipes of dissimilar materials are connected together.

2 Flushing and Cleaning

2.1 Completely clean and flush all piping systems. During flushing and cleaning, maintain all isolating and control valves in the open position.

3 Water Fill

3.1 Provide each water system with a make-up water combination feeder consisting of testable backflow preventer stop and check valve, strainer, pressure reducing valve, pressure gauge, and full sized quick fill by-pass.

3.2 Provide make-up water connections with shut-off valve to all equipment requiring same, such as boilers, cooling towers, portable water systems, etc.

23 21 16 HYDRONIC PIPING SPECIALTIES

1 Strainers

1.1 Provide strainers:

1.1.1 In the suction line of all pumps.

1.1.2 Upstream of pressure reducing valves.

1.1.3 Upstream of plate and frame heat exchangers (hot and cold sides). Screens to be fine enough mesh to protect heat exchanger plate openings from any solid debris.

2 Expansion Tanks

2.1 Each tank shall be complete with pressure gauge, drain valve and tapings.

2.2 Tank shall be replaceable bladder type, pre-pressurized, complete with a butyl bladder compatible with ethylene glycol.

3 Air Separators

3.1 Provide line size vortex air separators in hot water heating systems and chilled water systems.

4 Drain Pans

4.1 Provide fully welded 304 stainless steel drain pans below all pipes passing through Electrical, Battery, Transformer, UPS, Computer and Telephone Rooms and over horizontal runs of bus duct.

5 Connect the drain lines to the nearest hub drain or janitor's sink.

23 21 23 HYDRONIC PUMPS

1 General

1.1 Pumps and their associated systems should be designed to maximize energy efficiency, minimize moving parts and failure and optimize flexibility of use under varying conditions. Construction shall factor local condition for corrosion resistance. The pumps must be readily available and serviceable within 100km of the location of installation.

23 25 00 WATER TREATMENT

1 **Purpose**

1.1 The purpose of Water Treatment is to eliminate any possessed unsafe water quality resulted conditions or impact on occupants, public and or assets within the Infra Structure Ontario Owned/leased properties.

1.2 Chemicals as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment, and that can attain water quality specified and based on OBC, CSA, and GHS requirements. The chemicals must be environmentally friendly and conform to all local and provincial laws for labelling, storage and transport. All chemicals must come with means to safely add them and properly distribute them into the applicable system.

1.3 Various Methods are available to prevent or correct water-caused problems. The intent is to have the ability to add chemicals safely for maximum system effectiveness and be able to monitor the results (e.g.: pot feeder and a proper sampling port is the minimum requirement).

1.4 The selection of the proper water treatment method, and the chemicals and equipment necessary to apply that method, depends on several factors. The chemical characteristics of the water, which change with the operation of the equipment, are important. Other factors contributing to the selection of proper water treatment are:

1.4.1 Economics
1.4.2 Chemistry control mechanisms
1.4.3 Dynamics of the operating system
1.4.4 Design of major components (e.g., the cooling tower or boiler)
1.4.5 Number of operators available

1.4.6 Training and qualifications of personnel
1.4.7 Preventive maintenance program

2 HVAC water-treatment systems : General Performance Requirements

2.1.1 Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.

2.1.2 Base the HVAC water treatment on quality of water available, HVAC system equipment material characteristics and functional performance characteristics. Perform an analysis of supply water to determine quality of water available at Project site.

ALLOWED CORROSION RATES

- Corrosion rates shall not exceed the following:

METRIC UNITS — MILLIMETERS (mm)		
	OPEN SYSTEMS	CLOSED SYSTEMS
MILD STEEL	0.025	.005
COPPER	.0025	.0025

ENGLISH UNITS — MILS (mpy)		
	OPEN SYSTEMS	CLOSED SYSTEMS
MILD STEEL	1.0	0.2
COPPER	0.1	0.1

Conversion Factors:

- 1 mil = 0.001 inch
- 1 inch = 25.4 mm
- mm = mils x 0.0254

2.1.3 Provide temporary water treatment for chilled, hot and condenser water until facility has final connections.

2.1.4 After connection to the Central Utilities Plant direct connected systems (chilled water and low temperature hot water), treat those systems from the Central Plant. Treatment shall consist of monthly site visits with analysis of water conditions and adjustment of chemical treatment to maintain specified levels, up to project financial close. In glycol systems, glycol concentration, inhibitors and reserve alkalinity, to be as recommended by the glycol manufacturer.

3 **Closed hydronic systems**.

3.1 Includes ~~low temperature~~ Heating, hot-water heating, chilled water and glycol cooling - heating, shall have the following water qualities:

3.1.1 pH: Maintain a value within 8.8 to 9.5
3.1.2 Turbidity: Maintain a value less than 15 NTU
3.1.3 Boron: Maintain a value within 100 to 200 ppm. (Glycol system) and less than 10 ppm for the closed hydronic system
3.1.4 Soluble Copper: Maintain a maximum value of 0.20 ppm
3.1.5 TDS: Maintain a maximum value of 3000 ppm
3.1.6 Ammonia: Maintain a maximum value of 5 ppm
3.1.7 Free Caustic Alkalinity: Maintain a maximum value of 20 ppm
3.1.8 Microbiological Limits as per MD-15631

3.2 Treatment of Closed Hydronic Systems - Low temperature hot water, closed cooling and chilled water.

3.2.1 Mixture of sodium nitrite, borax and molybdate with other copper alloy inhibitor. For the chilled water a non-nitrite program of phosphate, polymer borate and copper alloy inhibitors: non-oxidizing, non-cationic biocide. Modify to low pH molybdate option for aluminum boilers

3.3 Treatment of Glycol low temperature - Ethylene and propylene glycol with buffered phosphate based corrosion inhibitor with copper alloy inhibitor in deionized water, if water chloride levels are 750 ppm and contains hard water ions.

3.4 Steam boilers and hot water reservoirs water treatment shall follow manufacturer specifications and codes.

4 **Open Hydronic Systems**.

4.1 Includes condenser water, shall have the following water qualities;

4.1.1 Same as Closed Hydronic Systems above plus

4.1.2 Polymer Testable: Maintain a minimum value within 10 to 40

4.2 Treatment of Open Hydronic - organic phosphonate and polymeric dispersant with copper alloy inhibitor, or other chromate- free treatment in liquid form; suitable for pumping from containers directly to water system. Alternate two biocides, one oxidizer and one non-oxidizer; increase dosage when significant amount of algae or slime are detected after system operations.

4.3 Bleed off for Open Hydronic

4.3.1 Automatic control by condenser water conductivity and water meter signals to maintain maximum chloride concentration at the maximum level possible based on the incoming water quality up to 7 times concentration of make-up water to minimize corrosion and scale formation

5 **Submittals** to include product data, (WHMIS/MSDS/**GHS**), rated capacities, operating characteristics, furnished specialties, and accessories such as meters, controllers, solution tanks, pumps, test equipment, written sequence of operation to achieve water quality defined in the Performance Requirements, etc.

6 **Shop Drawings**: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to HVAC systems. Include plans, elevations, sections, details, and attachments to other work.

7 Record actual locations of equipment and piping, including sampling points and locations of chemical injectors to guide installing contractors.

8 Wiring Diagrams: Power and control wiring, moreover, integration with existing systems as BAS including sequence of operations

9 **Quality Assurance**. HVAC Water-Treatment Service Provider Qualifications: HVAC water-treatment service provider with certified water techs, capable of analyzing water qualities, installing and maintaining water-treatment equipment.

10 **Maintenance Service.**

10.1 Provide chemicals and service program to maintain water conditions for a period of one year from date of Substantial Completion, and shall include the following:

10.1.1 Initial makeup and (and subsequent analysis of water quality changes) system water analysis with HVAC water-treatment recommendations.

10.1.2 Startup assistance for Contractor to flush the systems, clean with disinfectant detergents, and initially fill systems with required chemical treatment prior to operation.

10.1.3 Minimum 4 hours of on-site training of building operators to use water treatment equipment, to handle and administer treatment chemicals.

10.1.4 Monthly and or more frequent field service and consultation.

10.1.5 Customer report charts and log sheets.

10.1.6 Laboratory technical analysis.

10.1.7 Analyses and reports of all chemical items concerning safety and compliance with government regulations to be delivered

10.1.8 Summary review reports with graphs every six months in terms of treatment system performance or storage (ing) accompanied with recommended solutions to comply.

10.1.9 Limit the amount of make-up water by: locate and repair system leaks immediately; do not drain and fill these systems seasonally; minimize the amount of water lost from the system during sampling, blow down, safety valve testing and filter cartridge replacement.

11 **Chemical Treatment Test Equipment**

11.1 Test Kit: Manufacturer-recommended equipment and chemicals in a wall-mounting cabinet for:

11.1.1 Testing pH, TDS, inhibitor, chloride, alkalinity, phosphate, silica and hardness.

11.1.2 Oxygen scavenger and testable polymer tests for high-pressure boilers.

11.1.3 Oxidizing biocide test for open cooling systems

11.2 Sample Cooler.

11.3 **Automatic Chemical Feed Equipment**

11.4 Inhibitor Injection Timers:

11.5 Microprocessor-based controller with LCD display enclosure with gasketed and lockable door. Interface for start/stop and status indication at BAS.

11.6 Programmable timers with infinite adjustment over full range, and mounted in cabinet with hand-off-auto switches and status lights.

11.7 Test switch.

11.8 Hand-off-auto switch for chemical pump.

11.9 Illuminated legend to indicate feed when pump is activated.

11.10 Programmable lockout timer with indicator light.

11.11 LCD makeup totalizer to measure amount of makeup and bleed-off water from two water meter inputs.

11.12 The flow sensor will include a totalizer for chemical feeds. It will alarm for continuous use.

11.13 .7.2 pH Integral Controller:

11.14 Microprocessor-based controller, 1 percent accuracy in a range from zero to 14 units. Interface for start/stop and status indication at BAS- BacNet.

11.15 Digital display and touch pad for input.

11.16 Sensor probe adaptable to sample stream manifold.

11.17 High, low, and normal pH indication.

11.18 High or low pH alarm light, trip points field adjustable; with silence switch. Hand-off-auto switch for acid pump.

11.19 Internal adjustable hysteresis or deadband.

11.20 Chemical Solution Tanks:

11.21 Chemical-resistant reservoirs fabricated from high-density opaque polyethylene or higher quality stainless steel, with minimum 110 percent containment vessel.

11.22 Molded cover with recess for mounting pump.

11.23 Capacity: Maintain inventory sufficient to meet the system demands

11.24 Chemical Storage and Containment

11.25 Three (3) separate permanent barrels shall be provided for storage of cooling water chemicals. One for each; Inhibitor, Biocide A and Biocide B. All chemical barrels shall be stored within a common containment basin.

11.26 Specifications

11.27 Tote barrel capacity: 60 Liters -and or as design/manufacturer mandates

11.28 Tote barrel shall be fitted a 1" top mounted tank adapter for the level transmitter and low-level switch.

11.29 Containment Basin Capacity: 430 Liters (Sized to hold three (3) barrels)

11.30 Materials of construction: Low Density Polyethylene

11.31 .7.5 Chemical Solution Injection Pumps:

11.32 Self-priming, positive-displacement; rated for intended chemical with minimum 25 percent safety factor for design pressure and temperature.

11.33 Adjustable flow rate.

11.34 Metal and thermoplastic construction.

11.35 Built-in relief valve.

11.36 Fully enclosed, continuous-duty, single-phase motor.

11.37 Chemical Solution Tubing:

11.38 Polyethylene tubing with compression fittings and joints except ASTM A 269, Type 304, stainless steel for steam boiler injection assemblies.

11.39 Injection Assembly:

11.40 Capable of insertion length sufficient to discharge into at least 25 percent of pipe diameter.

11.41 Ball Valve: Two-piece, stainless steel.

11.42 Packing Gland: Mechanical seal

11.43 Assembly Pressure/Temperature Rating

11.44 Materials of construction: Stainless steel 316, Nickel alloy, Carpenter 20, PVC.

11.45 Fail-Safes and Alarms

11.46 Corrosion safety interlock: Alarm indication,.

11.47 PH interlock: Alarm indication,

11.48 Flow interlock (on loss of flow): Alarm indication, lock-out all control outputs and chemical feeds.

11.49 Low Level Alarms

11.50 Low level alarm system to monitor chemical solution level in inhibitor, pH modifier (acid or alkali), biocide, and dispersant drums.

11.51 Alarm probes, suitable current system capacity and connected with flexible cable.

11.52 Signal output suitable for remote alarm function in addition to local alarm.

11.53 Corrosion Coupon Rack –

11.54 The Corrosion Coupon (CC) 6 Racks will be mounted on a backboard and will stand alone, complete with flow meter 0- 17 GPM and isolating BALL valves.

11.55 Specifications:

11.56 Shall include six (6) PVC coupon holders with 3" Teflon stems The flow

12 Main Controller and Sensors

12.1 Open native BACNet communication protocol (BTL Certified and posted) for communication with BAS system.

12.2 Blow down / conductivity control shall be based on a direct sensor signal.

12.3 A self-test shall be available to verify the integrity of the control module's sensor input circuitry.

12.4 Sensor shall be provided to include plumbing manifold complete with a flow switch for detecting sample water and manual sample valve.

12.5 Chemical feed shall be selectable from bleed and feed, feed as a percentage of bleed, feed as a percentage of time, and feed based on a water meter contactor input. Biocide feed shall be selectable from up to 10 times per day, a weekly cycle, a two-week cycle, or a 28-day cycle.

12.6 The analog inputs shall be configurable for level sensors, corrosion monitors, or any other type of transmitter, providing appropriate units of measure and scaling. The digital inputs shall be configurable for level switches; chemical feed verification switches or generic interlock operation.

12.7 Pixel Backlit **LCD Graphics Module display** shall indicate the process values, and the status of outputs and alarms. The controller shall be capable of trending and displaying past hour, past 7 hours, past 24 hours, past week and past 30 days of data.

12.8 Access to the controller shall be possible via the local display and keypad.

12.9 No proprietary software shall be required on the user's computer to communicate with the controller, or to view or change set points.

12.10 The **conductivity sensor** shall be driven with a low voltage AC signal, and the return signal voltage will vary with the conductivity of the intervening solution. The temperature sensor within this sensor compensates for the effect of temperature on the conductivity signal. Range: 0 to 10,000 µS/cm conductivity. Accuracy: +/- 1 µS/cm conductivity. Materials of construction: Glass-Filled Polypropylene, Graphite, FKM.

12.11 The **ORP sensor** shall consist of replaceable cartridge containing a platinum electrode and silver/silver chloride reference. Voltage signals shall be measured against the solution ground, and the differential voltage measurement sent to the control module.

12.12 **Free chlorine sensor**. Oxidizer molecules diffuse through the membrane and in the acidic environment of the electrolyte fill solution, a redox reaction occurs at the electrodes in the sensor. The current generated by this reaction is converted to a voltage signal that is linear with the concentration of the oxidizer.

13 **Installation**.

13.1 Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.

13.2 Install water testing equipment on wall near water chemical application equipment.

13.3 Install corrosion resistant drip pan, a minimum of 3 in (75 mm) high, under tanks and pumps. Intent is to contain minor leaks.

13.4 Install unions, shutoff valves on HVAC water-treatment equipment inlet and outlet.

13.5 Provide backflow preventers.

13.6 Provide appropriate equipment grounding.

13.7 Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.

13.8 Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.

13.9 Do not circulate any water from the site chilled and high temperature hot water mains until the water treatment contractor has certified the water quality of both sides of the site utility isolation valves.

13.10 After connection to plant utilities are achieved remove temporary bypass pipes and cap.

23 25 13 CLOSED LOOP

23 25 16 OPEN LOOP

23 25 19 STEAM

23 25 23 HUMIDIFICATION

23 31 00 HVAC DUCTS AND CASINGS

1 Ductwork

1.1 All ductwork construction and installation to be in accordance with OBC, CSA and recommendations of the current SMACNA and ASHRAE standards. SMACNA pressure classification shall be followed based on calculated system pressure by the designer.

23 33 13 DAMPERS

1 Balancing Dampers

1.1 Provide balancing dampers in all locations necessary for balancing the air systems.

23 33 19 DUCT SILENCERS

1 Silencers - General

1.1 Design air distribution system including silencers to minimize static pressure requirement at fans for most energy efficient solution.

23 33 33 DUCT-MOUNTING ACCESS DOORS

1 Access Doors

1.1 Provide access panels in the following locations:

1.1.1 In ductwork to facilitate full cleaning of all ducts.

1.1.2 Bottom of all duct risers.

1.1.3 Next to outside air intakes and outlets.

1.1.4 At fire dampers.

1.1.5 Immediately upstream and downstream of each reheat coil.

1.2 For ductwork greater than 600mm in width, access doors shall be minimum 450mm x 450mm. For ductwork 600mm to 350mm in width, access doors shall be minimum 300mm x 300mm. For ductwork less than 350mm in width, provide largest access door to fit duct.

23 33 43 FLEXIBLE CONNECTORS

1 Flexible Connectors

1.1 Connect fan units to ductwork by means of a securely fastened to equipment and ductwork by a suitable band, provided with tightening screws.

23 33 46 FLEXIBLE DUCTS

1 Flexible Ducts

1.1 Maximum length of flexible ducts shall be 3.6m (12 ft.). Utilize rigid ductwork as required to meet this requirement.

23 34 00 HVAC FANS

1 Fans - General

1.1 Provide each fan with the AMCA seal. Fans to have non-overloading horsepower characteristics.

1.2 Provide all fan wheels statically and dynamically balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans. Fans to operate quietly and without pulsations.

23 36 00 AIR TERMINAL UNITS

1 Air Terminals - General

1.1 Terminal units must be located such that they are accessible through ceiling tiles or access doors directly or clearly identified.

1.2 Units are not to be located above lighting fixtures or equipment that would require removal.

2 Fan Powered Variable Volume Terminals

2.1 The terminal shall have top and bottom access panels, which allows for removal of fan assembly and servicing of terminal without disturbing duct connections.

2.2 Motor shall have built-in soft start and soft speed change ramps. Motor shall be directly coupled to the blower.

3 Controls

3.1 DDC controllers are required for new installations and recommended for renovation and retrofit projects.

3.2 All DDC controllers shall be open BACnet compliant and BACnet tested and listed on BTL website. Controllers shall be factory installed.

3.3 Controllers can be specified by the Terminal Manufacturer or by the BAS Manufacturer, however all controllers on each project will be of the same manufacturer.

3.4 All control components shall be mounted inside a protective metal shroud provided by the box manufacturer.

23 44 00 ECOLOGY UNIT

1 Ecology Unit

1.1 Provide ecology units for kitchen exhaust applications where removal of grease and odours from the exhaust air is required.

1.2 Controls shall be complete with timers, relays and lamps to indicate system on, condition of prefilter, bag filter, absolute filter, filter missing, fire and odour reducing operation.

1.3 Provide dry contacts in control panel for unit status, alarm, and start/stop for BAS connection.

23 50 00 CENTRAL HEATING EQUIPTMENT

23 51 00 BREECHINGS, CHIMNEYS, AND STACKS

1 General

1.1 All breechings, chimneys, vents and stacks must be engineered and stamped by professional engineer.

23 52 00 HEATING BOILERS

1 Heating Boilers General

1.1 The Heating System shall utilize continuous and automatic measures directly integrated into the Building Automation Systems, no external 3rd party module shall be used.

1.2 All points controlling the Heating System shall be visible and adjustable through the Building Automation System.

1.3 Provide isolation valves for each boiler so that it can be taken off-line without preventing the remaining heating system to function.

1.4 Provide drain valves at each boiler on inlet and outlet to allow for draining, flushing and chemical cleaning.

23 52 13 ELECTRIC BOILERS

1 Electric Boilers

1.1 To minimize energy costs, the use of electric boilers should be avoided wherever possible.

23 52 16 CONDENSING BOILERS

1 Condensing Boiler

1.1 The boiler shall comply with the energy efficiency requirements of the latest edition of the ASHRAE 90.1.

1.2 The boiler shall have a fully welded stainless steel, fire tube heat exchanger. The condensate collection basin shall be constructed of welded 316L stainless steel. The complete heat exchanger assembly shall carry a ten (10) year replacement warranty on materials. Aluminum core boilers shall not be considered.

1.3 The control system shall have a display for boiler set-up, boiler status, and boiler diagnostics. All components shall be easily accessed and serviceable from the front and top of the jacket.

23 57 00 HEAT EXCHANGERS FOR HVAC

1 Heat Exchangers

1.1 Provide drain valves and isolation valves on inlet and outlet.

23 64 00 WATER CHILLERS

23 65 16 INDUCED-DRAFT COOLING TOWERS

1 Induced Draft Tower

1.1 To prevent heating problems in the fan-cooled motor, the VFD drive shall cycle the motor on/off when the minimum allowable motor speed is reached.

1.2 There shall be a separate VFD drive for each cell of the cooling tower.

2 Provide all necessary components to allow each tower to be isolated without preventing other towers from operating in multiple tower installations23 65 36Closed Circuit Fluid CoolersClosed Circuit Fluid

23 72 00 AIR TO AIR ENERGY RECOVERY EQUIPMENT

1 Reverse Flow Heat Recovery

1.1 Unit is designed as a complete stand-alone energy recovery ventilator, supporting a dedicated HVAC system.

1.2 System shall utilize a “REVERSE FLOW” regeneration type fresh air / exhaust air recovery methodology.

1.3 Unit must meet or exceed a sensible temperature output effectiveness of 90% wintertime, 80% summertime +/- 5%. Based on manufactures published catalog.

1.4 Unit shall have a wintertime latent return effectiveness of 70%.

1.5 Unit shall have the ability to maintain a 90% effectiveness at varying flow rates.

1.6 Energy transfer cassettes shall be easily accessible individually.

1.7 All cassettes are removable and cleanable.

1.7.1 Unit shall be of a self-cleaning design. No filters will be required under normal operating conditions. Cassette will have the capability to be power washed in the field.

23 73 23 CUSTOM INDOOR CENTRAL STATION AIR HANDLING UNITS

1 Air Handling Units - General

1.1 Provide unit produced by a recognized manufacturer who maintains a local service agency and parts stock. Shop manufacture and test all units.

1.2 Air handling units and major components shall be products of the manufacturer regularly engaged in production of such equipment.

2 Filter Gauges

2.1 Magnehelic gauges shall be accurate to +/- 2% of full range.

2.2 Provide sensing probes and shut off valves for each gauge.

2.3 Provide one gauge flush mounted into the casing for each filter bank. Where a pre-filter bank is adjacent to a second filter bank, a gauge is required for each filter bank.

3 Humidifiers

3.1 Air handling units shall be built to accommodate full absorption atomizing humidification at the design operating setpoints.

4 Dampers

4.1 All hardware to be non-corrosive reinforced material or cadmium plated steel.

5 Air Leakage Testing

5.1 Unit manufacturer shall factory pressure test each air handling unit to ensure the leakage rate of the casing does not exceed 1.0% of the unit air flow at 1.5 times the rated static pressure.

23 74 00 PACKAGED OUTDOOR GAS-FIRED HVAC EQUIPMENT

1 Packaged Outdoor Equipment - General

1.1 This section shall follow 23 73 23 Custom Indoor Central Station Air Handling Units

23 81 19 COMPARTMENT AHUS

1 Compartment Unit

1.1 This section shall follow 23 73 23 Custom Indoor Central Station Air Handling Units

23 81 23 COMPUTER ROOM AIR CONDITIONERS

1 General

1.1 The system shall be designed to maintain temperature and humidity conditions in the rooms containing electronic equipment. Design equipment to be fully compatible with heat dissipation requirements of the room.

1.2 The controller shall be open BACnet tested and listed on BTL website, with a front monitor LCD display panel and control keys for user inputs. The controls shall be menu driven with on-screen prompts for easy user operation and programming of temperature and humidity setpoints, alarm parameters, and setup.

1.3 All the installations must be N+1 for redundancy.

1.4 A programmable common alarm shall be provided to interface user selected alarms with a remote alarm device.

1.5 The control system and electronic circuitry shall be provided with self-diagnostics to aid in troubleshooting.

1.6 Provide two (2) solid state water sensors per unit under the raised floor.

23 81 29 VARIABLE REFRIGERANT FLOW HVAC SYSTEM

1 General

1.1 The variable capacity air conditioning system shall be a Variable Refrigerant Volume Series (heat/cool) split system. The system shall consist of multiple evaporators, headers, branch selector boxes (for heat recovery systems), a two or three pipe refrigeration distribution system using PID control, and VRV condensing unit. The condensing unit is a direct expansion (DX), air cooled heat recovery, multi-zone air-conditioning system with variable speed inverter driven compressors.

1.2 Each indoor unit or group of indoor units shall be independently controlled.

1.3 Operation of the system shall permit either individual cooling or heating of each indoor unit simultaneously, or all of the indoor units associated with one branch cool/heat selector box (with heat recovery systems). Each indoor unit or group of indoor units shall be able to satisfy their set temperature independently via a local remote controller, or a centralized controller. The units shall be native BACnet compatible.

2 Branch Selector Box (For Heat Recovery System)

2.1 Branch selector boxes shall be located as shown on the drawing. Selector box cabinets shall have a galvanized steel plate casing and shall house multiple refrigeration control valves, a liquid gas separator and a tube in tube heat exchanger. The unit shall contain sound absorption thermal insulating material made of flame and heat resistant foamed polyethylene.

2.2 The branch selector box shall also contain the required electronics to facilitate communications between the main processor and between the indoor units. The use of

EEV's will ensure continuous heating during defrost (with air cooled systems), and have no heating impact during changeover modes. Use of multi-port branch selector boxes shall not be acceptable.

3 Controls

3.1 Fan coil units shall be supplied with Individual Zone Controllers.

3.2 The controller shall have a self-diagnosis function that constantly monitors the system for malfunctions.

3.3 The controller shall be able to immediately display fault location and condition.

3.4 Controller shall be open BACnet tested and listed on BTL website. All points required for control and monitoring of system performance must be exposed as open BACnet objects.

23 81 46 WATER SOURCE UNITARY HEAT PUMPS

1 Heat Pumps

1.1 Provide unit produced by a recognized manufacturer who maintains a local service agency and parts stock. Shop manufacture and test all units

1.2 Controller shall be open BACnet tested and listed on BTL website. All points required for control and monitoring of system performance must be exposed as open BACnet objects.

23 82 19 FAN COIL UNITS

1 Fan Coils

1.1 Cooling coil: copper tubes with aluminum fins, full length insulated drain pan, (under coil, valves and fittings).

1.2 Heating coil: copper tube with aluminum fins.

1.3 Multi-speed, permanent split capacitor, resilient mounted, built-in overload protection and oil-lubricated bearings.

1.4 Unit mounted 3-speed switch (Off-Low-Medium-High).

1.5 Forward curved double inlet fans with permanently lubricated sealed bearings.

1.6 Throw away filter MERV 8.

1.7 Removable access panels giving access to filter, fan/motor assembly and valves.

23 82 31 RADIANT HEATING PANELS

1 Radiant Heating Panels

1.1 **Can only be used when** heating fluid temperature is controlled separate from convectors, tube radiation or reheat coils.

23 83 19 SNOW/ICE MELTING SYSTEM (WALKWAYS AND RAMPS)

1 Snow Ice Melting (SIM) Detector And Melting Controls

1.1 Automatic SIM Detector and Melting Controls:

1.1.1 SIM control shall use low-voltage devices to monitor outdoor ambient, slab, fluid supply and/or return temperatures, as well as an automatic snow and ice detector to detect moisture in the SIM zone.

1.1.2 SIM control shall be capable of maintaining a set temperature in a SIM slab or thermal mass, with two adjustable settings for Idle and Melting mode.

1.2 Provide open BACnet exposed points for monitor and control from BAS system.

23 84 13 HUMIDIFIERS

1 Humidifiers - General

1.1 Humidifier grid shall provide absorption characteristics that preclude water accumulation on any in-duct surfaces downstream from the humidifier.

1.2 Provide unit produced by a recognized manufacturer who maintains a local service agency and parts stock. Shop manufacture and test all units.

1.3 Size all Steam Generating Humidifiers to produce an amount of steam equal to or greater than the actual humidification load and any steam that condenses within distribution piping and steam injection grids.

DIV 25: INTEGRATED AUTOMATION

ENERGY CONSERVATION STRATEGIES

1 System Strategies

1.1 Point 1: Unoccupied Times

1.1.1 The outdoor air dampers are set to the minimum unoccupied position when the building is on unoccupied mode.

1.1.2 During morning pre-heating and mechanical pre-cooling, the outdoor air dampers are to be set to the minimum unoccupied positions.

2 Point 2: Free Cooling

2.1 Use local weather station for the differential enthalpy calculations, when local relative humidity sensors are not feasible or available.

2.2 Use outdoor air for “free cooling” as much as possible.

2.3 AHU systems with VAV terminal units will require a global space temperature set-point to be commanded to enable the terminal unit dampers to open, prior to commencing free cooling.

3 Point 3: Demand Control Ventilation (DCV)

3.1 All times, Demand Control Ventilation, is to be the secondary control variable after minimum damper positions and/or temperature control.

3.2 Demand Control Ventilation is operating based on an average space/return air CO_2 set point (e.g. for offices, a CO_2 level of 800 ppm) except when on free cooling mode.

4 Point 4: Schedules

4.1 Time of day schedules: Use outdoor reset schedules to reduce as much as possible system operational schedules when optimum start/stop cannot be used.

4.2 HVAC and lighting control occupancy schedules shall follow the CFA established occupancy hours in the contract for the building.

5 Point 5: Optimum Start

5.1 Provide automatic optimum start control. The optimum start/stop algorithm available on most building automation systems an predict how long a space will take to reach the desired set point temperature based on variables that affect it, such as outdoor air temperature, space temperature, and building thermal characteristics.

5.2 Use this algorithm to start HVAC systems, such as air handling units and chillers/boilers, at the latest possible time to achieve the required space conditions before the space is occupied.

6 Point 6: Temperature Set-Point Monitoring

6.1 Monitor that room temperature set-point is maintained in the space. Designer shall clearly identify the primary field sensor to avoid simultaneous heating and cooling.

6.2 Include heating control valve, cooling control valve and damper positions where they exist and are used to maintain the space temperature.

7 Point 7: Setbacks

7.1 Implement unoccupied mode setback ands etup set point temperature control.

7.2 Use setup set point temperature of 28 deg C during summer non-condensing (cooling operation) and set back of 16 deg C during winter non-condensing (heating operation).

8 Point 8: Sequence of Operation

8.1 Building operator will be able to open control system detailed Sequence of Operation description screen using a button, SOOP/SOP, on each air and water system detail graphic. Button is located in same relative location on each graphic, e.g. upper right corner.

8.2 Sequence of Operation must be provided in editable Microsoft Word format for future editing as the system changes with time. Preliminary draft to be submitted prior to Substantial Completion, with final version at time of Closeout.

9 Point 9: Reset Variable Fan Speed Based on Demand

9.1 Reset the fan speed based on the zone demand (trim and response logic).

10 Point 10: Damper

10.1 The HVAC fan speeds and/or supply air temperature will be reset by the associated critical damper position to optimize both for occupant comfort and overall energy efficiency of the system as a whole.

25 00 00 INTEGRATED AUTOMATION (IA) SYSTEMS GENERAL

25 00 10 QUALIFICATIONS OF INTEGRATED AUTOMATION (IA) CONTRACTOR/MANUFACTURER

1 Qualifications

1.1 All IACM's must be temperature control manufacturers regularly engaged in the business of manufacturing and installing direct digital temperature controls for over twenty (20) years. Companies with less than twenty (20) years of experience shall submit qualifications to IO for approval prior to bid.

1.2 All IACM's shall have a local engineering and service office within 150 kilometers of the job site for the Central Region and 300 kilometers for other regions, and are able to support the project with the required manpower and equipment resources, unless approved otherwise by project stakeholders.

25 00 20 IA COORDINATION

1 Coordination

1.1 The platform must be designed to ensure value can be extracted from the infrastructure through advanced analytics, work order processing, remote services and integration of other building systems such as lighting, access control, video and informational dashboards.

1.2 The consultant shall arrange regular coordination meetings during design and construction to ensure all parties involved understand the requirements and expectations of the final Integrated Automation system.

25 05 00 COMMON WORK RESULTS FOR IA

1 Existing Conditions

1.1 Examine areas and conditions under which control systems are to be installed. In existing buildings examine the controls and related equipment that will be affected and provide replacement and upgrades as required. Ensure the final system will be fully functional through its life expectancy.

2 Communication Wiring

2.1 In addition, all wiring jackets shall be labelled at each end of the wiring run with a descriptive name and point name as identified in the BAS schematics.

2.2 Network no splices and separate from any wiring over 30V.

3 Identification of Equipment

3.1 Identify each piece of equipment, including sensors, controlled devices, and control panels, with a nameplate identifying the equipment and functions with a letter and number designation. Identifications shall meet the specifications developed by the designer.

3.2 Provide a single line diagram for the control points located in each controls enclosure.

4 Uninterruptible Power Supply (UPS)

4.1 Provide a commercial-grade true online UPS. UPS to provide battery backup for each operator workstation, server and peripheral devices, and all primary supervisory controllers.

4.2 UPS shall be sized for a typical runtime of 120 minutes.

4.2.1 UPS circuit shall be powered from a source that is supplied by the emergency power.

25 10 30 IA NETWORK EQUIPMENT – WIRELESS DEVICES "CONSULT IO"

1 ZigBee Wireless Mesh networking for BACnet

1.1 IO approval is mandatory when Wireless Mesh Networking is considered for project implementation.

25 11 00 IA NETWORK DEVICES

1 Operator Workstation

1.1 Latest supported Microsoft Operating System, automated to ensure the latest patch is applied.

1.2 The corporately supported Anti-virus (Windows Defender, McAfee or as directed by IO) set for automated patch update and scanning frequency.

1.3 An approved firewall hardware device set for 3rd party corporate management.

1.4 Log Me In software set automated patch update.

25 15 00 IA SOFTWARE (IAS)

1 Licensing

1.1 All related BAS, software licenses and administrative rights must be assigned in whole to Infrastructure Ontario. This includes all installations by sub-contractors and assigned agents during modification of any systems.

2 Operator Interfaces

2.1 The Controls Systems Operator Interfaces shall be user friendly, readily understood and shall make maximum use of colours, graphics, icons, embedded images text based information and data visualization techniques to simplify the use and understanding of the displays by authorized users at the Operator's Workstation (OWS).

2.2 User access shall be protected by a flexible and Owner redefinable software-based password access protection.

2.3 Password protection shall be multi-level and partition able to accommodate the varied access requirements of the different user groups to which individual users may be assigned.

2.4 Provide the means to define unique access privileges for each individual authorized user.

2.5 Provide the means to on-line manage password access control under the control of a project specific Master Password.

2.6 Provide an audit trail of all user activity on the Controls Systems including all actions and changes for a time period of most recent 6 months or greater.

2.7 The Operator Interface shall incorporate comprehensive support for functions including, but not necessarily limited to, the following:

2.7.1 Access for selective information retrieval and control command execution.

2.7.2 Monitoring and reporting.

2.7.3 Alarm and non-normal condition annunciation.

2.7.4 Selective operator override and other control actions.

2.7.5 Information archiving, manipulation, formatting, display, and reporting.

2.7.6 Controls Systems internal performance supervision and diagnostics.

2.7.7 On-line access to user HELP menus.

2.7.8 On-line access to current as-built records and documentation. At minimum, one (1) copy of all record documentation shall be stored on a designated OWS or Server and be accessible to the operators.

2.7.9 Means for the controlled re-programming, re-configuration of systems operation and for the manipulation of database information in compliance with the prevailing codes, approvals, and regulations for the component applications and elements.

2.7.10 Means to archive all configuration databases, software programs, and other pertinent operational data such that any component of the software and project specific operational databases may be reloaded on-site from archived data.

2.7.11 Contact CBRE BAS specialist for details to insert here for backing up databases to a cloud environment as part of the project final AI operational database.

2.7.12 Provide on-line reports and displays making maximized use of simple English language descriptions and readily understood acronyms, abbreviations, icons and the like to assist user understanding and interpretation.

2.7.13 All text naming conventions shall be consistent in their use and application throughout the Control Systems.

3 Navigation Trees

3.1 Provide the capability to display multiple navigation trees that aid the operator in navigating throughout all systems and points connected. At minimum, provide a tree that identifies all systems on the Control Systems networks.

3.2 Provide the capability for the Operator to add custom trees. The Operator shall be able to define any logical grouping of systems or points and arrange them on the tree in any selected order. Provide the capability to nest groups within other groups. Provide at minimum for five levels of nesting.

3.3 The navigation trees shall be “dock able” to other displays in the Operator interface including graphic displays. The trees shall appear as part of the display and may be individually detached and minimized to the Windows task bar or closed. Provide for a single keystroke to reattach the navigation tree to a primary display.

4 Divisible Display Windows

4.1 Provide for the operator to divide the display area within a single Browser window into multiple display panels. The content of each display panel can be any of the standard summaries and graphics provided in the Control Systems Application.

4.2 Provide each display panel with minimize, maximize, and close icons.

5 Alarms

5.1 Alarms shall be routed directly from primary Controls Systems Application Nodes to OWS and Server. Provide for specific alarms from specific points to be routed to selectable OWS and Server. The alarm management portion of the Controls Systems software shall, at minimum, provide the following functions:

5.1.1 Priority 1 alarms are reserved for “life and death safety” situations such as fire related and emergency generator battery status. (Purple colour)

5.1.2 Priority 2 alarms are reserved for “building damage” situations such as sump levels, etc. (Red colour)

5.1.3 Priority 3-5 alarms are dependent on system by system parameters. (Pink Colour)

5.2 Alarming of points shall be assigned the indicated priority and:

5.2.1 Sent to printer, pager and designated email addresses for each of priorities 1 to 3 inclusive (based on system having 6 or more levels of alarming priorities),

5.2.2 Printer and designated email addresses for each of priorities 4 to 5 inclusive,

5.2.3 Printer only for other priorities.

5.3 Typical Priority 3 Alarm: When any component fails to achieve its commanded status for more than 2 minutes; for example fan is off when it is to be on for more than 1 minute.

5.4 Typical Priority 4 Alarm: When room temperature is greater than 79F (26 C) or less than 68F (20C) for more than 15 minutes during ‘occupied’ mode. Alarm will clear when temperature has returned more than 1F (0.5C) into non alarm state for more than 1 minute.

5.5 Typical Priority 5 Alarm: When filter pressure differential is greater than 249 Pa or less than 25 Pa for more than 15 minutes when main supply fan is operating. Alarm will clear when pressure has returned more than 10 Pa into non alarm state for more than 1 minute.

5.6 Alarms for Priority 3 and greater alarms, will be disabled during system startup and until system has stabilized or been operating for at least 30 minutes. This time period may be adjustable based on the particular system and point.

5.7 Log date and time of alarm occurrence along with point description, type of alarm, value, point state and alarm priority.

5.8 Generate a “Pop-Up” window on the Browser display panel, with audible alarm, informing the Operator that an alarm has been received.

5.9 Allow an Operator, with the appropriate password, to acknowledge, temporarily silence or cancel an alarm.

5.10 Provide an audit trail on hard drive for alarms by recording user acknowledgement, deletion, or cancelling of an alarm. The audit trail shall include the ID of the user, the alarm, the action taken on the alarm and a time/date stamp.

5.11 Provide the ability to direct alarms to an e-mail address or alphanumeric pager.

5.12 Controls Systems that use e-mail and pagers as the exclusive means of annunciating alarms are not acceptable.

5.13 Provide for any attribute of any object in the Controls Systems to be designated to report as an alarm.

5.14 The Controls Systems Application shall annunciate systems diagnostic alarms indicating system failures and non-normal operating conditions.

5.15 Provide the on-line means to display alarms within the Browser windows by date/time of occurrence, priority class, point designation, value, or other defined text keywords.

5.16 BAS operators with access level 3 or higher (based on system having 6 or more levels of access) will be able to acknowledge alarms:

6 Operator Transaction Archiving

6.1 Provide the means to automatically archive all Operator activities on the Controls Systems Application and for the recall of same for reporting.

6.2 Transaction log shall store the latest 1000 actions, as a minimum, defaulting with most recent log at top of log list.

6.3 Provide the means to sort and report archived activities by Operator, date/time, activity type and system area.

6.4 Provide access protection to preclude the unauthorized removal or tampering with archived records.

6.5 Provide management support facilities for the deletion and re-initializing of archived record logs under Master Password control or equal means.

7 Reports

7.1 Reports shall be generated and directed to one or more of the following:

7.1.1 User interface displays,

7.1.2 printers

7.1.3 Archived at the Owner's defined option.

7.2 As a minimum, the Controls Systems Application shall provide the following reports:

7.2.1 All points in the Controls Systems Application.

7.2.2 All points in a specific Controls Systems.

7.2.3 All points in a user-defined group of points.

7.2.4 All points currently in alarm.

7.2.5 All points locked out.

7.2.6 All Controls Systems Application schedules.

7.2.7 All user defined and adjustable variables, schedules, interlocks, diagnostics, systems status reports, and the like.

7.3 Provide all applicable original manufacturers standard reports for the Controls Systems.

8 Dynamic Colour Graphics

8.1 On floor plan, background color indicates which main air system serves which zone. Identify each color zone with main supply fan number. Clicking on fan #, will jump the user to the main air system graphic.

8.2 Provide temperature, humidity and carbon dioxide actual values on floor plan for all sensors mounted in space. Clicking on a value will jump you to a detailed graphic of the room(s) served by that sensor including VAV schematic details, etc. Set points, etc. to be shown on this graphic.

8.3 On floor plan room graphic, clicking on VAV or reheat coil, etc. system will jump you to HVAC detailed data for air system.

8.4 Provide links between graphics to aid building operator in viewing and troubleshooting system problems. This includes returning to previous graphic, floor plan graphic and system main graphic.

8.5 Detail graphics are to clearly indicate if a particular point is in Auto or Manual state. Manual state means that a building operator has forced a set point into the system.

8.6 Graphics shall indicate any variables displayed, as to whether they are in alarm or normal mode. Alarm mode will be considered to be non-flashing background colour as indicated for alarming, unless it has been agreed otherwise and approved by CBRE BAS Specialist.

8.7 Graphics shall include all input/output field points, set points and calculated points used for monitoring and control purposes. Animation is not a substitute for putting values/states on the graphics.

8.8 Lettering/number font on graphics must be Arial or Times New Roman, minimum height of 64 mm (1/4“).

8.9 Graphics shall be created to fit the monitor at site, without the use of “sliding bars”.

8.10 Building operator will be able to open control system Sequence of Operation description screen using a button, SOOP/SOP, for the particular graphic displayed, on each air and water system graphic. Button is located in same relative location on all system graphics; for example, upper right corner.

8.11 Values of real-time attributes displayed on the graphics shall be dynamic and updated on the displays.

8.12 Provide for the Owner to be able to change values (set points) and states in system controlled equipment directly from the graphic display.

8.13 Provide a graphic editing tool that allows for the creation and editing of graphic files. It shall be possible to edit the graphics directly while they are on line, or at an off line location for later downloading.

9 Schedules

9.1 Provide multiple schedule input forms for automatic time-of-day scheduling and override scheduling of operations. At a minimum, the following schedule types shall be accommodated:

9.1.1 Weekly schedules.

9.1.2 Monthly schedules.

9.1.3 Holiday schedules.

9.1.4 Temporary override schedules.

10 Trending And Data Collection

10.1 Provide trending for all Analog (input/output), Digital (input/output) points and programmed/calculated variables (example: set point) values. Store minimum of 500 values in on-line trend and 5000 in history file.

10.1.1 Digital (input/output/variable) values trended as COV.

10.1.2 Analog (input/output/variable) values trended as Present Value.

10.2 Provide a symbol/button beside each point on graphic that is being trended that will immediately jump operator to on-line trend for that point. Symbol to clearly indicate it is for trend log information.

10.3 The trend data shall be stored in a manner that allows custom queries and reports using industry-standard software tools.

11 Operator Access Security (Combined Password and User ID)

11.1 BAS access levels will be setup by designers of the project for BAS. A complete list of access usernames will be created in Excel using PLMSP format and sent to the PLMSP "CBRE" BAS Control Center.

11.2 The following access matrix will be completed:

Administrator	All rights and privileges, only one user per site. One for the lead tech.
BAS Tech	All rights and privileges, dedicated for OEM only.
Operator	Access to schedules, overwrites, status changes, set-point changes, reset schemes, trending and report creation. For all regular technicians, managers, HVAC Service Provider or NOC troubleshooting.
Service Tech	Access to schedules, overwrites, status changes, set-point changes, reset schemes, trending and report creation. Also, access to sequences and base level programming but cannot replace or upgrade software.

	Dedicated for projects where higher level access is needed.
View Only	View only, cannot make changes. For consultants or non-technical review.

11.3 Stored password/user ID definitions shall be stored in encrypted formats whether at the Controls Server or at the application node.

11.4 Password logins shall not be echoed on any screen or printer except during Master Password definition processes.

11.5 An Operator defining a password shall be required to re-enter to confirm authenticity.

11.6 As part of the access privileges definition for each user the Owner shall be able to define at minimum the following:

11.6.1 Access times by day.

11.6.2 Permanent or temporary with expiry date, password.

11.6.3 Number of incorrect access attempts allowed before the password is disabled/locked.

11.6.4 Whether or not the Operators are able to redefine their own password.

11.6.5 A field for the Operator's e-mail address.

11.6.6 A field for the Operator's contact phone number.

11.6.7 Definition of the Operator's access privilege functionalities including viewing only, full control, selected functions, etc.

12 Paging/e-mail Notification

12.1 Provide the means of automatic alphanumeric paging and emailing of personnel for Owner defined events.

12.2 Contact CBRE BAS specialist to obtain and insert here the requirements for email setup for this project.

13 System Configuration

13.1 Contractor shall thoroughly and completely configure IAS system.

25 90 00 SEQUENCES OF OPERATION

1 General

1.1 Sequence of Operation to be written in plain English, including initial set points with comment as to which ones may need to be adjusted during the commissioning stage and normal day to day operation for maintenance purposes.

1.2 The consultant will provide a detailed schematic diagram and sequence of operation and points lists (on drawings or in table format) for each control system.

1.3 When upgrades to existing systems are being done, sequence shall include the “as-left” requirement which includes any existing sequences being retained, plus all new sequences.

1.4 Individual Sequence of Operation notes to be accessible through an icon on each system graphic.

1.5 Final BAS-as-built drawings to be accessible from the main graphic page.

DIVISION 26: ELECTRICAL

PURPOSE

1 The purpose of the IO Building Systems Design Guideline is to standardize design and construction objectives and technical requirements across the full portfolio of IO buildings to ensure higher performing buildings are designed and constructed in accordance with the Smart Green Portfolio Strategy, to ensure consistency and unity of IO sites and to integrate all relevant IO guidelines and systems, in order to achieve:

1.1 Increased occupant comfort and satisfaction.

1.2 Improved operational performance.

1.3 Improved energy efficiency.

1.4 Provision of technologies and tools to efficiently monitor, control and manage building systems.

THE SMART GREEN PORTFOLIO STRATEGY

1 The Smart Green Portfolio Strategy is a high performance building portfolio strategy that utilizes advanced automation and integration to measure, monitor, and control to optimize operations and maintenance at the lowest cost and environmental impact over the building lifecycle.

2 The Smart Green Portfolio involves integrating relevant building systems including, but not limited to, HVAC, Lighting, Security, Elevators, Fire Protection and Life Safety where possible to reduce energy consumption in a facility.

3 The Smart Green Portfolio Strategy includes the infrastructure required for centralized remote monitoring of building systems. The combination of integrated automation with centralized monitoring allows for all relevant building system information to be available to a supervisor for alarm or event management, troubleshooting, dispatch for service or repair, historical record keeping and utility metering including sub-metering for individual tenants.

4 Centralized building supervision results in faster response times, consistent implementation of policies and procedures, improved operational performance, and continuous energy efficiency optimization.

26 05 00 COMMON WORK RESULTS FOR ELECTRICAL

1 Power Quality

1.1 The consultant will not assume power quality or reliability of service from local hydro. Service has been found to vary +/- 8% on voltage on average. Power factor and phase imbalance issues are commonplace. If needed, designer shall verify the power quality.

2 Equipment Supports, Anchors and Hangers

2.1 All supports, anchors, hangers, braces and methods of holding any piping, conduits or any other electrical equipment shall be designed by a professional engineer taking into account the location and current conditions of the structure it is loading.

3 Record Drawings & Single Line Diagram

3.1 The record drawings must include all red-line reviews, changes, final walkthrough documentation, shop drawings, single diagrams, sequences included in the construction and shall be reviewed and certified by a professional engineer.

3.2 When project causes changes to the Single Line diagram, the diagram will be updates, printed and posted in the Electrical Rooms in the building and where requested by OBC.

4 Load Balance

4.1 After project completion, Phase voltages shall be measured at loads and transformer taps shall be adjust to ensure rated voltage of equipment are within 2%.

26 05 73 OVERCURRENT PROTECTIVE DEVICE COORDINATION & ARC FLASH STUDY

1 Studies – Electrical Power System Studies

1.1 An electrical system Coordination and Short Circuit Analysis:

1.1.1 Shall compare the calculated maximum fault current with interrupting ratings of overcurrent protective devices such as fuses and circuit breakers.

1.1.2 Shall investigate applicable short circuit series ratings and the protection of electrical equipment by current limiting devices.

1.1.3 Shall verify the adequacy of other equipment (such as transformers, switches, equipment bussing) to withstand the effects of the calculated maximum fault current levels.

1.1.4 Shall assist in the selection and/or determination of settings for relays, fuses and circuit breakers in order to provide best coordination and minimum Arc Flash.

1.1.5 Calculate the maximum available rms symmetrical three-phase short-circuit current at each significant location in the electrical system shall be made using a digital computer.

1.1.6 Shall simulate a bolted three phase fault at each point of consideration in the system, and calculate the maximum available short circuit current at that point without any reduction due to current limiting overcurrent devices which may be present.

1.1.7 Shall include appropriate motor generators and transformer short-circuit contributions (contribution and transformer data) at the appropriate locations in the system so that the computer calculated values represent the highest short-circuit current the equipment will be subjected to under fault conditions.

1.1.8 Shall include a tabular computer printout (three phase fault report and fault study summary) which lists the calculated short-circuit currents, X/R ratios, equipment short-circuit interrupting or withstand current ratings.

1.1.9 Shall include a computer printout of input circuit data (feeder data) including conductor lengths, number of conductors per phase, conductor impedance values, insulation types, transformer impedances and X/R ratios, motor contributions, and other circuit information as related to the short-circuit calculations.

1.1.10 Shall include a computer printout identifying the maximum available short-circuit current (short circuit comparison tables) in rms symmetrical amperes and the X/R ratio of the fault current for each bus/branch calculation.

1.1.11 Shall include a system one-line diagram which is a simplified version of the engineer's drawings showing only those parts of the electrical system under consideration.

1.2 An Overcurrent Device Time-Current Coordination Analysis is an organized effort to determine the settings and, where appropriate, the ampere ratings and types for the overcurrent protective devices in an electrical system. The objective of the coordination analysis is to effect a time current coordination among the devices which achieves the desired system protection and electrical service continuity goals.

1.2.1 The time-current coordination analysis shall be performed with the aid of a digital computer and shall include the determination of settings, ratings, or types for the overcurrent protective devices supplied.

1.2.2 Where necessary, an appropriate compromise shall be made between system protection and service continuity with system protection and service continuity considered to be of equal importance.

1.2.3 A sufficient number of computer generated log-log plots (time current curves) shall be provided to indicate the degree of system protection and coordination by displaying the time-current characteristics of series connected overcurrent devices and other pertinent system parameters.

1.2.4 Computer printouts shall accompany the log-log plots and shall contain descriptions for each of the devices shown, settings of the adjustable devices, the short-circuit current availability at the device location when known, and device identification numbers to aid in locating the devices on the log-log plots and the system one-line diagram.

1.2.5 The study shall include a separate, tabular computer printout containing the suggested device settings of all adjustable overcurrent protective devices.

1.2.6 Significant deficiencies in protection and/or coordination shall be called to the attention of the owner or designated representative and recommendations made for improvements as soon as they are identified.

26 09 00 INSTRUMENTATION AND CONTROL FOR ELECTRICAL SYSTEMS

1 References

1.1 ANSI C39.1-1981, Requirements for Electrical Analog Indicating Instruments.

1.2 CAN3-C17-M84, Alternating – Current Electricity Metering.

1.3 Combination energy and demand meter: to CAN3-C17.

1.4 Provision for remote sensing.

2 Meter Socket

2.1 (Weatherproof) meter socket(s) to suit meter(s) (with automatic current transformer shorting devices when meter removed).

3 Meter Cabinet

3.1 Sheet steel CSA enclosure with meter back plate, to accommodate meters, test terminal block and associated equipment, factory installed and wired.

4 Metering Instrument Transformer Cabinet

4.1 Sheet steel CSA enclosure to accommodate potential and current transformers.

5 Test Terminal Blocks

5.1 Test terminal blocks: as required.

6 Metering Transducers, Converters

6.1 Indicating Instruments

6.1.1 Digital indicating instruments: to ANSI C39.1, 1% accuracy, switchboard mounting.

6.1.1.1 Ammeter: true RMS.

6.1.1.2 Voltmeter: true RMS.

6.1.1.3 Wattmeter: range as indicated.

6.1.1.4 Varmeter: range as indicated.

6.1.1.5 Frequency meter: range as indicated.

6.1.1.6 Power factor meter: range as indicated.

6.1.1.7 Synchroscope: range as indicated.

26 09 23 LIGHTING CONTROL

1 Relay Panel Option

1.1 A low voltage relay lighting control system shall be utilized to control all indoor lighting.

1.2 A low voltage relay system shall be utilized to control all outdoor lighting (if applicable).

1.3 The indoor lighting control system shall have components from the same lighting controls manufacturer to form one system.

1.4 The outdoor lighting control system shall have components from the same lighting controls manufacturer to form one system.

1.5 Each individual private office, storage room, meeting room or other enclosed space shall have an occupancy sensor. Individual, dedicated relays in the relay panel serving only one room are unnecessary.

1.6 The lighting control system shall have an astronomical time clock, capable of switching on and off building lighting according to a defined schedule.

1.7 The lighting control system shall have an override switch in a centrally located area to switch lighting on after hours.

1.8 The lighting Control installations and retrofit shall be separated from the Building Automation System except integration on the field level (When occupancy sensors can be utilized for controlling the light and HVAC. No interface integration is needed), integration between Lighting Control and Building Automation System (BAS) shall be approved by IO.

1.9 The lighting control system must have the ability to operate as a separate stand-alone system or through command from the Building Automation System (BAS).

1.10 The lighting control system shall be computer processor based and shall be Web/IP enabled to allow for web access to system configuration without the need for additional special software.

1.11 The lighting control system software must be password protected.

1.12 Lighting control devices (switches, sensors) may be either wired or wireless detectors.

1.13 All wireless detectors (switches, sensors) must be complete with a 5 year battery that is easily replaceable at end of life.

1.13.1 Passive infrared (PIR) and/or dual technology (PIR and ultrasonic) ceiling mounted occupancy/vacancy sensors in open plan office areas as per manufacturer's recommendations;

1.13.2 Ceiling mounted ultrasonic occupancy sensors in washrooms;

1.13.3 Time switches in all mechanical, electrical & communication rooms;

1.13.4 Dual technology ceiling mounted occupancy sensors in public corridors and dual technology ceiling mounted vacancy sensors in storage rooms.

1.14 Daylight harvesting zones shall be defined in two zones along each perimeter window area. Lighting in these areas shall be controlled separately to maximize the benefit of the available natural light.

1.15 All daylight harvesting zones shall have a dedicated daylight sensor.

1.16 All luminaires within the defined daylight harvesting zone shall be step-dimmed with the light output intervals.

1.17 All luminaires within the defined daylight harvesting zone shall have adjustable time delay for step dimming such that changes in daylight availability result in gradual changes to the electric lighting level. The passing of clouds on the exterior shall not create spikes and dips in the lighting level.

1.18 All meeting rooms, conference rooms, board rooms, and rooms with A/V equipment shall have luminaires continuously dimmable from 100% down to 1%. These rooms shall have dimming control located in an accessible location.

1.19 All enclosed rooms shall have wall-mounted vacancy sensors and switches (combined or standalone)

1.20 The lighting control manufacturer shall provide products listed, classified, and labeled by either Canadian Standards Association (CSA) or Underwriter's Laboratories of Canada (ULC).

1.21 The lighting control manufacturer shall be a nationally recognized company specializing in lighting controls. This organization shall maintain a service organization within 100 kilometers of the project location. The manufacturer and service organization shall have a minimum of 10 years' experience in the controls industry, and be accessible via toll free telephone number 24/7.

2 Digital Addressable Option

2.1 A low voltage digital addressable system shall be utilized to control all indoor lighting.

2.2 Use Digital Addressable Lighting Interface (DALI) network consisting of a controller and one or more lighting devices (e.g., electrical ballasts and dimmers) that have DALI interfaces. The controller must be able to monitor and control each light by means of bi-directional data exchange.

2.3 A low voltage relay system may be utilized to control all outdoor lighting zones (if applicable).

2.4 Both the indoor and outdoor lighting control system shall have components from the same lighting controls manufacturer to form one system.

2.5 Each internal luminaire in tenancy areas shall be digital addressable (digital ballast, digital driver, or digital control module). Digital address shall allow for virtual zoning of luminaires, flexibility in the switching and control of luminaires from 0% to 100%, and shall be expandable to suit future tenancy sub-division/compartmentalization of the open plan areas.

2.6 The lighting control system shall have an astronomical time clock, capable of switching on and off building lighting according to a defined schedule.

2.7 The lighting Control installations and retrofit shall be separated from the Building Automation System except integration on the field level (When occupancy sensors can be utilized for controlling the light and HVAC. No interface integration is needed), integration between Lighting Control and Building Automation System (BAS) shall be approved by IO.

2.8 The lighting control system must have the ability to operate as a separate stand-alone system or through command from the Building Automation System (BAS).

2.9 The lighting control system shall be computer processor based and shall be Web/IP enabled to allow for web access to system configuration without the need for additional special software.

2.10 The lighting control system software must be password protected, with the ability to set tiered access to different user groups.

2.11 The lighting control system shall provide an energy monitoring function for real-time lighting energy usage.

2.12 The lighting control software shall be able to output the real-time power consumption of the lighting system on a graphical display.

2.13 Lighting control devices (switches, sensors) may be either wired or wireless detectors.

2.14 All devices shall be digital addressable and programmable.

2.15 All wireless detectors (switches, sensors) must be complete with a 5 year battery that is easily replaceable at end of life.

2.15.1 Passive infrared (PIR) and/or dual technology (PIR and ultrasonic) ceiling mounted occupancy/vacancy sensors in open plan office areas;

2.15.2 Ceiling mounted ultrasonic occupancy sensors in washrooms;

2.15.3 Time switches in all mechanical, electrical & communication rooms;

2.15.4 Dual technology ceiling mounted occupancy sensors in public corridors and dual technology ceiling mounted vacancy sensors in storage rooms.

2.16 Daylight harvesting zones shall be defined in two zones along each perimeter window area. Lighting in these areas shall be controlled separately to maximize the benefit of the available natural light.

2.17 All daylight harvesting zones shall have a dedicated daylight sensor.

2.18 All luminaires within the defined daylight harvesting zone shall be continuously dimmable from 100% down to 10%.

2.19 All luminaires within the defined daylight harvesting zone shall have adjustable time delay for dimming such that changes in daylight availability result in gradual changes to the electric lighting level. The passing of clouds on the exterior shall not create spikes and dips in the lighting level.

2.20 All meeting rooms, conference rooms, board rooms, and rooms with A/V equipment shall have luminaires continuously dimmable from 100% down to 1%. These rooms shall have dimming control located in an accessible location.

2.21 All enclosed rooms shall have wall-mounted or ceiling mounted vacancy sensors and switches. (combined or standalone)

2.22 Each tenant space shall be controlled via an intelligent lighting control processor. Each lighting control processor shall be web enabled to allow for tenant access, management and modification of the lighting and lighting control system within their tenancy area.

2.23 The lighting control manufacturer shall provide products listed, classified, and labeled by Canadian Standards Association (CSA) or Underwriter's Laboratories of Canada (ULC).

2.24 The lighting control manufacturer shall be a nationally recognized company specializing in lighting controls. This organization shall maintain a service organization within 100 kilometers of the project location. The manufacturer and service organization shall have a minimum of 10 years' experience in the controls industry, and be accessible via toll free telephone number 24/7.

3 Software including Licensing

3.1 All OEM software licenses must be assigned to Infrastructure Ontario.

26 10 00 MEDIUM-VOLTAGE ELECTRICAL DISTRIBUTION

26 31 00 PHOTOVOLTAIC POWER SYSTEM

1 Necessary Approval

1.1 Coordinate with local utility for interconnection approval.

1.2 Make sure you provide Infrastructure Ontario's approval in writing for each separate connection.

2 Building Structural approval

2.1 A Structural Engineer shall verify that the building structure shall accommodate the additional loads imposed by the array. Other loads, such as wind and snow loads, shall also be considered.

3 Products – General

3.1 The design of any photovoltaic system shall meet the highest available performance and power conversion rates readily available on the market at the time of design. Evaluation of new technology is encouraged.

4 PV Modules

4.1 PV modules shall have a minimum 25-year pro-rated power performance warranty and a minimum 2-year product warranty for defects in material and workmanship.

5 Monitoring Equipment

5.1 The monitoring systems shall provide access to operational and performance data of the Photovoltaic system via web-based interface, Monitoring Equipment shall be able to communicate the following via Open BACnet protocol and shall record and display at minimum:

5.1.1 Array voltage - VDC (V)

5.1.2 Grid voltage - VAC (V)

5.1.3 Array current - IDC (A)

5.1.4 Grid current - AC (A)

5.1.5 Array power - PDC (W)

5.1.6 Grid power - PAC (W)

26 32 00 PACKAGED GENERATOR ASSEMBLIES - DIESEL

1 General

1.1 All generator assemblies must include the following Systems. All these systems must be tied into the existing installations, ancillary equipment and coordinated electrically for functionality.

1.1.1 A load bank rated to 100% of the generator load and adjustable.

1.1.2 The ability to safely access all maintenance hatches in all weather conditions (access platforms).

1.1.3 A battery charger that is remotely monitored and alarmed.

1.1.4 A minimum of 48-72 hrs of fuel storage.

1.1.5 A monitored and alarmed pump controller if one is needed.

1.1.6 A fresh air damper louver by-pass switch.

1.1.7 An additional generator hookup for emergencies.

1.1.8 A block heater for the engine and the oil system.

1.1.9 A local space heating.

2 Generator Set Controller

2.1 The generator set shall be provided with a microprocessor-based controller that is designed to provide automatic starting, monitoring, and control functions for the generator set. The controller shall also be designed to allow local monitoring and control of the generator set and remote monitoring. All available output points must be BACnet compatible.

2.2 The annunciator shall include the following alarm labels and audible annunciation features:

Condition	**Audible Alarm**
Normal Power (to Loads)	No
Genset Supplying Loads	No
Genset Running	No
Not in Auto	Yes
High Battery Voltage	Yes
Low Battery Voltage	Yes
Charger AC Failure	Yes
Fail to Start	Yes
Low Engine Temperature	Yes
Pre-High Engine Temperature	Yes
High Engine Temperature	Yes
Pre-Low Oil Pressure	Yes
Overspeed	Yes
Low Oil Pressure	Yes
Low Coolant Level	Yes
Low Fuel Level	Yes
(4) Spares	Configurable

3 Permanent Load Bank

3.1 Provide cost analysis to perform annual load test.

26 36 00 TRANSFER SWITCHES

1 Additional Features

1.1 A three (3) position momentary-type test switch shall be provided for the test/automatic/reset modes. A two position maintained contact switch for manual/engine start.

1.1.1 Test position - Normal power failure simulated. Engine starts and transfer takes place. Return switch to "Auto" to stop engine.

1.1.2 Auto position - Normal operation of transfer switch on failure of normal power; retransfer on return of normal voltage and shuts down engine.

1.1.3 Manual position - Transfer switch may be operated by manual handle but transfer switch will not operate automatically and engine will not start.

1.1.4 Engine start position - Engine starts but unit will not transfer unless normal power supply fails. Switch must be returned to "Auto" to stop engine.

1.2 The following features shall be built-in to the controller, but capable of being activate through keypad programming or the serial port only when required by the user.

1.3 A set of DPDT gold-flashed contacts rated 10 amps, 32 VDC shall be provided for a low-voltage engine start signal. The start signal shall prevent dry cranking of the engine by requiring the generator set to reach proper output, and run for the duration of the cool down setting, regardless of whether the normal source restores before the load is transferred.

1.4 Quantity of four (4) Auxiliary contacts, rated 10 amps, 250 VAC shall be provided consisting of one contact, closed when the ATS is connected to the normal source and one contact closed, when the ATS is connected to the emergency source.

1.5 LED indicating lights (16 mm industrial grade, type 12) shall be provided; one to indicate when the ATS is connected to the normal source (green) and one to indicate when the ATS is connected to the emergency source (red).

1.6 LED indicating lights (16 mm industrial grade, type 12) shall be provided and energized by controller outputs. The lights shall provide true source availability of the normal and emergency sources, as determined by the voltage sensing trip and reset settings for each source.

1.7 Provide the ability to select “commit/no commit to transfer” to determine whether the load should be transferred to the emergency generator if the normal source restores before the generator is ready to accept the load.

1.8 Terminals shall be provided for a remote contact which opens to signal the ATS to transfer to emergency and for remote contacts which open to inhibit transfer to emergency and/or retransfer to normal. Both of these inhibit signals can be activated through the keypad or serial port.

1.9 An in-phase monitor shall be provided in the controller. The monitor shall control transfer so that motor load inrush currents do not exceed normal starting currents do not exceed normal starting currents, and shall not require external control of power sources. The in-phase monitor shall be specifically designed for and be the product of the ATS manufacturer.

1.10 The controller shall be capable of accepting a normally open contact that will allow the transfer switch to function in a non-automatic mode using an external control device.

1.11 Engine Exerciser – The controller shall provide an internal engine exerciser. The engine exerciser shall allow the user to program up to seven different exercise routines. For each routine, the user shall be able to:

1.11.1 Enable or disable the routine.

1.11.2 Engine or disable transfer of the load during routine.

1.11.3 Set the start time:

1.11.3.1 Time of day.

1.11.3.2 Day of week.

1.11.3.3 Week of month (1st, 2nd, 3rd, 4th, alternate or every).

1.11.3.4 Set the duration of the run.

1.11.3.5 At the end of the specified duration the switch shall transfer the load back to normal and run the generator for the specified cool down period. A ten (10)-year life battery that supplies power to the real time clock in the event of a power loss will maintain all time and date information.

1.12 System Status – the controller LCD display shall include a "System Status" screen which shall be readily accessible from any point in the menu by depressing the "ESC" key a maximum of two times. This screen shall display a clear description of the active operating sequence and switch position. For example:

1.12.1 Normal Failed

1.12.2 Load on Normal

1.12.3 TD Normal to Emergency

1.12.4 2min 15s. Controllers that require multiple screens to determine system status or display "coded" system status messages, which must be explained by references in the operator's manual, are not permissible.

1.13 Self-Diagnostics – The controller shall contain a diagnostic screen for the purpose of detecting system errors. This screen shall provide information on the status input signals to the controller which may be preventing load transfer commands from being completed.

1.14 Data Logging – The controller shall have the ability to log data and to maintain the last ninety-nine (99) events, even in the event of total power loss. The following events shall be time and date stamped and maintained in a non-volatile memory:

1.14.1 Event Logging:

1.14.1.1 Data and time and reason for transfer to normal to emergency.

1.14.1.2 Data and time and reason for transfer emergency to normal.

1.14.1.3 Data and time and reason for engine start.

1.14.1.4 Data and time engine stopped.

1.14.1.5 Data and time emergency source available.

1.14.1.6 Data and time emergency source not available.

1.14.2 Statistical Data:

1.14.2.1 Total number of transfers.

1.14.2.2 Total number of transfers due to source failure.

1.14.2.3 Total number of days the controller is energized.

1.14.2.4 Total number of hours both normal and emergency sources are available.

26 40 00 ELECTRICAL PROTECTION

26 50 00 LIGHTING

1 Ballasts

1.1 General

1.1.1 Submit manufacturer's technical data for ballasts which are specified to be installed in specified fixtures. Data shall include:

1.1.1.1 Operating watts

1.1.1.2 Input voltage

1.1.1.3 Starting method (Instant or Programmed)

1.1.1.4 Ballast factor

1.1.1.5 Power factor

1.1.1.6 Total Harmonic Distortion

1.1.1.7 Temperature range for operation

1.1.1.8 Lamp ballast compatibility

1.1.1.9 In rush current

2 Technical Requirements

2.1 All ballasts shall meet or exceed latest requirements of the Certified Ballast Manufacturers Association (CBM) manufacturers, and all ANSI requirements.

2.2 All ballasts shall contain dynamic end-of-lamp-life sensing circuitry to protect against overheated bases and sockets.

2.3 Ballast shall operate lamps at a frequency above 42 kHz and lamps shall have no detectable flicker.

2.4 Ballast shall operate from 60 Hz input source with transient variation of +/- 10% nominal ballast line voltage without damage to the ballast.

2.5 All 120V or 347V ballasts shall come with a quick disconnecting device at the ballast.

2.6 Ballast shall have input power factor above >98%.

2.7 Ballast shall have Total Harmonic Distortion of less than <10%.

2.8 Ballast shall have third order harmonic of less than <15%.

2.9 Ballast shall provide lamp starting conditions and operating parameters consistent with lamp manufacturer's recommendations.

2.10 Ballast shall be instant start in non-switched areas of the building (corridors) and shall be programmed start or dimming models in areas with occupancy sensors.

2.11 Instant start models shall operate lamps in parallel, such that if one lamp fails, other lamps will remain lit. Programmed start models shall also operate lamps in parallel.

2.12 Ballasts that operate lamps in series wiring are not permitted, with exception to dimming ballasts.

2.13 Except as noted in below, Ballasts shall provide a minimum start temp of: 0°C for instant start models, 0°C for programmed start models, 0°C for other models, 16°C for Energy Saving T8 lamps.

2.14 Ballasts intended for usage in non-heated areas of the building such as parking garages or warehouse areas shall have a minimum start temp of: -29°C or lower, depending on location in the province.

2.15 Ballast shall have remote/tandem wiring capability of up to 18 feet maximum between lamps and ballast.

2.16 Except as noted in below, Ballast shall have a maximum enclosure temperature rating of 70°C.

2.17 Ballasts intended for usage in unventilated high ceiling areas shall have a maximum enclosure temperature rating of 90°C.

2.18 Ballast shall have internal electrical protection to prevent catastrophic failure.

2.19 All ballasts shall have a maximum lamp current crest factor of 1.7.

3 Electronic Ballasts

3.1 The electronic ballast shall be Underwriters Laboratories (UL) listed, Class P, Type 1. CSA or CUL or CETL certified.

3.2 Ballast shall meet FCC standard for EMI/RFI (FCC 47CFR Part 18 Non-consumer), ensuring suitability for both commercial and industrial installations.

3.3 Ballast shall comply with applicable ANSI/IEEE standards/guides for harmonic distortion and line voltage transient protection.

3.4 Ballast shall have audible noise rating of Class A+ at a minimum.

3.5 Leaded and connector style ballasts shall be color-coded to ANSI standard C82.11 (where applicable).

3.6 Ballast shall be NEMA Premium/CEE Program Compliant (for High Efficiency T8 4 Foot Series).

3.7 Where project includes a complete lamp and ballast replacement, lamp and ballast shall come from the same manufacturer.

4 Other

4.1 HID ballasts shall be auto-transformer type, constant wattage with non PCB thermally protected capacitor.

4.2 Lamp and ballast shall be covered by the lamp and ballast manufacturer system warranty program.

4.3 Covered ballasts shall carry up to 5 year warranty and include a nominal replacement labor allowance.

4.4 Covered lamps shall carry up to a 5 year warranty and will be manufactured by the same company as the ballast. (Note: no labor allowance for lamps).

4.5 Ballast manufacturer shall have been manufacturing electronic ballasts for use in the Canadian market for a minimum of ten years.

5 Lamps

5.1 Submit manufacturer's technical data for lamps which are specified to be installed in fixtures. Data shall include:

5.1.1 Operating voltage (12V, 24V, 120V, 347V)

5.1.2 Wattage

5.1.3 Initial Lumens

5.1.4 Rated Lumens

5.1.5 Rated Life (non-LED)

5.1.6 L70 Information (LED only)

5.1.7 Color temperature and color rendering index

5.1.8 R9 Information (LED only)

5.1.9 Base Type

5.1.10 Lamp Shape

5.1.11 Mercury content (fluorescent only)

5.1.12 Read lamp schedule in conjunction with luminaire schedule.

6 Manufacturer

6.1 Fluorescent lamps shall be as manufactured by a manufacturer who also provides electronic ballasts or as otherwise specifically noted.

7 Exclusions

7.1 Incandescent lamps are not permitted.

7.2 Line voltage MR-16 (GU10 Base) are not permitted.

7.3 Screw in self-ballasted compact fluorescent lamps are not permitted.

7.4 Fluorescent T12 is not permitted.

7.5 8’ long fluorescent lamps are not permitted.

7.6 HPS lamps are not permitted.

7.7 Mercury vapor lamps are not permitted.

7.8 Metal Halide lamps are not permitted.

7.9 LED Retrofit lamps are not permitted.

8 Color (CRI)

8.1 All lamps of particular type shall have the same color temperature and color rendering index (CRI) and be from the same manufacturer and produced during the same batch.

8.2 Unless noted otherwise, the following color rendering features must be provided for lamps:

8.2.1 Halogen lamps shall have a minimum CRI of 95.

8.2.2 Compact fluorescent T4 and T5 lamps shall have a minimum CRI of 85.

8.2.3 Fluorescent T8 lamps shall have a minimum CRI of 85.

8.2.4 Fluorescent T5 lamps shall have a minimum CRI of 85.

8.2.5 Fluorescent T5HO lamps shall have a minimum CRI of 85.

8.2.6 Induction lamps shall have a minimum CRI of 80.

9 Life

9.1 All halogen lamps shall be long life with a minimum rated life of 4,000 hours (except as otherwise noted.)

9.2 Compact fluorescent a minimum of 12,000 hours.

9.3 Fluorescent a minimum of 40,000 hours.

9.4 Induction lamps a minimum of 60,000 hours.

9.5 LED complete fixtures a minimum of 50,000 hours.

9.6 All lamps provided on the site shall be new.

10 Minimum Lamp Efficacy

10.1 Halogen a minimum of 15 lumens/watt.

10.2 Compact fluorescent a minimum of 65 lumens/watt.

10.3 Fluorescent a minimum of 90 lumens/watt.

10.4 Induction lamp a minimum of 80 lumens/watt.

11 Special Considerations

11.1 Halogen lamps

11.1.1 Shall not be handled with bare hands and must be cleaned thoroughly with alcohol after installation and before use.

11.2 Fluorescent lamps (including compact fluorescent)

11.2.1 All lamps to be used with a dimming system shall come pre-seasoned by the lamp manufacturer for a minimum of 100 hours.

11.2.2 All lamps intended to be used in partial or unconditioned spaces shall be complete with amalgam technology.

11.2.3 All energy saving lamps shall be complete with compatible ballast that features striation control.

11.2.4 Shall have a mercury content of no greater than 70 pictograms per rated life (hours) of the lamp for new construction and no more than 90 pictograms per rated life hours of the lamp for existing building retrofits.

12 Installation

12.1 Replace all lamps with new if there is any rapid deterioration of lamps which the Consultant views as excessive in terms of the project warranty, replace at no cost to the Owner.

12.2 Replace all lamps with a noticeable color shift which does not correlate to manufacturer's published data.

13 Lenses

13.1 All fixtures shall be complete with integral lenses specified.

14 Interior Lighting

14.1 The lighting design shall generally follow the recommendations for good lighting practice as set out by the Illuminating Engineering Society of North America (IESNA) and Recommended Practice for Office Lighting IESNA/ANSI RP-1-12.

14.2 Lighting systems used shall be energy efficient in nature and by design.

14.3 The lighting design shall generally consist of the following:

14.3.1 Office Areas: design illuminance of 300-350lux (30-35fc) on the working plane. Office area lighting shall be lensed, linear fixtures with either T8 fluorescent or LED light sources. Fixture shall be selected to best coordinate with ceiling modules and diffusers.

14.3.2 Circulation Areas: design illuminance of 100-150lux (10-15fc) provided for by a combination of surface mounted fluorescent luminaires, custom pendant luminaries, recessed direct luminaries and/or indirect concealed luminaires.

14.3.3 Core Facilities: design illuminance provided for by recessed compact fluorescent or LED downlights.

14.3.4 Parking area: design illuminance of 100lux (10fc) as provided for by surface mounted fluorescent luminaires or LED sources. Lighting levels in the parking area shall also meet the requirements of the Local Municipal Code.

14.4 All linear fluorescents shall be T8 with a color temperature of 3500K, a minimum color rendering index of 85 and shall have long life (40,000 hour) lamps. Lamps shall also be of low-mercury type, to comply with Toxic Characteristics Leaching Procedure (TCLP) chemical analysis requirements.

14.5 All luminaire ballasts shall be electronic energy saving ballasts. Ballasts shall have a Total Harmonic Distortion (THD) of 10% or less and shall be high frequency.

14.6 Luminaires shall be glare-free.

14.7 Linear fluorescent lighting or linear LED shall be provided in coves above washroom vanities.

14.8 All task lighting shall be LED.

14.9 All lighting intended to be installed in areas which contain flammable gas or vapors or the presence of combustible dust shall be explosion proof rated.

14.10 All lighting intended to be installed in high abuse areas shall be vandal resistant and accompanied by a life time warranty by the luminaire manufacturer.

15 Emergency Lighting

15.1 Follow the most recent version on Ontario Building Code.

16 Exit Signs

16.1 Follow the most recent version on Ontario Building Code.

17 Exterior Lighting

17.1 All exterior lighting sources shall be LED.

17.2 The external lighting system shall be designed in accordance with IESNA recommendations and shall be classified as per the Sustainability Consultant.

17.3 Full cut-off luminaires with LED lamp sources shall be used for the exterior building lighting system. The exterior lighting shall be controlled by photocell, time clocks and the internal lighting control system.

INFRASTRUCTURE ONTARIO

2017 BUILDING SYSTEMS COMMISSIONING GUIDELINE – PMSP

This document is intended for use by:

Ministry and Infrastructure Ontario Program Planners
Infrastructure Ontario Senior Project Managers and Project Services Managers
Property Land Management Service Provider
Project Management Service Providers
Vendors including Design Consultants
Commissioning Authorities and Contractors

TABLE OF CONTENTS

1. ABOUT THIS GUIDELINE

The purpose of this guideline is to set out the commissioning process for new buildings, systems and equipment installed by IO's Project Management Service Providers (PMSP) and Property and Land Management Services Providers (PLMSP) operating under the Master Services Agreement between IO and each PMSP and PLMSP. The guideline describes the minimum requirements and limitations of the required commissioning services for projects delivered by PMSPs or PLMPS through the planning, execution and close out phases of the work. It is bound by the relevant articles in the MSA, which requires the PMSP to provide acceptable and appropriate commissioning of operating systems and equipment as a part of the services.

The intent of this guideline is to ensure building equipment performs as specified and originally intended as per IO Design Guidelines, installation of equipment meets contract specifications, the commissioning of building systems/equipment, sequence of operations have been verified to on site conditions, and the total performance/integration of new equipment/systems are fully commissioned.

Studies must identify existing building conditions and identify available options based on performance, efficient operation, operating, and capital costs. The options identified in the study shall include Life Cycle Cost Analysis, payback, implementation and preventive maintenance costs, energy savings, and return on investment up to a 25 year period, with a full integration with this guide.

Design solutions are to be based on the studies and confirmed by the Design Engineer. The design engineer is responsible for the overall design and performance and integration of building systems to ensure that they are specified, installed, commissioned and equipment is operating within their design including the requirements of the bid documents, with a full integration with this guide.

Building systems installations are to ensure that the contractor has supplied and installed the equipment and is operating as originally specified and intended to operate. The contractor and consultant are to ensure that final sequence of operations are completed and adjusted throughout the commissioning and warranty process as required.

References are made to ASHRAE Commissioning Guideline 0 in various sections, but IO Commissioning Guideline does not reiterate those procedures that are very familiar to the design and construction industry. It is more heavily focused on the initiation and outcomes of commissioning specific to IO's projects, than the commissioning process. Any definitions that differ from ASHRAE definitions are acknowledged.

In this guideline, the traditional ASHRAE term "Owner" is sometimes represented by the term "stakeholder". Projects undertaken by PMSP will have multiple stakeholders each of who have specific "owner" interests to be verified through the commissioning process.

2. DEFINITION

This guideline uses definitions included in ASHRAE Commissioning Guideline 0, the PMSP MSA, the IO Design Guideline, the IO Sustainability Standards, and other IO contractual documents. Additional information regarding the Project Delivery processes described below is found in the Asset Management Project Delivery Methodology matrices and process maps.

Asset Management: IO's business unit responsible for management of the portfolio of government owned and leased properties through the services of the PLMSP. Asset Management also oversees project delivery undertaken by the Project Management Service Provider(s).

Building Systems: The dynamic operating systems in a building that will be subject to the commissioning process, including but not limited to: HVAC, automation, refrigeration, plumbing, power and lighting, life safety, fire protection, vertical transportation, site services, communication and signal, audio visual, security, food preparation and storage, and other specialized systems. In this guideline, Building Systems includes specialized equipment or systems included in the construction that may be provided for customer programs, such as security systems, CCTV, uninterruptible power supplies and computer room cooling systems. The building envelope including roofing assembly (while not a dynamic system) is also considered a building system for the purposes of this guideline.

Checklists: Verification checklists that are developed and used during all phases of the commissioning process to verify that the owners project requirements are being achieved. This includes checklists for general verification, plus testing, training and other specific requirements.

CMMS (Computerized Maintenance Management System) Asset Update Forms: a tabular process to record specific data on every piece of building equipment that is added, changed, removed or replaced within the scope of the project, to be included in the project O&M manuals, and deliver to the PLMSP CMMS database for inventory and lifecycle maintenance management.

Commissioning (Process): a quality assurance oriented process that ensures the building systems and assemblies perform interactively according to the design document, and that the stakeholders' objectives and operational criteria are achieved through a process of planning, testing, verifying, and documenting the performance of the facilities as it is constructed, and where necessary through seasonal commissioning after occupancy.

Commissioning Authority: an individual or firm identified by the PMSP who will lead, plan, and schedule and coordinate the activities to implement the commissioning process. The commissioning authority may be the project design consultants for lower complexity projects, or another specialist retained by the PMSP. This definition reflects IO's model and may be slightly at variance from the ASHRAE definition. See also: Independent Commissioning Authority.

Commissioning Plan: a document prepared by the commissioning authority to set out the organization, schedule, specifications, and documentation requirements of the Commissioning Process for inclusion in tender documents as a draft, with fine tuning of plan when shop drawings are received

Commissioning Reports: functional performance verification reports, test data records, performance reports etc that record the commissioning results for every item of equipment, assembly, or entire system as described in the commissioning plan.

Commissioning Verification Forms: an IO template to record the completion of commissioning work that is documented in detail in the commissioning reports

Commissioning Issues Log: a formal and ongoing record of problems or concerns, and their resolutions, during the course of the Commissioning Process, and included in the Final Commissioning Report.

Contractor commissioning: commissioning activities on non-complex projects carried out by the contractor following a basic commissioning plan, but not necessarily needing a commissioning authority.

Design Review - Commissioning: a review of the design documents to determine compliance with the Owner's Project Requirements, including coordination between systems and assemblies being commissioned, features and access for testing, commissioning and maintenance, and other reviews required by the commissioning plan.

Independent Commissioning Authority: a commissioning specialist who is independent of the design team engaged by the PMSP who leads, plans, and schedules and coordinates the commissioning team to implement the

commissioning process for complex or LEED projects. This term "independent" reflects IO's model and may be slightly at variance from the ASHRAE definition.

Ministry Scope Definition Document: a checklist used by the Ministry to identify in scope requirements of a project. It is submitted as an attachment to the Project Services Initiation form.

Operations and Maintenance (O&M) Manual "Schedule B": systems-focused composite document of use to the building operator and owner during the occupancy and operation phase, which includes the owner's requirements, operating manual, maintenance manual and additional information such as warranties. Each O&M manual shall include an electronic copy in searchable PDF format of the manual on a USB drive in the back of the manual.

Owner: the various project stakeholders, being IO, its PLMS, and its customer ministries, each of which may have program specific requirements and deliverables that may vary between building types and regions.

Owner's Project Requirements (OPR): The IO Design Guideline, a document that details the scope of the project and the expectations of how it will be used and operated. For IO projects, the OPR is:

- PJ (project justification document) for the project.
- Attachments to the project PJ
- Charter for project as agreed with owner

Post Occupancy Commissioning: the detailed calibration of the systems and equipment designed to control the indoor environment, through a full cycle of four seasons (usually 12 months or longer, commencing from the date of Substantial Performance), to maximize the building efficiency and occupant comfort.

Project Bid Documents: a collection of written documents including bid information and forms, contract forms and conditions, and drawings, specifications and schedules, the combination of which provides all particulars required to complete the construction project, including commissioning specifications for each trade.

Project Charter: the IO form used to confirm the client/stakeholders' scope, schedule, budget and other delivery considerations in the initiation stage of a project or study

Project Management Service Providers (PMSP): an entity engaged by IO to provide all services required to deliver projects in accordance with the MSA. In this Guideline the term "PMSP" means any employee of the PMSP team.

Project Justification Form (PJF): a form prepared by IO, or its PLMSP to identify scope and funding requirements related to upcoming capital repairs and replacements.

Project Services Initiation Form (PSIF): the form prepared by customer ministries to authorize funding and request initiation of a customer funded project.

Project Service Manager (PSM): the IO project manager (IO Representative) who oversees the PMSP's activities at a regional level, to ensure delivery of projects to meet owner's needs.

Project Delivery Methodology: the business process designed in accordance with PMI principles that prescribe each discrete element and sub element for delivery of a design and construction or study project to be delivered by PMSPs. The elements are organized in phases described as "Initiation, Planning, Execution and Close Out".

Startup Checklist: the record of the initial starting or activating of systems and equipment, including completion of construction checklists.

Scope of Work: means the description of the project scope as approved by the client through the project charter.

Training Plan: a written document that details the expectations, schedules, budget and deliverables of commissioning process activities, related to training of project operating and maintenance personnel, users and occupants.

Verification: the process by which specific components, equipment, assemblies, systems, and interfaces among systems are confirmed to comply with the criteria described in the Bid documents and the project requirements. Verification onsite will include at least 10% of input/output devices including terminal units such as VAV boxes, 100% of supply and generating systems, along with testing of 100% of sequences of operation.

3. INTRODUCTION

3.1 PREAMBLE

Traditionally, the term "commissioning" generally means testing and acceptance of only individual components and systems of newly constructed facilities such as the HVAC systems, elevators, electrical and life safety systems. Today, with increasing concerns of meeting energy targets, emphasis on the green environment, increased complexity of building systems, equipment, assemblies, new materials, and the impact on the environment and sustainability, there is a renewed emphasis on commissioning as an important part of ensuring sustainability targets are met in new construction, and also through the operating life cycle of our buildings. In this context, commissioning will sometimes extend to static elements of buildings such as building envelope (doors, windows, and cladding and roof systems) which are a key part of overall building performance.

IO has many commitments to sustainability established through assessment and target exercises, and companywide targets. In 2008, IO established sustainability objectives that are now embedded in its corporate goals, including reducing electrical demand, increasing waste diversion, extended certification of buildings, and responding to a sustainability framework. In 2007, the Government adopted the LEED framework as the standard for all new Ontario Government buildings that meet established criteria. Commissioning by a third party is a mandatory component of LEED certification. The Government is expected to direct (within parameters described later), that new buildings and major building retrofits will be designed to achieve LEED silver as a base level certification. Within the certification, there will be mandatory LEED credits related to re-commissioning procedures to maintain the LEED levels of operational performance throughout the lifecycle of the building.

IO projects delivered by PMSPs by nature are "situational", meaning that the commissioning requirements for each project will vary according to the project scope, cost, complexity, and various other project specific factors. For this reason these guidelines are scalable for various project sizes and types, and can be adjusted at the project charter stages by default and exception mechanisms, as mentioned in the **IO Design Guideline.**

3.2 SCOPE

The intended audience for this guideline includes:

- Ministry and IO Program Planners
- Property Land Management Service Provider (PLMSP)
- Project Management Service Providers (PMSPs)
- Commissioning Authorities, Consultants and Contractors (if no Consultant engagement), and
- Project Services Managers (PSMs)

Supplementary technical guidelines for any given system or assembly are not included, but may be developed later by IO if required to provide specific information on specialized systems. When using this guideline, the user should always check the PMO Web portal to ensure they have the most current version.

This guideline is organized around the project management principles established by the Project Management Institute (PMI), being the framework for the business processes in the Project Services business model, and embedded in the articles of the Master Services Agreement. It includes principles from the ASHRAE Commissioning Guideline 0 "The Commissioning Process".

This guideline describes the application of the Commissioning process for the entire project life cycle beginning with project identification in the Program Planning phase followed by the Initiation, Planning, Execution, and Close Out phases as summarized below:

- **Program Planning and Project Identification Phase** identifies the Owner's Project Requirements and commissioning requirements including the identification of specific CMMS forms.
- **Initiation Phase** describes the intended commissioning process as established by IO in the project charter.

- **Planning Phase** The Commissioning Authority sets out the commissioning requirements, including the equipment specific CMMS forms for existing equipment to be modified and/or removed, during the project design work.
- **Execution Phase** describes the requirements for start-up, verification, seasonal performance testing, and training during the construction stage, including post-occupancy Fine Tuning and final submission of CMMS forms for new equipment.
- **Close Out phase** describes the handover documents and requirements for post occupancy commissioning at the close out stage of the project, and re commissioning where it applies.

3.3 APPLICATION

The unique nature of any project (or program of similar projects) means that each project will require its own documentation, performance criteria, and checklists for each system or assembly to be commissioned. Throughout, references to process thresholds, codes, other guidelines and industry references should be considered as the minimum, whereas the project stakeholders have more stringent requirements, Owner Project Requirements that may modify or replace the benchmark for verifying the requirement. This includes hiring an independent commissioning authority as per schedule A & C or if requested by IO or its representatives.

3.4 GOVERNANCE

Ministry Accommodation Planners and PLMS Facility Managers are responsible for project identification and ensuring commissioning requirements comply with this guideline.

IO Staff (Director, Portfolio Real Estate Manager, Project Services Managers and Technical Services Team) is responsible for an initial definition of the commissioning deliverables in the project charter. Also, to review and approve a project charter, approve an acceptable Commissioning Plan, and oversee PMSP compliance with the approved commissioning activities

The PMSP is responsible to refine and confirm the commissioning requirements in the project charter, including all associated costs. The PMSP is responsible for preparation of a commissioning plan (via the design consultant or commissioning authority) to define roles and responsibilities in accordance with IO requirements.

4. INITIATION PHASE

4.1 OBJECTIVE

The objective in this phase is to ensure that planning for commissioning proceeds in an organized manner as per this guideline to ensure the project charter is complete and accurate, and to avoid project charter changes after approval. A properly defined project charter is the cornerstone of an effective commissioning program.

4.2 PROJECT INITIATION

In the project delivery methodology, the Initiation Phase includes all processes beginning with a request to initiate a project through a PSIF or a PJF, to where a consultant is retained by the PMSP to begin design. A key step in this phase is that the PMSP identify and confirm commissioning requirements in the project charter.

Preparation of the project charter includes a detailed project scope of work including requirements in the PSIF/PJF and any attachments to those documents. Within the project scope, the intended Commissioning approach (in respect to the specifics of the project) should be defined. Section 3 of the project charter also includes a simple check-box section to indicate (among other things) commissioning related deliverables and project specific requirements such as the need for an independent commissioning authority.

4.3 IO RESPONSIBILITIES

Project Charter: The PSM must ensure that IO Design Guideline and IO commissioning Guideline requirements are included in the Project Charter produced by the PMSP.

4.4 PMSP RESPONSIBILITIES:

At project initiation the PMSP will determine the following parameters and enter the details in the project charter. The PMSP will make any enquiries necessary to clarify the intended scope of work to determine the basic commissioning requirements:

- Is commissioning needed in this project? For most building systems, Answer should be yes.
- If no, provide a reason why it is not needed? If yes, provide a high level description of the scope of commissioning required including a list of which systems will be commissioned.
- Is this a “LEED” certified project, and what level of certification will be pursued?
- Based on the anticipated schedule and system complexity, is the post occupancy commissioning needed?

The PMSP will also select and indicate the required deliverables, and the project specific requirements related to commissioning in Section 3 of the project charter.

Commissioning Thresholds: Refer to Schedule A

Commissioning requirements for IO projects delivered by PMSPs need to be scalable to match a wide range of project types, scope, cost and complexity. Schedule A of this Guideline provides a chart of thresholds to be used to determine who will oversee the contractor’s commissioning activities. The IO Design Guideline provides the Owner Project Requirements. The decision on who will manage the commissioning, guided by schedule A, will be confirmed by all parties in the project.

It is essential that the PMSP fully understand the scope of work, in particular the work to be performed on building systems, to be able to define the high level commissioning requirements ensuring that The IO Design Guideline is followed. In Capital and Repair projects, the PJF will usually be accompanied by substantive technical information that should permit the commissioning decisions to be made with minimal additional effort. Conversely, in ministry funded projects, the information may be no more than what is included in the PSIF, which will require some investigative work by the PMSP to complete the commissioning requirements in the project charter.

Project Specific Requirements must follow the sections below

- Owner's Project Requirements (OPR) – IO Design Guideline
- Commissioning Authority – see Schedule A & C
- M&V Consultant – measurement and verification role, key in energy savings projects,
- Post Occupancy Commissioning – consider project timing, system complexity and seasonal impact on system operation such as HVAC

Complete the Project Charter

Once the level of commissioning is determined and client agreement is reached, the associated costs for commissioning must be included in the project estimate. This is a critical step because once all parties have signed off on the project charter a subsequent change will require a charter change process.

5. PLANNING PHASE

5.1 OBJECTIVE

The objective of the activities in this phase is to clearly lay out all commissioning activities in a complete and logical manner, ensuring a successful outcome to the commissioning activities to follow in the execution phase.

5.2 THE COMMISSIONING PLAN

Schedule A describes 3 thresholds of commissioning responsibilities:

- Projects where NO Design Consultant is engaged, contractor and trades are responsible for all commissioning activities (contractor commissioning)
- Projects up to $1million where the Design Consultants are the commissioning authority, as long as certified.
- Projects over $1million where the commissioning authority is a specialist that is independent of the design consultants and the PMSP.

The designer and/or commissioning authority will prepare an initial concise commissioning plan (the plan) near the completion of schematic design stage. The plan will prescribe all activities and responsibilities to be completed throughout the subsequent planning, execution and close out stages. The PSM, Asset Management staff, PLMSP and the ministry representative will review the plan and provide comments to the PMSP. As the project proceeds through the design stages, the plan will be updated to reflect the specifics of the project.

The plan will be finalized at the completion of the bid documents stage to be reviewed by IO stuff, PLMSP and the ministry representative where appropriate. Once all comments have been addressed by the designer and/or commissioning authority, the PMSP will formally accept the plan. The initial investment of time in a properly developed plan will be repaid later in the project as it will form the core of the final commissioning report.

The plan should be based upon ASHRAE Commissioning Guideline 0, and at a minimum, should include the following topics in a concise manner, of which some topics will be included in the tender documents that directly relate to the implementation stage:

- Overview of the commissioning process specific to the project including definitive listing of systems to be commissioned. A high level explanation of what commissioning entails is not needed.
- Special design/commissioning requirement for BAS related projects on sites that have a diagnostic analytic system, such as Backbone (data logger) system or any other system. The project manager or commissioning agent will need to issue a PO to the base diagnostic system vendor to eliminate gross markups by contractors. It should be noted that this system can and shall be used to verify the contractors work. The reconfiguration needs to be completed for substantial performance and then updated at final performance in case any changes were done
- Format for describing commissioning requirements in trade sections of the specifications
- Startup checklist sample as provided by recognized equipment manufacturer representative(s)
- Intended test procedures, and test data records specific to the project
- Statement of design and performance requirements including integration to existing systems and OPR.
- Detailed description of activities during the construction, substantial performance, occupancy and post occupancy stages
- Format for commissioning submittals and final documentation for verification, and performance testing
- CMMS Asset Update forms and data collection process
- Review of shop drawing submittals for compliance with design intent and bid documents.

- Procedures for situations where verification process fails to achieve design requirements
- Quality based sampling procedures for verification of design requirements having been achieved
- Issues log process, and corrective procedure
- Procedures specific to LEED certification where applicable

Commissioning Plan shall be sent to Project.Review@InfrastructureOntario.ca account

5.3 OPERATION AND MAINTENANCE MANUAL

In accordance with the MSA, the PMSP will coordinate the development of an Operations and Maintenance Manual, Schedule B of this guide. The O&M manual will be submitted in hard copy and electronic copy versions, meaning every part of the manual must be scanned into an electronic form.

The manual will be prepared by the general contractor, certified by the design team as well as the commissioning authority, and once accepted by the PMSP, submitted to the client and IO at Substantial Performance. The requirement for an O&M manual will be noted by PSM in the project charter. The manual may take several forms:

- Where the project involves significant work on building systems and the project will produce information essential to the ongoing operation of the building such as commissioning data, equipment inventories, warranties, maintenance data etc, a full scope O&M manual is required;
- Where the project involves minor change to building systems and the quantity of project information related to the ongoing operation of the facility is minor, a condensed version of the O&M manual is required. This reduced scale manual could be considered as an annex to the existing O&M manuals for the facility.

On a project specific basis, where little significant documentation will be produced to pass on to IO, the PSM may determine that an O&M manual or an annex to the manual is not required, and shall indicate that in Section 3 of the project charter.

5.4 COMMISSIONING AUTHORITY TASK AT THE DESIGN STAGE

In projects where the project design team will be the commissioning authority, IO will rely upon the professional integrity of the entire design team under the direction of the PMSP, to achieve the design intent through all design stages, in the most cost effective and environmentally responsible manner possible in compliance with this guideline.
In projects where an independent commissioning authority will be engaged, they must be hired sufficiently early in the planning phase to ensure the Owner Project Requirements are translated accurately. They will formally review the design as it evolves, confirming that it will achieve the owners' project requirements, and that the systems are arranged to permit commissioning to be implemented effectively.

5.5 BID DOCUMENTS AND COMMISSIONING PROCESS

A critical subset to the commissioning plan is the documentation of the commissioning process in the specifications portion of the bid documents. When the commissioning requirements are clearly defined in the bid documents, the contractor is contractually bound to the process, and bidders are fully informed at the tender stage. The PMSP will ensure that the format for commissioning specifications set out in the commissioning plan is accurately translated by the design team into the bid documents.

5.6 CMMS INVENTORY PROCESS

The Computerized Maintenance Management System (CMMS) is a database operated by the PLMSP that records all life cycle data logged against an item of equipment or system. This is an important feature as it permits the PLMSP to determine service and replacement intervals and carry out cost efficiency analysis. The Project Services process methodology for commissioning requires the completion of CMMS forms and handover requirements from the PMSP to the PLMSP (ioepr@cbre.com) before the substantial completion meeting

6. EXECUTION PHASE

6.1 OBJECTIVE

The overall objective during this phase is to ensure that all building systems, or in the case of smaller projects, all systems in the area of work, are integrated and function as intended and that stakeholders are trained to operate the systems correctly, and that all objectives set out in the commissioning plan are achieved at Substantial Performance.

6.2 COMMISSIONING UP TO SUBSTANTIAL PERFORMANCE

In the later stages of the construction work, systems and assemblies are installed, inspected, tested and placed into service to meet the project design requirements. The key steps in the execution phase with the participation of a commissioning authority, in order to achieve Substantial Performance, are:

- Ongoing refinement of the commissioning plan – within the limits permitted by the contractor's construction contract includes:
  - HVAC systems including air handling units, boiler, chiller or major BAS upgrade projects.
  - At least 10% of field input/output devices must be commissioned along with 100% of sequences of operation.
  - Performance and reliability run for 15 days in appropriate season. During this test period, the complete system must operate. If there is any interruption due to any fault or adjustment, the test period will restart. If this is not achievable, it will be considered seasonal commissioning
- Building Automation System (BAS) related projects with potential analytic software shall include:
  - The project will affect the open BACnet object point names that are being monitored by the diagnostic systems if any point names are added, modified or BAS system software is updated or replaced.
  - The project will include for an order issued for reconfiguration of any new or changed points on the BAS system as a result of this project. Upgrade to latest version of software is required if not already existing.
  - All points on the BAS control system used for control and monitoring, including points in any terminal units, and set points, need to be full exposed open BACnet objects on the BAS network. This is required by the IO Guidelines for all BAS systems.
- Complete set of design drawings, including incorporated red lines, shop drawings, delegated design to enable final deficiency inspection to reflect the site conditions (this might change from the final)
- Orderly startup, pre-functional, and functional performance verification of designated systems
- Correction of deficiencies, including those identified during commissioning
- Coordination and compilation of the commissioning documentation during startup, verification and performance testing stages, and completion of the CMMS verification forms for new systems installed. (Schedule D)
- Stakeholder training (Schedule G)
- Submitting and approval of O&M manuals. (Schedule B)
- Written TSSA inspection, including "PASS" certificate.
- ESA field inspection sticker including written confirmation
- Completion of activities necessary to achieve LEED certification, where applicable
- Completion of Instrument 3.2.1 T1 - Commissioning Verification Form (Schedule E)
- Completion of Instrument 3.1.4 T2 - Project Handover Checklist (Schedule H)

7. CLOSE-OUT PHASE

POST OCCUPANCY COMMISSIONING:

Post Occupancy Commissioning during the close out phase of the project begins at substantial performance and may continue through to the end of the contractual warranty/correction period. It is required where additional performance testing is needed because of seasonal changes, or varying building occupancy loads, or occasionally where all parties have agreed that substantial performance can occur before all systems have been constructed. Similarly, post occupancy commissioning in a registered LEED project may only be managed by an independent commissioning authority.

The activities of all participants in the commissioning process throughout the execution phase will generally follow the principles set out in ASHRAE Commissioning Guideline 0, other than situation-specific differences for IO projects noted herein.

The key steps to achieve this with the participation of a commissioning authority are:

- Oversight of the commissioning activities by the commissioning authority
- Witness orderly startup, verification and testing of designated systems for equipment installed during the Post Occupancy Commissioning.
- Correction of remaining deficiencies, including those identified during commissioning.
- Coordination and compilation of the commissioning documentation during the fine tuning and performance testing stages, and completion of any outstanding CMMS Asset Update forms. (Schedule D)
- Completion of any remaining stakeholder training (Schedule G)
- Submittal of remaining items for the O&M manuals(Schedule B)
- Completion of activities necessary to achieve LEED certification where applicable
- Completion of Instrument 4.1.3 T1 - Post Occupancy Commissioning Verification Form (Schedule F)
- Update of Instrument 3.1.4 T2 - Project Handover Checklist (Schedule H) – Completed earlier in Execution Phase

If the project is registered for LEED certification, in accordance with the Government directive on LEED, the O&M manuals must include a re-commissioning manual that prescribes on going testing to maintain the performance levels established for LEED certification.

The commissioning reports for post occupancy will be submitted under the cover of a “Post Occupancy Commissioning Verification Form” downloaded from the PMO Web Portal.

SCHEDULE A: COMMISSIONING FRAMEWORK – THRESHOLDS

CONTRACTOR COMMISSIONING	COMMISSIONING AUTHORITY	
General Contractor and Trades	Design Consultant(s) is the Commissioning Authority	Independent Commissioning Authority
No Design Consultant Engagement	Construction cost up to $1,000,000	Construction cost over $1,000,000

DEFAULT CONDITION Commissioning via the contractor and trades is required where no Design Consultant is needed by the project, except for BAS projects. - Every new Building System or assembly of Systems installation shall be commissioned according to this guideline. - Unless the PSM in conjunction with PLMSP and PMSP determines that commissioning is not required. - The PSM in conjunction with PLMSP and PMSP may over-ride any threshold at the project charter and decide that an independent commissioning authority is required.	**DEFAULT CONDITION** Commissioning under the direction of the project Design Consultant(s), as defined within this document, is required - Unless the PSM in conjunction with PLMSP and PMSP determines that an independent commissioning authority is required. - Unless the PSM in conjunction with PLMSP and PMSP determines that commissioning is not required.	**DEFAULT CONDITION** Commissioning under the direction of an independent commissioning authority, as defined within this document, is required - Unless the PSM in conjunction with PLMSP and PMSP may determine at project charter that commissioning by the Design Consultant will be adequate for a project where the services of an independent commissioning authority are not necessary.

SCHEDULE B: OPERATING AND MAINTENANCE MANUALS

"The PMSP shall coordinate the development of the operations and maintenance manual (O&M Manual) in a timely manner with the support of the PMSPs General Contractor and Consultant so that these documents are provided to IO at substantial performance of the contract. The PMSP shall also provide IO the validation certificate from the Consultant as proof that the O&M Manual has been reviewed and that the content included in the submission complies with the as-built acceptance criteria as defined in the specifications and contract documents. IO Project Services and property management stakeholders must be consulted and the O&M manual must be submitted to IO in order to be able to properly operate the facility before release of the certificate of substantial performance"

The O&M manual shall be submitted to the client, IO and the PLMSP in a form acceptable to IO, at least a week prior to Substantial Performance of the Project.

1.0 HOW THE MANUAL IS USED

This initial section shall be a guide to the contents, structure and layout of the manual. This section will enable the reader to comprehend the scope and purpose of the document and to identify readily where specific information can be obtained.

2.0 CONTRACTUAL AND LEGAL GUIDES

The contractual and legal records shall include:

- The name and address of the installation
- Details of ownership, leases;
- Details of local and public authority consents;
- Details of the design teams, consultants, commissioning authorities, installation contractors and associated subcontractors;
- Dates for the start of the installation, for handover (practical completion) and for the expiry of the defects liability period; (Warranty)
- Information of all guarantees affecting components, systems/plant items, together with expiry dates and names, addresses and telephone numbers of relevant contacts.

For each item of plant and equipment installed within the building and contained in the list of services covered by the O&M manual, copies of the following documents shall also be provided, where applicable:

- Test certificates;
- Manufacturers' guarantees and warranties;
- Insurance inspection reports;
- Safety and fire certificates

A clear statement shall be made in this section concerning those hazards and safety precautions of which the operators and maintainers of the installations need to be made aware. They shall include the following:

- Any known feature or operational characteristic of the equipment or systems installed which may produce a hazard;

- Any known hazards against which protection must be provided; including site specific detailed lock out/tag out requirements for all equipment installed as part of this project.
- Any mandatory requirements relating to safety;
- Any other safety requirements which should be observed;
- Any other relevant warnings

3.0 OVERALL PURPOSE

This section shall provide a general overview of the original design intent. It shall include a summary for each engineering system installed giving

- The parameters and conditions within which it has been designed to operate, including known hazards;
- The type of each service (gas, water, electricity etc) required to operate the system;
- The intended method of control

4.0 DESCRIPTION

This provides a detailed description of each engineering system installed. It shall include

- The system type (e.g. cold water supply, chilled water supply)
- System location and what it serves
- What the system depends upon in order to function;
- Design data, basic design parameters, basic assumptions made during design;
- Reasons for selecting particular plants;
- Expected service life (where applicable)
- Planned operational efficiency
- Copy of all reviewed as-built shop drawings

5.0 EQUIPMENT SCHEDULE

The type, model number and serial number of all component items within the system should be listed, together with the names of their respective manufacturers or suppliers, including copies of CMMS forms for all new equipment here.

6.0 PARTS IDENTIFICATION AND RECOMMENDED SPARES

This shall comprise a parts identification list detailing and identifying replaceable assemblies, sub-assemblies and components. It shall include suppliers' recommendations for both spares and 'running spares' (i.e. parts required for scheduled replacement due to wear or deterioration).

Items normally held in stock by a supplier, or for which a refurbishment service is available, shall be identified separately.

7.0 COMMISSIONING DATA

The results of all commissioning work and associated tests shall be provided, this shall include

- Measured data and Measurement points;
- Test equipment used;
- Calibration certificate details;

- A statement confirms that weather design requirements were achieved.

8.0 OPERATION

Instructions must be given for the safe and efficient operation, under normal, maintenance and emergency conditions, of each engineering systems installed. These will be in addition to manufactures' literature for plant items and shall include

- A recommended strategy for operation and control;
- An outline of the general operation mode;
- Control data (location, effect, object, sequence, limits of capability, modes, set points)
- Procedure and sequences for start-up, running and shut down, under both normal and emergency conditions;
- Operating procedure for stand-by plant;
- Precautions necessary to overcome known hazards;
- The means by which potentially hazardous plant may be made safe;
- Target figures for both energy consumption and energy use;
- Forms for recording plant running hours, energy consumption and the energy costs

9.0 MAINTENANCE INSTRUCTIONS

The manufacturer's recommendations and instructions for maintenance must be detailed for each item of plant and equipment installed. Clear distinction shall be made between planned tasks (preventive maintenance) and work done on corrective basis. Instructions shall be given on each of the following, as appropriate:

- The isolation and return to service of plant and equipment;
- Adjustments, calibration and testing;
- Dismantling and assembly;
- The exchange of components and assemblies;
- Dealing with hazards which may arise during maintenance;
- The nature of deterioration and defects to be looked for;
- Special tools, test equipment and ancillary services.

10.0 MAINTENANCE SCHEDULES

Maintenance schedules shall be provided for all preventive maintenance tasks identified in section 9.0. These shall be based on both manufacturers' recommendations and other authoritative sources (e.g. statutory or mandatory requirements) and shall include

- Inspections;
- Examinations and Tests;
- Adjustments and Calibrations;
- Lubrication;
- Periodic overhaul

11.0 FAULT FINDING

Procedure for the logical diagnosis and correction of faults shall be provided for critical components, equipment and systems.

12.0 LUBRICATION

A schedule of all plant requiring lubrication shall be provided together with manufacturers' recommendations on the type of lubricant and the method and frequency of application. Where the type of lubricant is identified by product name, a generic reference (e.g. CSA, ASTM standard) should be given. Information must also be provided on special requirements for the handling and storage of lubricants.

13.0 MODIFICATION INFORMATION

Modifications are authorized changes which may affect the safety, reliability, operation or maintenance of a system or any components.

Information on permitted plant or system modifications allowed for by manufacturers or system designers shall be included for each system. Space must be provided in the manual for the recording of all modifications and changes as they occur (this would initially comprise a series of appropriately headed blank pages).

14.0 DISPOSAL INSTRUCTIONS

Where relevant, information shall be provided detailing

- Any known dangers likely to arise during the disposal of specific items of plant or equipment together with the necessary precautions and safety measures;
- Methods for safely disposing of or destroying the equipment or any part thereof, including packaging, insulation and fluids;
- Sources from which further information can be obtained

15.0 NAMES AND ADDRESSES OF MANUFACTURERS

Details of all manufacturers and suppliers of equipment listed in the manual shall be provided under this heading giving name, address, telephone number, fax number, email and web address. Any additional information likely to help the building operator to make contact with or obtain advice from a manufacturer or supplier shall also be included.

Where appropriate, details of local stocking or spare parts, replaceable assemblies or complete units shall also be provided.

Details shall be arranged in alphabetical order of manufacturer or supplier name to provide a logical information retrieval procedure.

16.0 INDEX OF PLANS AND DRAWINGS

An index shall be provided of all 'as built' drawings supplied during the course of the installation work and on completion, identified by number and title.

The index shall also include a schedule of all drawings issued by manufacturers and suppliers during the course of the installation work and on completion e.g. control panel wiring diagrams.

17.0 EMERGENCY INFORMATION

An important feature of any manual is the emergency information. Located, for ease of reference, at the end of the document, this should include names, address, telephone numbers, fax numbers and emails addresses of the appropriate contacts in the event of fire, theft or burglary, and gas, electricity or water failure/leaks. It shall also list those firms or staff to contact in the event of the failure or breakdown of such plant as lifts, boilers, chillers, building automation system and pumps.

Where applicable, location of firefighting equipment, hydrants and rising mains shall be described.

Special attention shall be given to hazards particular to the building.

Depending on client policy, a note of security installations may also be included.

18.0 MANUFACTURERS LITERATURE

A complete set of all manufacturers' literature shall be provided for the plant and equipment installed, and assembled for each building services systems. (1 copy of all information including as-built drawings on a CD will be provided.)

This literature shall provide the following information:

- Manufactures literature and specifications are to be inserted in the close out documents identifying operating and design temperatures, pressures, flow rates, and differentials.
- The manufacturer and design consultants are to identify in the close out documents all preliminary sequence of operations on major components and equipment.
- Description of the product purchased;
- The cost and date of purchase;
- Performance- behavioral characteristics of the equipment in use;
- Applications- suitability for use;
- Operation and maintenance details;
- Reviewed/as-built shop drawings;
- Site map showing exact location of any meters installed;
- Calibration Certificates and expiry
- Resources of labor, plant, material and space required;
- Methods of operation and control;
- Cleaning and maintenance requirements;
- Protective measures;
- Labor safety and welfare associated with equipment;
- Public safety consideration

Where this data is not adequately provided in manufacturers' literature the author of the manual shall augment the literature as necessary.

SCHEDULE C: QUALIFICATIONS OF THE COMMISSIONING AUTHORITY

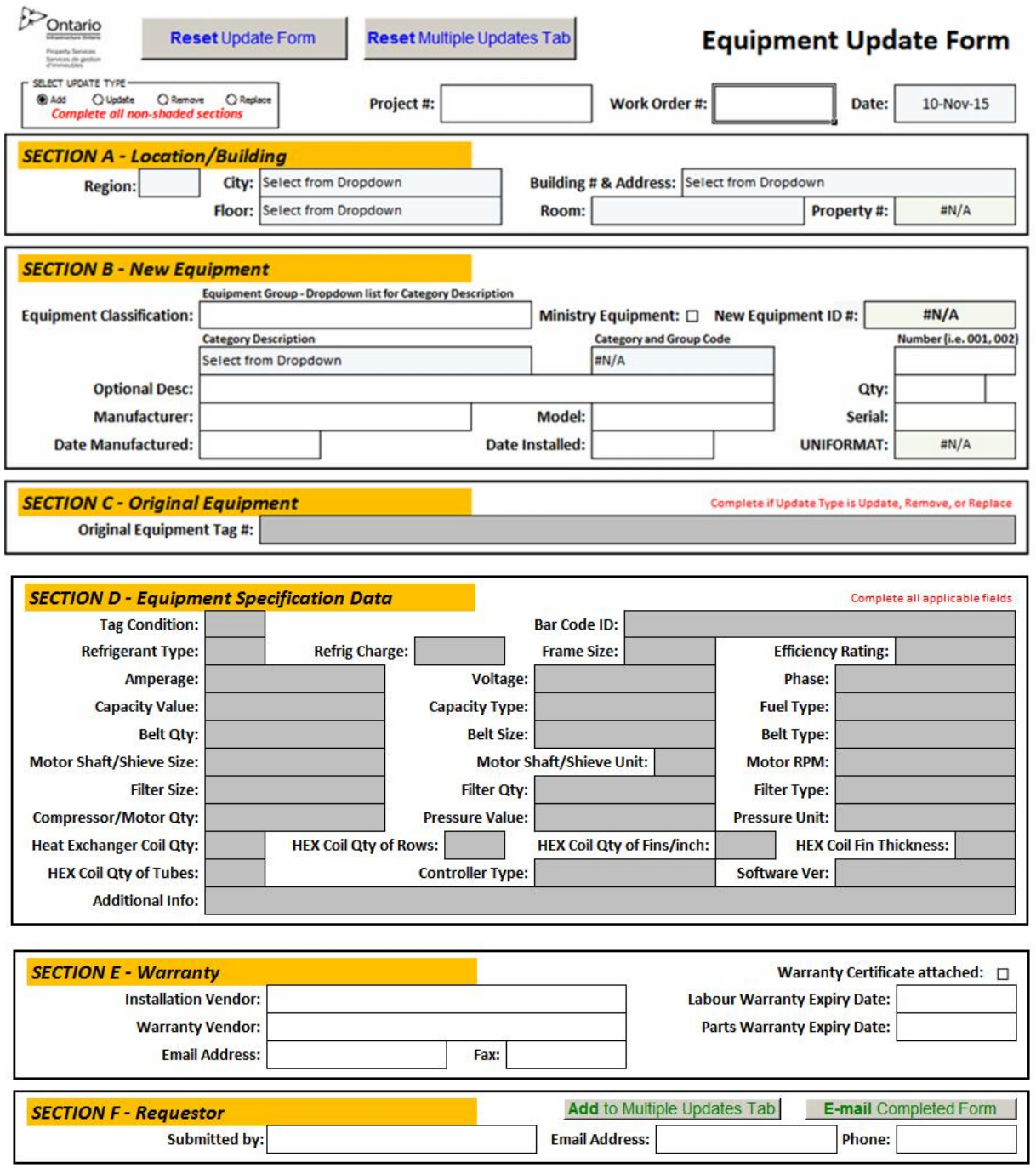
When an independent commissioning authority is required, retaining the commissioning authority is the sole responsibility of the PMSP, and IO needs to be assured that the individual/firm selected is a truly independent specialist, and will be acceptable to the CaGBC if the project is to be LEED certified.

Commissioning of the systems shall be carried out by commissioning authority in compliance to ASHRAE Guide line 0-2005 and in compliance with IO Guidelines. HVAC & R Technical Requirements for The Commissioning Process –ASHRAE Guideline 1.1-2007 or PECI published guidelines will provide guidance.

Whether commissioning is carried out by the contractor, design consultant or an independent commissioning authority, the commissioning authority used shall be certified as a commissioning professional and hold a currently valid certificate from one of the following national and/or international organizations American Society of Heating, Refrigerating & Air Conditioning Engineers Inc.(ASHRAE), Association of Air Balance Council(AABC), National Environmental Balancing Bureau (NEBB), Association of Energy Engineers (AEE), and/or Building Commissioning Association (BCA).

SCHEDULE D: COMPUTERIZED MAINTENANCE MANAGEMENT SYSTEM ASSET UPDATE FORM

The Computerized Maintenance Management System (CMMS) is a database operated by the PLMSP that records all life cycle data against a piece of equipment or system. This is an important feature as it permits the PLMSP to monitor the device against manufactures service recommendations to determine service and replacement intervals and carry out cost efficiency analysis. PMSP to ensure CMMS forms are completed and submitted by General Contractor or alternate at substantial completion.



Ontario

Reset Update Form | Reset Multiple Updates Tab

Equipment Update Form

SELECT UPDATE TYPE: (•) Add ( ) Update ( ) Remove ( ) Replace

Complete all non-shaded sections

Project #: | Work Order #: | Date: 10-Nov-15

SECTION A - Location/Building

Region: | City: Select from Dropdown | Building # & Address: Select from Dropdown

Floor: Select from Dropdown | Room: | Property #: #N/A

SECTION B - New Equipment

Equipment Group - Dropdown list for Category Description

Equipment Classification: | Ministry Equipment: ☐ | New Equipment ID #: #N/A

Category Description: Select from Dropdown | Category and Group Code: #N/A | Number (i.e. 001, 002)

Optional Desc: | Qty:

Manufacturer: | Model: | Serial:

Date Manufactured: | Date Installed: | UNIFORMAT: #N/A

SECTION C - Original Equipment

Complete if Update Type is Update, Remove, or Replace

Original Equipment Tag #:

SECTION D - Equipment Specification Data

Complete all applicable fields

Tag Condition:			Bar Code ID:		
Refrigerant Type:		Refrig Charge:	Frame Size:	Efficiency Rating:	
Amperage:		Voltage:		Phase:	
Capacity Value:		Capacity Type:		Fuel Type:	
Belt Qty:		Belt Size:		Belt Type:	
Motor Shaft/Sheive Size:		Motor Shaft/Sheive Unit:		Motor RPM:	
Filter Size:		Filter Qty:		Filter Type:	
Compressor/Motor Qty:		Pressure Value:		Pressure Unit:	
Heat Exchanger Coil Qty:		HEX Coil Qty of Rows:	HEX Coil Qty of Fins/inch:	HEX Coil Fin Thickness:	
HEX Coil Qty of Tubes:		Controller Type:		Software Ver:	
Additional Info:					

SECTION E - Warranty

Warranty Certificate attached: ☐

Installation Vendor: | Labour Warranty Expiry Date:

Warranty Vendor: | Parts Warranty Expiry Date:

Email Address: | Fax:

SECTION F - Requestor

Add to Multiple Updates Tab | E-mail Completed Form

Submitted by: | Email Address: | Phone:

SCHEDULE E: COMMISSIONING VERIFICATION FORM

Ontario
Infrastructure Ontario

Commissioning Verification Form

Ministry	PS Project #		Project Name
Portfolio ID #	Portfolio Name	Building #	Building Name

COMPONENT(S) / SYSTEM(S):

CONSULTANT/COMMISSIONING AGENT CERTIFICATION

The commissioning verification test(s) of the following equipment have been completed and performance of the component(s) / system(s) complies with the acceptance criteria in the testing of the specifications and contract documents.

Component(s) / System(s):		
	☐ Yes	☐ No
	☐ Yes	☐ No
	☐ Yes	☐ No
	☐ Yes	☐ No
	☐ Yes	☐ No

Signature: _____ Date: _____

Organization: _____

PMSP ACCEPTANCE

Signature: _____ Date: _____

Organization: _____

PLEASE PROVIDE THIS COMPLETED FORM TO IO-PS AS A PART OF THE O&M DOCUMENTATION

IO-PS Methodology Sub-Element Reference:

SUB-ELEMENT#
3.2.1 Commissioning

June 6th, 2011 Instrument#3.2.1 T1 Page 1 of 1

SCHEDULE F: POST OCCUPANCY COMMISSIONING VERIFICATION FORM

Ontario
Infrastructure Ontario

Post Occupancy Commissioning Verification Form

PS Project #		Project Name	
Portfolio ID #	Portfolio Name	Building #	Building Name

COMPONENT(S) / SYSTEM(S):

CONSULTANT/COMMISSIONING AGENT CERTIFICATION

The commissioning verification test(s) of the following equipment have been completed and performance of the component(s) / system(s) complies with the acceptance criteria in the testing of the specifications and contract documents.

Component(s) / System(s):		
	☐ Yes	☐ No
	☐ Yes	☐ No
	☐ Yes	☐ No
	☐ Yes	☐ No
	☐ Yes	☐ No

Exclusions:

Signature: _____ **Date:** _____

Organization: _____

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PMSP ACCEPTANCE
Signature: _____ **Date:** _____
Organization: _____
PLEASE PROVIDE THIS COMPLETED FORM TO IO-PS AS A PART OF THE O&M DOCUMENTATION

IO-PS Methodology Sub-Element Reference:

SUB-ELEMENT#
4.1.4 Post Occupancy Commissioning (Seasonal)

SCHEDULE G: TRAINING

Review with PLMSP and adjust the number of training sessions and content to suit the project complexity, size and number of staff to be trained – Project training can be tailored according to the size of the project, any changes to the training needs to be discussed with the PLMS.

- Provide four (4) on-site training sessions including classroom and terminal hands on, half day each, for personnel designated by the owner/owners service provider prior to and at substantial completion or when system starts affecting conditions in tenant spaces that owner/owners service provider must respond to.
- Provide one (1) additional training session at each of 6 and 9 months, following substantial completion. Each session shall be a half day in length and must be coordinated with the building owner/owners service provider.
- Train the designated staff of IO and its representative to enable them to do the following:
- Day-to-day Operators: range of 4 to 8 persons (2 sessions)
    - Proficiently operate the system
    - Understand control system architecture and configuration
    - Understand DDC system components
    - Understand system operation, including DDC system control and optimizing routines (algorithms)
    - Operate the workstation and peripherals
    - Log on and off the system
    - Access graphics, point reports, and logs
    - Adjust and change system set points, time schedules, and holiday schedules
    - Recognize malfunctions of the system by observation of the printed copy and graphical visual signals
    - Understand system drawings and Operation and Maintenance manual
    - Understand the job layout and location of control components
    - Access data from DDC controllers and ASCs
    - Operate portable operator's terminals
- Advanced Operator (in addition to above): 2-4 persons (1 session)
    - Make and change graphics on the workstation
    - Create, delete, and modify alarms, including annunciation and routing of these
    - Create, delete, and modify point trend logs and graph or print these both on an ad-hoc basis and at user-definable time intervals
    - Create, delete, and modify reports
    - Add, remove, and modify system's physical points
    - Create, modify, and delete programming
    - Add panels when required
    - Add operator interface stations
    - Create, delete, and modify system displays, both graphical and others
    - Perform DDC system field checkout procedures
    - Perform DDC controller unit operation and maintenance procedures
    - Perform workstation and peripheral operation and maintenance procedures
    - Perform DDC system diagnostic procedures
    - Configure hardware including PC boards, switches, communication, and I/O points
    - Maintain, calibrate, troubleshoot, diagnose, and repair hardware
    - Adjust, calibrate, and replace system components
- System Managers/Administrator (in addition to above): 2-4 persons (1 session)
    - Maintain software and prepare backups
    - Interface with job-specific, third-party operator software
    - Add new users and understand password security procedures
- Participants may attend one or more of these, depending on level of knowledge required.
- The instructor(s) shall provide one copy of training material per student.
- The instructor(s) shall be factory-trained instructors experienced in presenting this material.
- Training shall include classroom and onsite training, using the installed system working controllers without affecting the space conditions

CONTACT INFORMATION

Should you have any questions or feedback about the IO Building Systems Commissioning Guideline, please contact:

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END OF SCHEDULES