

**Parry Sound, Ontario
28 Waubeek Street**

**Canadian Coast Guard Base
HVAC Upgrade to Main Building**

PROJECT NO: R.064667.004

ISSUED
Jan 26th, 2015, Issued for TENDER

SPECIFICATIONS

Consultant: Taylor Hazell Architects

PWGSC Ontario	SPECIFICATION	Section 00 00 00
Region Project	TITLE SHEET	Page 1
Number R.064667.004		2016-01-26

Project Title Parry Sound, Ontario
 28 Waubeek Street
 Canadian Coast Guard Base
 HVAC Upgrade To Main Building

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PWGSC Ontario
Region Project
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SEALS PAGE

Section 00 01 07

2016-01-26

Consultant for Building Code Review:



Building Code Designation Number (BCDN):

Section	Title	Pages
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DIVISION 00 - PROCUREMENT AND CONTRACTING REQUIREMENTS

00 00 00	Specification Title Sheet	1
00 01 07	Seals Page	1
00 01 11	List of Contents	4

DIVISION 01 - GENERAL REQUIREMENTS

01 11 00	Summary of Work	4
01 14 00	Work Restrictions	3
01 31 19	Project Meetings	3
01 32 00	Construction Progress Documentation	2
01 32 16	Construction Progress Schedule - Bar (Gantt) Chart	4
01 33 00	Submittal Procedures	7
01 35 29	Health and Safety Requirements	6
01 35 35	Fire Safety Requirements	6
01 35 43	Environmental Procedures	6
01 41 00	Regulatory Requirements	2
01 45 00	Quality Control	5
01 51 00	Temporary Utilities	2
01 52 00	Construction Facilities	5
01 56 00	Temporary Barriers and Enclosures	3
01 61 00	Common Product Requirements	8
01 73 00	Execution	3
01 74 11	Cleaning	3
01 74 21	Construction/Demolition Waste Management and Disposal ..	4
01 77 00	Closeout Procedures	2
01 78 00	Closeout Submittals	9
01 79 00	Demonstration and Training	3
01 91 13	General Commissioning (Cx) Requirements	13
01 91 51	Building Management Manual (BMM)	5

DIVISION 02 - EXISTING CONDITIONS

02 41 19	Selective Structure Demolition	8
----------	--------------------------------------	---

DIVISION 05 - METAL

05 12 23	Structural Steel for Buildings	14
05 50 01	Metal Fabrications	5

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

07 46 19	Preformed Steel Siding	2
07 52 16	2-Ply SBS Modified Bituminous Membrane Roofing	7
07 62 00	Sheet Metal Flashing and Trim	4
07 90 00	Joint Sealing	3

DIVISION 09 - FINISHES

09 51 23	Acoustic Tile Ceilings.....	2
----------	-----------------------------	---

DIVISION 23 - HEATING, VENTILATION AND AIR-CONDITIONING (HVAC)

23 03 01	Use Of Mechanical Systems during Construction.....	2
23 05 00	Common Work Results - Mechanical.....	11
23 05 03	Mechanical Systems Commissioning.....	1
23 05 05	Installation of Pipework Mechanical.....	6
23 05 13	Common Motor Requirements for HVAC Equipment.....	5
23 05 14	Variable Frequency Drives.....	9
23 05 19.01	Thermometers and Pressure Gauges - Piping Systems	4
23 05 23.01	Valves - Bronze	6
23 05 23.02	Valves - Cast Iron	7
23 05 23.05	Butterfly Valves	5
23 05 29	Hangers and Supports for HVAC Piping and Equipment.....	8
23 05 48	Vibration Controls For HVAC Piping and Equipment.....	4
23 05 53.01	Mechanical Identification	7
23 05 93	Testing, Adjusting and Balancing for HVAC.....	7
23 07 13	Duct Insulation.....	6
23 07 15	Thermal Insulation for Piping.....	9
23 08 01	Performance Verification Mechanical Piping Systems.....	5
23 08 02	Cleaning and Start-Up of Mechanical Piping Systems.....	4
23 11 23	Facility Natural Gas Piping.....	4
23 21 13.01	Hydronic Systems: Copper	7
23 21 13.02	Hydronic Systems: Steel	6
23 21 14	Hydronic Specialties.....	4
23 21 23	Hydronic Pumps.....	5
23 23 00	Copper Tubing and Fittings Refrigerant.....	5
23 25 00	HVAC Water Treatment Systems.....	3
23 31 13.01	Metal Ducts - Low Pressure to 500 Pa	6
23 33 00	Air Duct Accessories.....	4
23 33 14	Dampers - Balancing.....	2
23 33 15	Dampers - Operating.....	2
23 33 16	Dampers - Fire.....	3
23 33 46	Flexible Ducts.....	3
23 34 00	HVAC Fans.....	4
23 34 25	Packaged Roof and Wall Exhausters.....	3
23 36 00	Air Terminal Units.....	5
23 37 13	Diffusers, Registers and Grilles.....	4
23 37 20	Louvres, Intakes and Vents.....	3
23 41 00	Particulate Air Filtration.....	7
23 51 00	Breeching, Chimneys and Stacks.....	8
23 52 00	Heating Boilers.....	14
23 64 19	Reciprocating Water Chillers.....	6
23 75 00	Air Handling Units - Custom Indoor.....	17
23 82 19	Fan Coil Units.....	4

DIVISION 25 - Integrated Automation

25 05 01	EMCS: General Requirements and Scope of Work.....	63
----------	---	----

25 90 01	EMCS: Site Requirements Applications and Systems Sequences of Operations.....	27
----------	--	----

DIVISION 26 - ELECTRICAL

26 05 01	Common Work Results for Electrical.....	15
26 05 05	Electrical Systems Commissioning.....	16
26 05 20	Wire and Box Connectors (0-1000 V).....	3
26 05 21	Wires and Cables (0-1000 V)	3
26 05 22	Connectors and Terminations.....	2
26 05 28	Grounding - Secondary.....	3
26 05 29	Hangers and Supports for Electrical Systems.....	2
26 05 31	Splitters, Junction, Pull Boxes and Cabinets.....	3
26 05 32	Outlet Boxes, Conduit Boxes and Fittings.....	2
26 05 34	Conduits, Conduit Fastenings and Conduit Fittings.....	5
26 05 80	Fractional Horsepower Motors.....	2
26 27 26	Wiring Devices.....	4
26 28 16.02	Moulded Case Circuit Breakers	3
26 28 20	Ground Fault Circuit Interrupters - Class "A".....	3
26 28 23	Disconnect Switches - Fused and Non-Fused.....	1
26 29 01	Contactors.....	3
26 29 10	Motor Starters to 600 V.....	4

DRAWINGS AND SCHEDULES

Drawing List

No.	Description
------------	--------------------

ARCHITECTURAL

A-000	COVER SHEET & SITE PLAN
A-A01	SHOP WING - FLOOR PLAN
A-A02	ADMIN. WING - FLOOR PLAN
A-A03	SHOP WING - ROOF PLAN
A-A04	ADMIN. WING - ROOF PLAN & DETAILS
A-A05	ELEVATIONS
A-A06	ELEVATIONS
A-A07	SHOP WING - R.C.P
A-A08	ADMIN. WING - R.C.P
A-A12	DETAILS

STRUCTURAL

S100	GENERAL NOTES AND TYPICAL DETAILS
S-A01	PART ROOF FRAMING PLAN SECTIONS

MECHANICAL

M-001	MECHANICAL LEGEND, DRAWING LIST
MA-001	KEY PLAN - SHOP WING
MA-002	KEY PLAN - ADMINISTRATION AREA - GROUND AND SECOND FLOOR
MA-402	ADMINISTRATION - HVAC DUCTWORK
MA-403	FAN ROOM - HVAC DUCTWORK
MA-404	MECHANICAL - HVAC DUCTWORK
MA-405	MECHANICAL ROOM - HVAC PIPING
MA-451	BOILER ROOM LAYOUT HVAC PIPING
MA-452	ROOF PLAN HVAC PIPING

MA-501	CENTRAL STORES - HVAC DUCTWORK
MA-502	IT ROOM - HVAC DUCTWORK
MA-503	BOILER ROOM HVAC DUCTWORK
M-701	HOT WATER HEATING SCHEMATIC-NEW
M-701D	HOT WATER HEATING SCHEMATIC - DEMOLITION
MA-801	MAIN BUILDING - MECHANICAL DETAILS
MA-802	MAIN BUILDING - MECHANICAL DETAIL
MA-803	MAIN BUILDING - MECHANICAL DETAILS

ELECTRICAL

E-001	ELECTRICAL LEGEND, DRAWING LIST AND KEY PLANS
E-100	MECHANICAL EQUIPMENT SCHEDULE & DETAIL
E-101	ELECTRICAL PANEL SCHEDULES
E-200	SHOP WING GROUND FLOOR PLAN
E-201	ADMIN WING - GROUND, SECOND & THIRD FLOOR PLAN
E-202	SHOP WING - ROOF PLAN
E-203	ADMIN WING - ROOF PLA
E-500	SINGLE LINE DIAGRAM

APPENDICES

Appendix

No.	Description
A.1	Designated Substances and Hazardous Material Survey Canada's Coast Guard Base, Parry Sound, Ontario R.064667.007 59
A.2	Canadian Coast Guard Base Reconstruction As-Built Drawings..... 95
A.3	Parry Sound - Specifications Volumel-4 -1984-05-31.. 1066

-----END OF SECTION-----

PART 1 - GENERAL

<u>1.1 SECTION INCLUDES</u>	.1	Title and description of Work.
	.2	Contract Method.
	.3	Cost breakdown.
	.4	Work sequence.
	.5	Contractor use of premises.
	.6	Owner occupancy.
	.7	Alterations to existing building.
<u>1.2 PRECEDENCE</u>	.1	For Federal Government Projects, Division 01 Sections take precedence over technical specification sections in other Divisions of this Project Manual.
<u>1.3 WORK COVERED BY CONTRACT DOCUMENTS</u>	.1	Work of this Contract comprises HVAC upgrades to main building of Parry Sound Canadian Coast Guard Base located at 28 Waubeek Street, Parry Sound, Ontario; and further identified as HVAC Upgrades.
<u>1.4 CONTRACT METHOD</u>	.1	Construct work under lump sum contract.
	.2	Relations and responsibilities between Contractor and subcontractors and suppliers assigned by Owner are as defined in Conditions of Contract. Assigned Subcontractors must, in addition: .1 Furnish to Contractor, bonds covering faithful performance of subcontracted work and payment of obligations thereunder when Contractor is required to furnish such bonds to Departmental Representative.

- 1.4 CONTRACT METHOD .2 (Cont'd)
(Cont'd)
- .2 Purchase and maintain liability insurance to protect Contractor from claims for not less than limits of liability which Contractor is required to provide to Departmental Representative.
- 1.5 COST BREAKDOWN .1 Within 48 hours of notification of acceptance of bid furnish a cost breakdown by Section aggregating contract Price.
- .2 Show separately cost of equipment purchased exempt from Ontario Retail Sales Tax under your Ontario Sales Tax licence number.
- .3 Within 48 hours of acceptance of bid submit a list of subcontractors.
- 1.6 WORK SEQUENCE .1 Construct Work in stages to accommodate Owner's continued use of premises during construction.
- .2 Coordinate Progress Schedule and coordinate with Owner Occupancy during construction.
- .3 Maintain fire access/control.
- 1.7 CONTRACTOR USE OF PREMISES .1 Contractor shall limit use of premises for Work, for strage, and for access, to allow;
- .1 Owner occupancy.
- .2 Partial owner occupancy.
- .3 Work by other contractors.
- .4 Public usage.
- .2 Coordinate use of premises under direction of Departmental Representative.
- .3 Obtain and pay for use of additional storage or work areas needed for operations under this Contract.
- 1.8 OWNER OCCUPANCY .1 Owner will occupy premises during entire construction period for execution of normal operations.
-

<u>1.8 OWNER OCCUPANCY</u> (Cont'd)	.2	Cooperate with Owner in scheduling operations to minimize conflict and to facilitate Owner usage.
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<u>1.9 ALTERATIONS TO EXISTING BUILDING</u>	.1	Remove and recycle, compost, anaerobically digest, sell material for reuse or dispose of: .1 Concrete roof pavers. .2 Existing roofing system including gypsum sheathing board, insulation and membrane. .3 Mechanical and electrical items as indicated.
	.2	Remove in good order, turn over to Department, and store within building where designated by Departmental Representative: .1 Mechanical and electrical items as indicated.
	.3	Remove, temporarily store, clean, alter to suit and reinstall: .1 Roof Drains. .2 Parapet Caps. .3 Metal panels. .4 Stone ballast. .5 Mechanical and electrical items as indicated.
	.4	Remove, temporarily store and turn over to other sections for building in: .1 Mechanical and electrical items as indicated.
	.5	Provide new openings required in existing construction.
	.6	Block in openings where items removed with material and finish to match existing adjoining construction.

PART 2 - PRODUCTS

<u>2.1 NOT USED</u>	.1	Not used.
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PART 3 - EXECUTION

3.1 NOT USED .1 Not used.

PART 1 - GENERAL

1.1 ACCESS AND
EGRESS

- .1 Design, construct and maintain temporary "access to" and "egress from" work areas, including stairs, runways, ramps or ladders and scaffolding, independent of finished surfaces and in accordance with relevant municipal, provincial and other regulations.

1.2 USE OF SITE AND
FACILITIES

- .1 Execute work with least possible interference or disturbance to normal use of premises. Make arrangements with Departmental Representative to facilitate work as stated.
- .2 Maintain existing services to building and provide for personnel and vehicle access.
- .3 Where security is reduced by work provide temporary means to maintain security.
- .4 Departmental Representative will assign sanitary facilities for use by Contractor's personnel. Keep facilities clean.
- .5 Use only elevators existing in building for moving workers and material.
 - .1 Protect walls of passenger elevators, to approval of Departmental Representative prior to use.
 - .2 Accept liability for damage, safety of equipment and overloading of existing equipment.
- .6 Closures: protect work temporarily until permanent enclosures are completed.

1.3 ALTERATIONS,
ADDITIONS OR
REPAIRS TO EXISTING
BUILDING

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

1.4 EXISTING
SERVICES

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

1.5 SPECIAL
REQUIREMENTS

- .1 Carry out Work Monday to Friday from 07:30 to 16:00 hours.
- .2 Submit schedule in accordance with Section 01 32 16 - Construction Progress Schedule - Bar (GANTT) Chart.
- .3 Ensure Contractor's personnel employed on site become familiar with and obey regulations including safety, fire, traffic and security regulations.
- .4 Keep within limits of work and avenues of ingress and egress.
- .5 Prior to cutting or drilling horizontal or vertical surfaces including concrete, concrete block or other structural substrate, determine location of reinforcing, service lines, pipes, conduits or other items by x-ray, ground penetrating radar or other appropriate method. Submit findings to Departmental Representative prior to cutting or drilling.

1.6 SECURITY

- .1 Where security has been reduced by Work of Contract, provide temporary means to maintain security.
 - .2 Security clearances:
-

1.6 SECURITY <u>(Cont'd)</u>	.2	(Cont'd) .1 Personnel employed on this project will be subject to security check. Obtain clearance, as instructed, for each individual who will require to enter premises. .2 Personnel will be checked daily at start of work shift and provided with pass which must be worn at all times. Pass must be returned at end of work shift and personnel checked out.
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1.7 BUILDING <u>SMOKING ENVIRONMENT</u>	.1	Comply with smoking restrictions. Smoking is not permitted.
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PART 2 - PRODUCTS

<u>2.1 NOT USED</u>	.1	Not Used.
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PART 3 - EXECUTION

<u>3.1 NOT USED</u>	.1	Not Used.
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PART 1 - GENERAL

- 1.1 ADMINISTRATIVE
- .1 Schedule and administer project meetings throughout the progress of the work at the call of Departmental Representative.
 - .2 Prepare agenda for meetings.
 - .3 Distribute written notice of each meeting 4 days in advance of meeting date to Departmental Representative.
 - .4 Provide physical space and make arrangements for meetings.
 - .5 Preside at meetings.
 - .6 Record the meeting minutes. Include significant proceedings and decisions. Identify actions by parties.
 - .7 Reproduce and distribute copies of minutes within three days after meetings and transmit to Departmental Representative, meeting participants and affected parties not in attendance.
 - .8 Representative of Contractor, Subcontractor and suppliers attending meetings will be qualified and authorized to act on behalf of party each represents.
- 1.2 PRECONSTRUCTION MEETING
- .1 Within 15 days after award of Contract, request meeting of parties in contract to discuss and resolve administrative procedures and responsibilities.
 - .2 Departmental Representative, Contractor, major Subcontractors, field inspectors and supervisors will be in attendance.
 - .3 Establish time and location of meeting and notify parties concerned minimum 5 days before meeting.
-

- 1.2 PRECONSTRUCTION MEETING
(Cont'd)
- .4 Incorporate mutually agreed variations to Contract Documents into Agreement, prior to signing.
 - .5 Agenda to include:
 - .1 Appointment of official representative of participants in the Work.
 - .2 Schedule of Work: in accordance with Section 01 32 16.
 - .3 Schedule of submission of shop drawings, samples, mock-ups, colour chips. Submit submittals in accordance with Section 01 33 00.
 - .4 Requirements for temporary facilities, site sign, offices, storage sheds, utilities, fences in accordance with Section 01 52 00.
 - .5 Site security in accordance with Section 01 56 00.
 - .6 Health and safety in accordance with Section 01 35 29.
 - .7 Proposed changes, change orders, procedures, approvals required, mark-up percentages permitted, time extensions, overtime, administrative requirements.
 - .8 Owner provided products.
 - .9 Record drawings and specifications in accordance with Sections 01 33 00 and 01 78 00.
 - .10 Maintenance manuals in accordance with Section 01 78 00.
 - .11 Take-over procedures, acceptance, warranties in accordance with Section 01 78 00.
 - .12 Monthly progress claims, administrative procedures, photographs, hold backs.
 - .13 Appointment of inspection and testing agencies or firms.
 - .14 Insurances, transcript of policies.
- 1.3 PROGRESS MEETINGS
- .1 During course of Work and two weeks prior to project completion, schedule progress meetings biweekly.
 - .2 Contractor, major Subcontractors involved in Work and Departmental Representative are to be in attendance.
 - .3 Notify parties minimum three days prior to meetings. Unexpected or urgent meetings require minimum 24 hours notice.

- 1.3 PROGRESS MEETINGS
(Cont'd)
- .4 Record minutes of meetings and circulate to attending parties and affected parties not in attendance within three days after meeting.
- .5 Agenda to include the following:
- .1 Review, approval of minutes of previous meeting.
 - .2 Review of Work progress since previous meeting.
 - .3 Field observations, problems, conflicts.
 - .4 Problems which impede construction schedule.
 - .5 Review of off-site fabrication delivery schedules.
 - .6 Corrective measures and procedures to regain projected schedule.
 - .7 Revision to construction schedule.
 - .8 Progress schedule, during succeeding work period.
 - .9 Review submittal schedules: expedite as required.
 - .10 Maintenance of quality standards.
 - .11 Review proposed changes for affect on construction schedule and on completion date.
 - .12 Other business.

PART 2 - PRODUCTS

- 2.1 NOT USED .1 Not Used.

PART 3 - EXECUTION

- 3.1 NOT USED .1 Not Used.

PART 1 - GENERAL

1.1 RELATED SECTIONS .1 Section 01 77 00 - Closeout Procedures.

1.2 PROGRESS PHOTOGRAPHS .1 Viewpoints: interior and exterior locations in viewpoints determined by Departmental Representative.

.2 Frequency: monthly with progress statement as directed by Departmental Representative.

.3 Submit all digital files of coloured prints before final acceptance of building.

.4 Insert C.D. of files in envelopes and identify with name and number of project.

1.3 ELECTRONIC COPY .1 Submit electronic and hard copy of colour digital photography in jpg format, standard resolution.

.2 Identification: name and number of project and date of exposure indicated.

.3 Number of viewpoints: 4. Locations of viewpoints determined by Departmental Representative.

.4 Frequency: as directed by Departmental Representative.

PART 2 - PRODUCTS

2.1 NOT USED .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED .1 Not Used.

PART 1 - GENERAL

1.1 DEFINITIONS

- .1 Activity: element of Work performed during course of Project. Activity normally has expected duration, and expected cost and expected resource requirements. Activities can be subdivided into tasks.
 - .2 Bar Chart (GANTT Chart): graphic display of schedule-related information. In typical bar chart, activities or other Project elements are listed down left side of chart, dates are shown across top, and activity durations are shown as date-placed horizontal bars. Generally Bar Chart should be derived from commercially available computerized project management system.
 - .3 Baseline: original approved plan (for project, work package, or activity), plus or minus approved scope changes.
 - .4 Construction Work Week: Monday to Friday, inclusive, will provide five day work week and define schedule calendar working days as part of Bar (GANTT) Chart submission.
 - .5 Duration: number of work periods (not including holidays or other nonworking periods) required to complete activity or other project element. Usually expressed as workdays or workweeks.
 - .6 Master Plan: summary-level schedule that identifies major activities and key milestones.
 - .7 Milestone: significant event in project, usually completion of major deliverable.
 - .8 Project Schedule: planned dates for performing activities and the planned dates for meeting milestones. Dynamic, detailed record of tasks or activities that must be accomplished to satisfy Project objectives. Monitoring and control process involves using Project Schedule in executing and controlling activities and is used as basis for decision making throughout project life cycle.
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- | | | |
|-----------------------------|----|--|
| 1.1 DEFINITIONS
(Cont'd) | .9 | Project Planning, Monitoring and Control System: overall system operated by Departmental Representative to enable monitoring of project work in relation to established milestones. |
| 1.2 REQUIREMENTS | .1 | Ensure Master Plan and Detail Schedules are practical and remain within specified Contract duration. |
| | .2 | Plan to complete Work in accordance with prescribed milestones and time frame. |
| | .3 | Limit activity durations to maximum of approximately 10 working days, to allow for progress reporting. |
| | .4 | Ensure that it is understood that Award of Contract or time of beginning, rate of progress, Certificate of Substantial Performance and Certificate of Completion as defined times of completion are of essence of this contract. |
| 1.3 SUBMITTALS | .1 | Provide submittals in accordance with Section 01 33 00. |
| | .2 | Submit to Departmental Representative within 10 working days of Award of Contract Bar (GANTT) Chart as Master Plan for planning, monitoring and reporting of project progress. |
| | .3 | Submit Project Schedule to Departmental Representative within 5 working days of receipt of acceptance of Master Plan. |
| 1.4 MASTER PLAN | .1 | Structure schedule to allow orderly planning, organizing and execution of Work as Bar Chart (GANTT). |
| | .2 | Departmental Representative will review and return revised schedules within 5 working days. |

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|-----------------------------------|----|--|
| 1.4 MASTER PLAN
(Cont'd) | .3 | Revise impractical schedule and resubmit within 5 working days. |
| | .4 | Accepted revised schedule will become Master Plan and be used as baseline for updates. |
| 1.5 PROJECT
SCHEDULE | .1 | Develop detailed Project Schedule derived from Master Plan. |
| | .2 | Ensure detailed Project Schedule includes as minimum milestone and activity types as follows: <ul style="list-style-type: none"> .1 Award. .2 Shop Drawings, Samples. .3 Permits. .4 Mobilization. .5 Siding and Roofing. .6 Plumbing. .7 Lighting. .8 Electrical. .9 Piping. .10 Controls. .11 Heating, Ventilating, and Air Conditioning. .12 Testing and Commissioning. .13 Departmental Representative supplied equipment required dates. |
| 1.6 PROJECT
SCHEDULE REPORTING | .1 | Update Project Schedule on weekly basis reflecting activity changes and completions, as well as activities in progress. |
| | .2 | Include as part of Project Schedule, narrative report identifying Work status to date, comparing current progress to baseline, presenting current forecasts, defining problem areas, anticipated delays and impact with possible mitigation. |

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

PART 2 - PRODUCTS

- 2.1 NOT USED
- .1 Not used.

PART 3 - EXECUTION

- 3.1 NOT USED
- .1 Not used.

PART 1 - GENERAL

1.1 ADMINISTRATIVE

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

1.1 ADMINISTRATIVE
(Cont'd)

- .10 Keep one reviewed copy of each submission on site.
- .11 Submit number of hard copies specified for each type and format of submittal and also submit in electronic format as pdf files. Forward pdf, NMSEdit Professional spp, MS Word, MS Excel, MS Project and Autocad dwg files on USB compatible with PWGSC encryption requirements or through email or alternate electronic file sharing service such as ftp, as directed by Departmental Representative.

1.2 SHOP DRAWINGS
AND PRODUCT DATA

- .1 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by Contractor to illustrate details of a portion of Work.
 - .2 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario of Canada.
 - .3 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been co-ordinated, regardless of Section under which adjacent items will be supplied and installed. Indicate cross references to design drawings and specifications.
 - .4 Allow 3 working days for Departmental Representative's review of each submission.
 - .5 Adjustments made on shop drawings by Departmental Representative are not intended to change Contract price. If adjustments affect value of Work, state such in writing to Departmental Representative prior to proceeding with Work.
-

1.2 SHOP DRAWINGS
AND PRODUCT DATA
(Cont'd)

- .6 Make changes in shop drawings as Departmental Representative may require, consistent with Contract Documents. When resubmitting, notify Departmental Representative in writing of revisions other than those requested.
- .7 Accompany submissions with transmittal letter, in duplicate, containing:
 - .1 Date.
 - .2 Project title and number.
 - .3 Contractor's name and address.
 - .4 Identification and quantity of each shop drawing, product data and sample.
 - .5 Other pertinent data.
- .8 Submissions shall include:
 - .1 Date and revision dates.
 - .2 Project title and number.
 - .3 Name and address of:
 - .1 Subcontractor.
 - .2 Supplier.
 - .3 Manufacturer.
 - .4 Contractor's stamp, signed by Contractor's authorized representative certifying approval of submissions, verification of field measurements and compliance with Contract Documents.
 - .5 Details of appropriate portions of Work as applicable:
 - .1 Fabrication.
 - .2 Layout, showing dimensions, including identified field dimensions, and clearances.
 - .3 Setting or erection details.
 - .4 Capacities.
 - .5 Performance characteristics.
 - .6 Standards.
 - .7 Operating weight.
 - .8 Wiring diagrams.
 - .9 Single line and schematic diagrams.
 - .10 Relationship to adjacent work.
- .9 After Departmental Representative's review, distribute copies.
- .10 Submit one electronic copy of shop drawings for each requirement requested in specification Sections and as Departmental Representative may reasonably request.

1.2 SHOP DRAWINGS
AND PRODUCT DATA
(Cont'd)

- .11 Submit three hard copies and one electronic copy of product data sheets or brochures for requirements requested in specification Sections and as requested by Departmental Representative where shop drawings will not be prepared due to standardized manufacture of product.
- .12 Submit three hard copies and one electronic copy of test reports for requirements requested in specification Sections and as requested by Departmental Representative.
 - .1 Report signed by authorized official of testing laboratory that material, product or system identical to material, product or system to be provided has been tested in accord with specified requirements.
 - .2 Testing must have been within 3 years of date of contract award for project.
- .13 Submit three hard copies and one electronic copy of certificates for requirements requested in specification Sections and as requested by Departmental Representative.
 - .1 Statements printed on manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that product, system or material meets specification requirements.
 - .2 Certificates must be dated after award of project contract complete with project name.
- .14 Submit three hard copies and one electronic copy of manufacturers instructions for requirements requested in specification Sections and as requested by Departmental Representative.
 - .1 Pre-printed material describing installation of product, system or material, including special notices and Material Safety Data Sheets concerning impedances, hazards and safety precautions.
- .15 Submit three hard copies and one electronic copy of Manufacturer's Field Reports for requirements requested in specification Sections and as requested by Departmental Representative.
- .16 Documentation of the testing and verification actions taken by manufacturer's representative to confirm compliance with manufacturer's standards or instructions.

1.2 SHOP DRAWINGS
AND PRODUCT DATA
(Cont'd)

- .17 Submit three hard copies and one electronic copy of Operation and Maintenance Data for requirements requested in specification Sections and as requested by Departmental Representative.
- .18 Delete information not applicable to project.
- .19 Supplement standard information to provide details applicable to project.
- .20 If upon review by Departmental Representative, no errors or omissions are discovered or if only minor corrections are made, copies will be returned and fabrication and installation of Work may proceed. If shop drawings are rejected, noted copy will be returned and resubmission of corrected shop drawings, through same procedure indicated above, must be performed before fabrication and installation of Work may proceed.
- .21 The review of shop drawings by Public Works and Government Services Canada (PWGSC) is for sole purpose of ascertaining conformance with general concept.
 - .1 This review shall not mean that PWGSC approves detail design inherent in shop drawings, responsibility for which shall remain with Contractor submitting same, and such review shall not relieve Contractor of responsibility for errors or omissions in shop drawings or of responsibility for meeting requirements of construction and Contract Documents.
 - .2 Without restricting generality of foregoing, Contractor is responsible for dimensions to be confirmed and correlated at job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for co-ordination of Work of sub-trades.

1.3 SAMPLES

- .1 Submit for review samples in duplicate as requested in respective specification Sections. Label samples with origin and intended use.
- .2 Deliver samples prepaid to Departmental Representative's business address.

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| <u>1.3 SAMPLES
(Cont'd)</u> | .3 | Notify Departmental Representative in writing, at time of submission of deviations in samples from requirements of Contract Documents. |
| | .4 | Where colour, pattern or texture is criterion, submit full range of samples. |
| | .5 | Adjustments made on samples by Departmental Representative are not intended to change Contract Price.If adjustments affect value of Work, state such in writing to Departmental Representative prior to proceeding with Work. |
| | .6 | Make changes in samples which Departmental Representative may require, consistent with Contract Documents. |
| | .7 | Reviewed and accepted samples will become standard of workmanship and material against which installed Work will be verified. |
| <u>1.4 MOCK-UPS</u> | .1 | Erect mock-ups in accordance with Section 01 45 00. |
| <u>1.5 PHOTOGRAPHIC
DOCUMENTATION</u> | .1 | Refer to Section 01 32 00. |
| <u>1.6 CERTIFICATES
AND TRANSCRIPTS</u> | .1 | Immediately after award of Contract, submit Workers' Safety and Insurance Board Experience Report. |
| <u>1.7 FEES, PERMITS
AND CERTIFICATES</u> | .1 | Provide authorities having jurisdiction with information requested. |
| | .2 | Pay fees and obtain certificates and permits required. |
| | .3 | Furnish certificates and permits. |
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<u>1.7 FEES, PERMITS AND CERTIFICATES (Cont'd)</u>	.4	Submit acceptable certificate stating that suspended ceiling systems provide adequate support for electrical fixtures, as required by current bulletin of Electrical Safety Authority (ESA).
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PART 2 - PRODUCTS

<u>2.1 NOT USED</u>	.1	Not Used.
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PART 3 - EXECUTION

<u>3.1 NOT USED</u>	.1	Not Used.
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PART 1 - GENERAL

- 1.1 REFERENCES
- .1 Canadian Standards Association (CSA): Canada
 - .1 CSA S350-M1980(R2003), Code of Practice for Safety in Demolition of Structures.
 - .2 National Building Code 2010 (NBC):
 - .1 NBC 2010, Division B, Part 8 Safety Measures at Construction and Demolition Sites.
 - .3 National Fire Code 2010 (NFC):
 - .1 NFC 2010, Division B, Part 5 Hazardous Processes and Operations, subsection 5.6.1.3 Fire Safety Plan.
 - .4 Province of Ontario:
 - .1 Occupational Health and Safety Act Revised Statutes of Ontario 1990, Chapter O.1 as amended, and Regulations for Construction Projects, O. Reg. 213/91 as amended.
 - .2 O. Reg. 490/09, Designated Substances.
 - .3 Workplace Safety and Insurance Act, 1997.
 - .4 Municipal statutes and authorities.
 - .5 Treasury Board of Canada Secretariat (TBS):
 - .1 Treasury Board, Fire Protection Standard April 1, 2010 www.tbs-sct.gc.ca/pol/doc-eng.aspx?id=17316§ion=text.
- 1.2 ACTION AND INFORMATIONAL SUBMITTALS
- .1 Submit in accordance with Section 01 33 00.
 - .2 Submit site-specific Health and Safety Plan: Within 7 days after date of Notice to Proceed and prior to commencement of Work. Health and Safety Plan must include:
 - .1 Results of site specific safety hazard assessment.
 - .2 Results of safety and health risk or hazard analysis for site tasks and operation found in work plan.
 - .3 Measures and controls to be implemented to address identified safety hazards and risks.
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1.2 ACTION AND
INFORMATIONAL
SUBMITTALS
(Cont'd)

- .3 Provide a Fire Safety Plan, specific to the work location, in accordance with NBC, Division B, Article 8.1.1.3 prior to commencement of work. The plan shall be coordinated with, and integrated into, the existing Emergency Procedures and Evacuation Plan in place at the site. Departmental Representative will provide Emergency Procedures and Evacuation Plan. Deliver two copies of the Fire Safety Plan to the Departmental Representative not later than 14 days before commencing work.
 - .4 Contractor's and Sub-contractors' Safety Communication Plan.
 - .5 Contingency and Emergency Response Plan addressing standard operating procedures specific to the project site to be implemented during emergency situations. Coordinate plan with existing Emergency Response requirements and procedures provided by Departmental Representative.
 - .6 Departmental Representative will review Contractor's site-specific Health and Safety Plan and provide comments to Contractor within 14 days after receipt of plan. Revise plan as appropriate and resubmit plan to Departmental Representative within 7 days after receipt of comments from Departmental Representative.
 - .7 Departmental Representative's review of Contractor's final Health and Safety plan should not be construed as approval and does not reduce the Contractor's overall responsibility for construction Health and Safety.
 - .8 Submit names of personnel and alternates responsible for site safety and health.
 - .9 Submit records of Contractor's Health and Safety meetings when requested.
 - .10 Submit 2 copies of Contractor's authorized representative's work site health and safety inspection reports to Departmental Representative, weekly.
 - .11 Submit copies of orders, directions or reports issued by health and safety inspectors of the authorities having jurisdiction.
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| <u>1.2 ACTION AND
INFORMATIONAL
SUBMITTALS
(Cont'd)</u> | .12 | Submit copies of incident and accident reports. |
| | .13 | Submit Material Safety Data Sheets (MSDS). |
| | .14 | Submit Workplace Safety and Insurance Board (WSIB)- Experience Rating Report. |
| <u>1.3 FILING OF
NOTICE</u> | .1 | File Notice of Project with Provincial authorities prior to commencement of Work. |
| <u>1.4 WORK PERMIT</u> | .1 | Obtain building permits related to project prior to commencement of Work. |
| | .2 | Obtain Hot Work Permit from Property Manager. |
| <u>1.5 SAFETY
ASSESSMENT</u> | .1 | Perform site specific safety hazard assessment related to project. |
| <u>1.6 MEETINGS</u> | .1 | Schedule and administer Health and Safety meeting with Departmental Representative prior to commencement of Work. |
| <u>1.7 REGULATORY
REQUIREMENTS</u> | .1 | Comply with the Acts and regulations of the Province of Ontario. |
| | .2 | Comply with specified standards and regulations to ensure safe operations at site. |
| <u>1.8 PROJECT/SITE
CONDITIONS</u> | .1 | Work at site may involve contact with designated or hazardous substances. Contractor shall coordinate and take necessary precautions and/or measures in accordance with information on hazardous or designated substances provided by Departmental Representative. |
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| <u>1.9 GENERAL REQUIREMENTS</u> | .1 | Develop written site-specific Health and Safety Plan based on hazard assessment prior to beginning site Work and continue to implement, maintain, and enforce plan until final demobilization from site. Health and Safety Plan must address project specifications. |
| | .2 | Departmental Representative may respond in writing, where deficiencies or concerns are noted and may request re-submission with correction of deficiencies or concerns either accepting or requesting improvements. |
| | .3 | Relief from or substitution for any portion or provision of minimum Health and Safety standards specified herein or reviewed site-specific Health and Safety Plan shall be submitted to Departmental Representative in writing. |
| <u>1.10 COMPLIANCE REQUIREMENTS</u> | .1 | Comply with Ontario Occupational Health and Safety Act, R.S.O. 1990 Chapter 0.1, as amended. |
| <u>1.11 RESPONSIBILITY</u> | .1 | Be responsible for health and safety of persons on site, safety of property on site and for protection of persons adjacent to site and environment to extent that they may be affected by conduct of Work. |
| | .2 | Comply with and enforce compliance by employees with safety requirements of Contract Documents, applicable federal, provincial, territorial and local statutes, regulations, and ordinances, and with site-specific Health and Safety Plan. |
| | .3 | Where applicable the Contractor shall be designated "Constructor", as defined by Occupational Health and Safety Act and Regulations for Construction Projects for the Province of Ontario. |
| <u>1.12 UNFORSEEN HAZARDS</u> | .1 | Should any unforeseen or peculiar safety-related factor, hazard, or condition become evident during performance of Work, immediately stop work and advise Departmental Representative verbally and in writing. |
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| 1.12 UNFORSEEN
HAZARDS
<u>(Cont'd)</u> | .2 | Follow procedures in place for Employees Right to Refuse Work as specified in the Occupational Health and Safety Act for the Province of Ontario. |
| 1.13 POSTING OF
DOCUMENTS
<u></u> | .1 | Ensure applicable items, articles, notices and orders are posted in conspicuous location on site in accordance with Acts and Regulations of Province of Ontario, and in consultation with Departmental Representative.
.1 Contractor's Safety Policy.
.2 Constructor's Name.
.3 Notice of Project.
.4 Name, trade, and employer of Health and Safety Representative or Joint Health and Safety Committee members (if applicable).
.5 Ministry of Labour Orders and reports.
.6 Occupational Health and Safety Act and Regulations for Construction Projects for Province of Ontario.
.7 Address and phone number of nearest Ministry of Labour office.
.8 Material Safety Data Sheets.
.9 Written Emergency Response Plan.
.10 Site Specific Safety Plan.
.11 Valid certificate of first aider on duty.
.12 WSIB "In Case of Injury At Work" poster.
.13 Location of toilet and cleanup facilities. |
| 1.14 CORRECTION OF
NON-COMPLIANCE
<u></u> | .1 | Immediately address health and safety non-compliance issues identified by authority having jurisdiction or by Departmental Representative. |
| | .2 | Provide Departmental Representative with written report of action taken to correct non-compliance of health and safety issues identified. |
| | .3 | Departmental Representative may stop Work if non-compliance of health and safety regulations is not corrected. |
| 1.15 POWDER
ACTUATED DEVICES
<u></u> | .1 | Use powder actuated devices only after receipt of written permission from Departmental Representative. |
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- 1.16 WORK STOPPAGE .1 Give precedence to safety and health of public and site personnel and protection of environment over cost and schedule considerations for Work.
- .2 Assign responsibility and obligation to Competent Supervisor to stop or start Work when, at Competent Supervisor's discretion, it is necessary or advisable for reasons of health or safety. Departmental Representative may also stop Work for health and safety considerations.

PART 2 - PRODUCTS

- 2.1 NOT USED .1 Not used.

PART 3 - EXECUTION

- 3.1 NOT USED .1 Not used.

PART 1 - GENERAL

1.1 GENERAL .1 This section specifies general requirements and procedures for fire safety. Additional requirements may be specified in individual sections elsewhere in specifications.

1.2 REPORTING FIRES .1 The Departmental Representative will co-ordinate arrangements for the Contractor to be briefed at the pre-construction meeting concerning Building's fire safety protocol.

.2 Building Manager will supply a copy of "Fire Safety Emergency Evacuation Plan" in effect for this building. Contractor shall comply with outlined fire safety requirements.

.3 Know location of nearest fire alarm box and telephone, including emergency phone number.

.4 Report immediately all fire incidents to Fire Department as follows:
.1 activate nearest fire alarm box; or
.2 telephone.

.5 Person activating fire alarm box will remain at box to direct Fire Department to scene of fire.

.6 When reporting fire by telephone, give location of fire, name or number of building and be prepared to verify the location.

1.3 FIRE WATCH .1 Appoint a Fire Watch at locations where welding and soldering, torching or roofing is to take place.

.2 A dedicated Fire Watch is not required. A competent person from the workforce on site may be assigned as Fire Watch for duration of work.

.3 Assign a person who is knowledgeable in the correct use of fire extinguishers on the project.

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| 1.3 FIRE WATCH
(Cont'd) | .4 | Have work inspected by the Fire Watch up to 1.0 hours after work stoppage for each work period. |
| 1.4 INTERIOR AND EXTERIOR FIRE PROTECTION AND ALARM SYSTEMS | .1 | Fire protection and alarm system will not be: <ul style="list-style-type: none"> .1 obstructed; .2 shut-off; or .3 left inactive at end of working day or shift. |
| | .2 | Fire hydrants, standpipes and hose systems will not be used for other than fire-fighting purposes unless authorized by Departmental Representative. |
| | .3 | Provide and maintain free access to fire extinguishing equipment. Maintain exit facilities. Keep means of egress free from materials, equipment and obstructing. |
| 1.5 FIRE EXTINGUISHERS | .1 | Supply fire extinguishers, as necessary to protect work in progress and contractor's physical plant on site. |
| 1.6 INSTALLATION AND/OR REPAIR OF ROOF TO INCLUDE CONTRACTORS PHYSICAL PLANT AT SITE | .1 | Ensure personnel use and take precautions as follows: <ul style="list-style-type: none"> .1 Use kettles equipped with thermometers or gauges in good working order. .2 Locate kettles in safe place outside of building. Locate to avoid danger of igniting combustible material. .3 Maintain continuous supervision while kettles are in operation and provide metal covers for kettles to smother any flames in case of fire. Fire extinguishers shall be provided as required in 1.6. .4 Prior to start of work, demonstrate container capacities to Departmental Representative. .5 Use only glass fibre roofing mops. .6 Used roofing mops will not be left unattended on roof and shall be stored away from building and combustible materials. .7 All roofing materials will be stored in location no closer than 3 m to any structures. |

1.7 BLOCKAGE OF
ROADWAYS

- .1 Advise Departmental Representative of any work that would impede fire apparatus response. This includes violation of minimum required overhead clearance.

1.8 SMOKING
PRECAUTIONS

- .1 Smoking is not permitted within areas of work or site storage.

1.9 RUBBISH AND
WASTE MATERIALS

- .1 Rubbish and waste materials are to be kept to a minimum.
- .2 Burning of rubbish is prohibited.
- .3 Remove all rubbish from work site at end of work day or shift or as directed.
- .4 Storage:
 - .1 Store oily waste in approved receptacles to ensure maximum cleanliness and safety.
 - .2 Deposit greasy or oily rags and materials subject to spontaneous combustion in approved receptacles and remove from site daily or at the end of each shift.

1.10 FLAMMABLE AND
COMBUSTIBLE LIQUIDS

- .1 Handling, storage and use of flammable and combustible liquids are to be governed by the current National Fire Code of Canada.
- .2 Flammable and combustible liquids such as gasoline, kerosene and naphtha will be kept for ready use in quantities not exceeding 45 litres provided they are stored in approved safety cans bearing Underwriters' Laboratory of Canada or Factory Mutual seal of approval. Storage of quantities of flammable and combustible liquids exceeding 45 litres for work purposes requires permission of local Building Manager.
- .3 Transfer of flammable and combustible liquids is prohibited within buildings or jetties.
- .4 Transfer of flammable and combustible liquids will not be carried out in vicinity of open flames or any type of heat-producing devices.

1.10 FLAMMABLE AND
COMBUSTIBLE LIQUIDS
(Cont'd)

- .5 Flammable liquids having a flash point below 38°C such as naphtha or gasoline will not be used as solvents or cleaning agents.
- .6 Flammable and combustible waste liquids, for disposal, will be stored in approved containers located in a safe ventilated area. Quantities are to be kept to a minimum and Fire Department is to be notified when disposal is required.

1.11 HAZARDOUS
SUBSTANCES

- .1 Work entailing use of toxic or hazardous materials, chemicals and/or explosives, or otherwise creating hazard to life, safety or health, will be in accordance with National Fire Code of Canada.
- .2 Obtain from local Building Manager a "Hot Work" permit for work involving welding, burning or use of blow torches and salamanders, in building or facility.
- .3 When Work is carried out in dangerous or hazardous areas involving use of heat, provide fire watchers equipped with sufficient fire extinguishers. Determination of dangerous or hazardous areas along with level of protection necessary for Fire Watch is at discretion of the local Building Manager. Contractors are responsible for providing fire watch service for work on a scale established and in conjunction with Building Manager at pre-construction meeting.
- .4 Where flammable liquids, such as lacquers or urethanes are to be used, proper ventilation will be assured and all sources of ignition are to be eliminated. Building Manager is to be informed prior to and at cessation of such work.

1.12 WELDING,
BURNING AND
CUTTING

- .1 Contractor performing work of this section must notify Departmental Representative in advance of commencing work.
 - .2 Use non-combustible shields for electric and gas welding or cutting executed within 3 m of combustible material or in occupied spaces.
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| 1.12 WELDING,
BURNING AND
CUTTING
(Cont'd) | .3 | Place cylinders supplying gases as close to work as possible. Secure cylinders in upright position, free from exposure to sun or high temperature. |
| | .4 | Locate fire extinguishing equipment near all welding, cutting and soldering operations. |
| | .5 | Contractor's mechanics shall be properly equipped with required protective clothing, including goggles or welding hood or face mask, gloves, etc. |
| | .6 | Contractor is responsible for the protection of his work and the Departmental Representative 's property. |
| | .7 | Provide Fire Watch on standby with approved fire extinguisher while burning or welding is in progress. |

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| 1.13 QUESTIONS
AND/OR
CLARIFICATIONS | .1 | Direct any questions or clarification on Fire Safety in addition to above requirements to local Building Manager. |
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| 1.14 FIRE
INSPECTION | .1 | Site inspections by Building Manager will be coordinated through Departmental Representative. |
| | .2 | Allow local Building Manager unrestricted access to work site. |
| | .3 | Co-operate with Building Manager during routine fire safety inspection of work site. |
| | .4 | Immediately remedy all unsafe fire situations observed by Building Manager. |

PART 2 - PRODUCTS

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| 2.1 NOT USED | .1 | Not used. |
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PART 3 - EXECUTION

3.1 NOT USED .1 Not used.

PART 1 - GENERAL

- 1.1 DEFINITIONS
- .1 Environmental Pollution and Damage: presence of chemical, physical, biological elements or agents which adversely affect human health and welfare; unfavourably alter ecological balances of importance to human life; affect other species of importance to humans; or degrade environment aesthetically, culturally and/or historically.
 - .2 Environmental Protection: prevention/control of pollution and habitat or environment disruption during construction.
- 1.2 REFERENCES
- .1 U.S. Environmental Protection Agency (EPA)/Office of Water
 - .1 EPA 832/R-92-005-92, Storm Water Management for Construction Activities, Chapter 3.
 - .2 EPA General Construction Permit (GCP) 2012.
- 1.3 ACTION AND INFORMATIONAL SUBMITTALS
- .1 Submit in accordance with Section 01 33 00.
 - .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for products and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit 2 copies of WHMIS MSDS.
 - .3 Before commencing construction activities or delivery of materials to site, submit Environmental Protection Plan for review and approval by Departmental Representative.
 - .4 Environmental Protection Plan must include comprehensive overview of known or potential environmental issues to be addressed during construction.
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1.3 ACTION AND
INFORMATIONAL
SUBMITTALS
(Cont'd)

- .5 Address topics at level of detail commensurate with environmental issue and required construction tasks.
- .6 Include in Environmental Protection Plan:
 - .1 Names of persons responsible for ensuring adherence to Environmental Protection Plan.
 - .2 Names and qualifications of persons responsible for manifesting hazardous waste to be removed from site.
 - .3 Names and qualifications of persons responsible for training site personnel.
 - .4 Descriptions of environmental protection personnel training program.
 - .5 Erosion and sediment control plan identifying type and location of erosion and sediment controls to be provided including monitoring and reporting requirements to assure that control measures are in compliance with erosion and sediment control plan, Federal, Provincial, and Municipal laws and regulations and EPA 832/R-92-005, Chapter 3.
 - .6 Drawings indicating locations of proposed temporary excavations or embankments for haul roads, stream crossings, material storage areas, structures, sanitary facilities, and stockpiles of excess or spoil materials including methods to control runoff and to contain materials on site.
 - .7 Traffic Control Plans including measures to reduce erosion of temporary roadbeds by construction traffic, especially during wet weather.
 - .1 Plans to include measures to minimize amount of material transported onto paved public roads by vehicles or runoff.
 - .8 Work area plan showing proposed activity in each portion of area and identifying areas of limited use or non-use.
 - .1 Plan to include measures for marking limits of use areas and methods for protection of features to be preserved within authorized work areas.
 - .9 Spill Control Plan to include procedures, instructions, and reports to be used in event of unforeseen spill of regulated substance.
 - .10 Non-Hazardous solid waste disposal plan identifying methods and locations for solid waste disposal including clearing debris.

1.3 ACTION AND
INFORMATIONAL
SUBMITTALS
(Cont'd)

- .6 (Cont'd)
- .11 Air pollution control plan detailing provisions to assure that dust, debris, materials, and trash, are contained on project site.
 - .12 Contaminant Prevention Plan identifying potentially hazardous substances to be used on job site; intended actions to prevent introduction of such materials into air, water, or ground; and detailing provisions for compliance with Federal, Provincial, and Municipal laws and regulations for storage and handling of these materials.
 - .13 Waste Water Management Plan identifying methods and procedures for management and or discharge of waste waters which are directly derived from construction activities, such as concrete curing water, clean-up water, dewatering of ground water, disinfection water, hydrostatic test water, and water used in flushing of lines.
 - .14 Historical, archaeological, cultural resources biological resources and wetlands plan that defines procedures for identifying and protecting historical, archaeological, cultural resources, biological resources and wetlands.
 - .15 Pesticide treatment plan to be included and updated, as required.

1.4 FIRES

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

1.5 DRAINAGE

- .1 Develop and submit erosion and Sediment Control Plan (ESC) identifying type and location of erosion and sediment controls provided. Plan to include monitoring and reporting requirements to assure that control measures are in compliance with erosion and sediment control plan, Federal, Provincial, and Municipal laws and regulations, EPA 832/R-92-005, Chapter 3.
- .2 Storm Water Pollution Prevention Plan (SWPPP) to be substituted for erosion and sediment control plan.

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| 1.5 DRAINAGE
(Cont'd) | .3 | Provide temporary drainage and pumping required to keep excavations and site free from water. |
| | .4 | Ensure pumped water into waterways, sewer or drainage systems is free of suspended materials. |
| | .5 | Control disposal or runoff of water containing suspended materials or other harmful substances in accordance with local authority requirements. |

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| 1.6 WORK ADJACENT
TO WATERWAYS | .1 | Construction equipment to be operated on land only. |
| | .2 | Use waterway beds for borrow material only after written receipt of approval from Departmental Representative. |
| | .3 | Waterways to be kept free of excavated fill, waste material and debris. |
| | .4 | Design and construct temporary crossings to minimize erosion to waterways. |
| | .5 | Do not skid logs or construction materials across waterways. |
| | .6 | Avoid indicated spawning beds when constructing temporary crossings of waterways. |
| | .7 | Blasting is allowed only above water and 100 m minimum from indicated spawning beds. |

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| 1.7 POLLUTION
CONTROL | .1 | Maintain temporary erosion and pollution control features installed under this Contract. |
| | .2 | Control emissions from equipment and plant in accordance with local authorities' emission requirements. |
| | .3 | Prevent sandblasting and other extraneous materials from contaminating air and waterways beyond application area. |
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| 1.7 POLLUTION
CONTROL
<u>(Cont'd)</u> | .3 | (Cont'd)
.1 Provide temporary enclosures where directed by Departmental Representative. |
| | .4 | Cover or wet down dry materials and rubbish to prevent blowing dust and debris. Provide dust control for temporary roads. |
| 1.8 HISTORICAL/
ARCHAEOLOGICAL
CONTROL
<u></u> | .1 | Provide historical, archaeological, cultural resources, biological resources, and wetlands plan that defines procedures for identifying and protecting historical, archaeological, cultural resources, biological resources and wetlands known to be on project site: and identifies procedures to be followed if historical archaeological, cultural resources, biological resources and wetlands not previously known to be onsite or in area are discovered during construction. |
| | .2 | Plan: include methods to assure protection of known or discovered resources and identify lines of communication between Contractor personnel and Departmental Representative. |
| 1.9 NOTIFICATION
<u></u> | .1 | Departmental Representative will notify Contractor in writing of observed noncompliance with Federal, Provincial or Municipal environmental laws or regulations, permits, and other elements of Contractor's Environmental Protection plan. |
| | .2 | Contractor: after receipt of such notice, inform Departmental Representative of proposed corrective action and take such action for approval by Departmental Representative.
.1 Take action only after receipt of written approval by Departmental Representative. |
| | .3 | Departmental Representative will issue stop order of work until satisfactory corrective action has been taken. |
| | .4 | No time extensions granted or equitable adjustments allowed to Contractor for such suspensions. |
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PART 2 - PRODUCTS

2.1 NOT USED .1 Not Used.

PART 3 - EXECUTION

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

.2 Bury rubbish and waste materials on site where directed after receipt of written approval from Departmental Representative.

.3 Ensure public waterways, storm and sanitary sewers remain free of waste and volatile materials disposal.

.4 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11.

.5 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21.
.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

PART 1 - GENERAL

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| <u>1.1 REFERENCES AND CODES</u> | .1 | Perform Work in accordance with National Building Code of Canada (NBC) 2010, National Fire Code of Canada (NFC) 2010 and Ontario Building Code (OBC) 2012, including all amendments up to bid closing date and other codes of provincial or local application provided that in case of conflict or discrepancy, more stringent requirements apply as directed by the Departmental Representative. |
| | .2 | Meet or exceed requirements of:
.1 Contract documents.
.2 Specified standards, codes and referenced documents. |
| <u>1.2 HAZARDOUS MATERIAL DISCOVERY</u> | .1 | Stop work immediately and notify Departmental Representative if materials which may contain designated substances or PCB's, other than those identified in Section 01 35 29 are discovered in course of work. |
| <u>1.3 BUILDING SMOKING ENVIRONMENT</u> | .1 | Comply with smoking restrictions. |
| <u>1.4 IAQ - INDOOR AIR QUALITY</u> | .1 | Comply with CSA-Z204-94(R1999), Guideline for Managing Indoor Air Quality in Office Buildings and CSA B651-12. |
| <u>1.5 TAXES</u> | .1 | Pay applicable Federal, Provincial and Municipal taxes. |
| <u>1.6 EXAMINATION</u> | .1 | Examine existing conditions and determine conditions affecting work. |
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PART 2 - PRODUCTS

2.1 NOT USED .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED .1 Not Used.

PART 1 - GENERAL

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| <u>1.1 SECTION INCLUDES</u> | .1 | Inspection and testing, administrative and enforcement requirements. |
| | .2 | Tests and mix designs. |
| | .3 | Mock-ups. |
| | .4 | Mill tests. |
| | .5 | Equipment and system adjust and balance. |
| <u>1.2 RELATED SECTIONS</u> | .1 | Section 01 91 13 - Commissioning - General Requirements. |
| <u>1.3 INSPECTION</u> | .1 | Allow Departmental Representative access to Work. If part of Work is in preparation at locations other than Place of Work, allow access to such Work whenever it is in progress. |
| | .2 | Give timely notice requesting inspection if Work is designated for special tests, inspections or approvals by Departmental Representative instructions, or law of Place of Work. |
| | .3 | If Contractor covers or permits to be covered Work that has been designated for special tests, inspections or approvals before such is made, uncover such Work, have inspections or tests satisfactorily completed and make good such Work. |
| | .4 | Departmental Representative may order any part of Work to be examined if Work is suspected to be not in accordance with Contract Documents. If, upon examination such work is found not in accordance with Contract Documents, correct such Work and pay cost of examination and correction. If such Work is found in accordance with Contract Documents, Departmental Representative shall pay cost of examination and replacement. |
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1.4 INDEPENDENT
INSPECTION AGENCIES

- .1 Independent Inspection/Testing Agencies will be engaged by Departmental Representative for purpose of inspecting and/or testing portions of Work, above and beyond those required of the Contractor. Cost of such services will be borne by Departmental Representative.
- .3 Provide equipment required for executing inspection and testing by appointed agencies.
- .4 Employment of inspection/testing agencies does not relax responsibility to perform Work in accordance with Contract Documents.
- .5 If defects are revealed during inspection and/or testing, appointed agency will request additional inspection and/or testing to ascertain full degree of defect. Correct defect and irregularities as advised by Departmental Representative at no cost to Departmental Representative. Pay costs for retesting and reinspection.

1.5 ACCESS TO WORK

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

1.6 PROCEDURES

- .1 Notify appropriate agency and Departmental Representative in advance of requirement for tests, in order that attendance arrangements can be made.
 - .2 Submit samples and/or materials required for testing, as specifically requested in specifications. Submit with reasonable promptness and in an orderly sequence so as not to cause delay in Work.
 - .3 Provide labour and facilities to obtain and handle samples and materials on site. Provide sufficient space to store and cure test samples.
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- 1.7 REJECTED WORK
- .1 Remove defective Work, whether result of poor workmanship, use of defective products or damage and whether incorporated in Work or not, which has been rejected by Departmental Representative as failing to conform to Contract Documents. Replace or re-execute in accordance with Contract Documents.
 - .2 Make good other Contractor's work damaged by such removals or replacements promptly.
 - .3 If in opinion of Departmental Representative it is not expedient to correct defective Work or Work not performed in accordance with Contract Documents, Departmental Representative may deduct from Contract Amount difference in value between Work performed and that called for by Contract Documents, amount of which shall be determined by Departmental Representative.

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

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

- 1.10 MOCK-UPS
- .1 Prepare mock-ups for Work specifically requested in specifications. Include for Work of all Sections required to provide mock-ups.
 - .2 Construct in all locations acceptable to Departmental Representative.
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| <u>1.10 MOCK-UPS
(Cont'd)</u> | .3 | Prepare mock-ups for Departmental Representative's review with reasonable promptness and in an orderly sequence, so as not to cause any delay in Work. |
| | .4 | Failure to prepare mock-ups in ample time is not considered sufficient reason for an extension of Contract Time and no claim for extension by reason of such default will be allowed. |
| | .5 | If requested, Departmental Representative will assist in preparing a schedule fixing dates for preparation. |
| | .6 | Specification section identifies whether mock-up may remain as part of Work or if it is to be removed and when. |

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| <u>1.11 MILL TESTS</u> | .1 | Submit mill test certificates as requested. |
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| <u>1.12 EQUIPMENT AND
SYSTEMS</u> | .1 | Submit testing, adjusting and balancing reports for mechanical, electrical systems. |
| | .2 | Submit Commissioning Documentation in accordance with Section 01 91 13. |

PART 2 - PRODUCTS

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| <u>2.1 NOT USED</u> | .1 | Not Used. |
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PART 3 - EXECUTION

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| <u>3.1 NOT USED</u> | .1 | Not Used. |
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PART 1 - GENERAL

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| <u>1.1 SECTION INCLUDES</u> | .1 | Temporary utilities. |
| <u>1.2 RELATED SECTIONS</u> | .1 | Section 01 52 00 - Construction Facilities. |
| | .2 | Section 01 56 00 - Temporary Barriers and Enclosures. |
| <u>1.3 SUBMITTALS</u> | .1 | Provide submittals in accordance with Section 01 33 00. |
| <u>1.4 INSTALLATION AND REMOVAL</u> | .1 | Provide temporary utilities controls in order to execute work expeditiously. |
| | .2 | Remove from site all such work after use. |
| <u>1.5 WATER SUPPLY</u> | .1 | Departmental Representative will provide continuous supply of potable water for construction use. |
| | .2 | Arrange for connection with appropriate utility company and pay all costs for installation, maintenance and removal. |
| | .3 | Departmental Representative will pay for utility charges at prevailing rates. |
| <u>1.6 TEMPORARY POWER AND LIGHT</u> | .1 | Departmental Representative will pay for temporary power during construction for temporary lighting and operating of power tools, to a maximum supply of 120 volts 15 amps. |
| | .2 | Arrange for connection with appropriate utility company. Pay all costs for installation, maintenance and removal. |
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| <u>1.6 TEMPORARY POWER AND LIGHT</u>
(Cont'd) | .3 | Temporary power for electric cranes and other equipment requiring in excess of above is responsibility of Contractor. |
| | .4 | Provide and maintain temporary lighting throughout project. Ensure level of illumination on all floors and stairs is not less than 162 lx. |
| | .5 | Electrical power and lighting systems installed under this Contract may be used for construction requirements only with prior approval of Departmental Representative provided that guarantees are not affected. Make good damage to electrical system caused by use under this Contract. Replace lamps which have been used for more than 3 months. |
| <u>1.7 TEMPORARY COMMUNICATION FACILITIES</u> | .1 | Provide and pay for temporary telephone, data hook up, lines and equipment necessary for own use and use of Departmental Representative. |
| <u>1.8 FIRE PROTECTION</u> | .1 | Provide and maintain temporary fire protection equipment during performance of Work required by insurance companies having jurisdiction and governing codes, egulations and bylaws. |
| | .2 | Burning rubbish and construction waste materials is not permitted on site. |

PART 2 - PRODUCTS

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| <u>2.1 NOT USED</u> | .1 | Not Used. |
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PART 3 - EXECUTION

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| <u>3.1 NOT USED</u> | .1 | Not Used. |
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PART 1 - GENERAL

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| <u>1.1 SECTION INCLUDES</u> | .1 | Construction aids. |
| | .2 | Office and sheds. |
| | .3 | Parking. |
| | .4 | Project identification. |
| <u>1.2 REFERENCES</u> | .1 | Canadian Standards Association (CSA International) |
| | .1 | CSA Z797-09(R2014), Code of practice for Access Scaffold. |
| | .2 | CAN/CSA-Z321-96(R2006), Signs and Symbols for the Occupational Environment, withdrawn but still available from CSA, CCOHS and Techstreet. |
| <u>1.3 SUBMITTALS</u> | .1 | Provide submittals in accordance with Section 01 33 00. |
| <u>1.4 INSTALLATION AND REMOVAL</u> | .1 | Prepare site plan indicating proposed location and dimensions of area to be fenced and used by Contractor, number of trailers to be used, avenues of ingress/egress to fenced area and details of fence installation. |
| | .2 | Identify areas which have to be gravelled to prevent tracking of mud. |
| | .3 | Indicate use of supplemental or other staging area. |
| | .4 | Provide construction facilities in order to execute work expeditiously. |
| | .5 | Remove from site all such work after use. |
| <u>1.5 SCAFFOLDING</u> | .1 | Scaffolding in accordance with CSA Z797. |
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| <u>1.5 SCAFFOLDING
(Cont'd)</u> | .2 | Provide and maintain scaffolding, ramps, and ladders. |
| <u>1.6 HOISTING</u> | .1 | Provide, operate and maintain hoists/cranes required for moving of workers, materials and equipment. Make financial arrangements with Subcontractors for use thereof. |
| | .2 | Hoists/cranes shall be operated by qualified operator. |
| <u>1.7 ELEVATORS</u> | .1 | Designated existing elevators may be used by construction personnel and transporting of materials. Co-ordinate use with Departmental Representative. Maintain elevator in clean state, free of debris at all times. |
| | .2 | Provide protective coverings for finish surfaces of cars and entrances. |
| <u>1.8 SITE
STORAGE/LOADING</u> | .1 | Confine work and operations of employees to areas defined by Contract Documents. Do not unreasonably encumber premises with products. |
| | .2 | Do not load or permit to load any part of Work with a weight or force that will endanger the Work. |
| <u>1.9 CONSTRUCTION
PARKING</u> | .1 | Parking will be permitted outside entrance gate provided it does not disrupt performance of Work. |
| | .2 | Provide and maintain adequate access to project site. |
| | .3 | Build and maintain temporary roads where indicated or directed by Departmental Representative and provide snow removal during period of Work. |
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| 1.9 CONSTRUCTION
PARKING
<u>(Cont'd)</u> | .4 | If authorized to use existing roads for access to project site, maintain such roads for duration of Contract and make good damage resulting from Contractors' use of roads. |
| | .5 | Clean construction runways and taxi areas where used by Contractor's equipment. |
| 1.10 EQUIPMENT,
TOOL AND MATERIALS
STORAGE
<u></u> | .1 | Provide and maintain, in a clean and orderly condition, lockable weatherproof sheds for storage of tools, equipment and materials. |
| | .2 | Locate materials not required to be stored in weatherproof sheds on site in a manner to cause least interference with work activities. |
| 1.11 SANITARY
FACILITIES
<u></u> | .1 | Provide sanitary facilities for work force in accordance with governing regulations and ordinances. |
| | .2 | Post notices and take such precautions as required by local health authorities. Keep area and premises in sanitary condition. |
| | .3 | When permanent water and drain connections are completed, provide temporary water closets and urinals complete with temporary enclosures, inside building. Permanent facilities may be used on approval of Departmental Representative. |
| 1.12 CONSTRUCTION
SIGNAGE
<u></u> | .1 | No other signs or advertisements, other than warning signs, are permitted on site. |
| | .2 | Signs and notices for safety and instruction shall be in both official languages. Graphic symbols shall conform to CAN/CSA-Z321. |
| | .3 | Maintain approved signs and notices in good condition for duration of project, and dispose of off site on completion of project or earlier if directed by Departmental Representative. |
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1.13 PROTECTION AND
MAINTENANCE OF
TRAFFIC

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

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| 1.13 PROTECTION AND
MAINTENANCE OF
TRAFFIC
(Cont'd) | .14 | Remove, upon completion of work, haul roads designated by Departmental Representative. |
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| 1.14 CLEAN-UP | .1 | Remove construction debris, waste materials, packaging material from work site daily. |
| | .2 | Clean dirt or mud tracked onto paved or surfaced roadways. |
| | .3 | Store materials resulting from demolition activities that are salvageable. |
| | .4 | Stack stored new or salvaged material. |

PART 2 - PRODUCTS

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| 2.1 NOT USED | .1 | Not Used. |
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PART 3 - EXECUTION

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| 3.1 NOT USED | .1 | Not Used. |
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PART 1 - GENERAL

<u>1.1 SECTION INCLUDES</u>	.1	Barriers.
	.2	Environmental Controls.
	.3	Traffic Controls.
	.4	Fire Routes.
<u>1.2 RELATED SECTIONS</u>	.1	Section 01 51 00 - Temporary Utilities.
	.2	Section 01 52 00 - Construction Facilities.
<u>1.3 REFERENCES</u>	.1	Canadian General Standards Board (CGSB): .1 CAN/CGSB-1.189-2000, Exterior Alkyd Primer for Wood. .2 CAN/CGSB-1.59-97, Alkyd Exterior Gloss Enamel.
	.2	Canadian Standards Association (CSA): .1 CSA 0121-08(R2013), Douglas Fir Plywood.
<u>1.4 INSTALLATION AND REMOVAL</u>	.1	Provide temporary controls in order to execute Work expeditiously.
	.2	Remove from site all such work after use.
<u>1.5 HOARDING</u>	.1	Provide barriers around trees and plants designated to remain. Protect from damage by equipment and construction procedures.
	.2	Erect temporary site enclosure using modular freestanding fencing: galvanized, minimum 1.8 m high, chain link or welded steel mesh, pipe rail. Provide one lockable truck entrance gate and at least one pedestrian door as directed and conforming to applicable traffic restrictions on adjacent streets. Equip gates with locks and keys. Maintain fence in good repair.

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| <u>1.6 GUARD RAILS AND BARRICADES</u> | .1 | Provide secure, rigid guard rails and barricades around open shafts, and open edges of roofs. |
| | .2 | Provide as required by governing authorities. |
| <u>1.7 WEATHER ENCLOSURES</u> | .1 | Provide weather tight closures to unfinished door and window openings, tops of shafts and other openings in floors and roofs. |
| | .2 | Close off floor areas where walls are not finished; seal off other openings; enclose building interior work for temporary heat. |
| | .3 | Design enclosures to withstand wind pressure and snow loading. |
| <u>1.8 ACCESS TO SITE</u> | .1 | Provide and maintain access roads, sidewalk crossings, ramps and construction runways as may be required for access to Work. |
| <u>1.9 PUBLIC TRAFFIC FLOW</u> | .1 | Provide and maintain competent signal flag operators, traffic signals, barricades and flares, lights, or lanterns as required to perform Work and protect the public. |
| <u>1.10 FIRE ROUTES</u> | .1 | Maintain access to property including overhead clearances for use by emergency response vehicles. |
| <u>1.11 PROTECTION FOR OFF-SITE AND PUBLIC PROPERTY</u> | .1 | Protect surrounding private and public property from damage during performance of Work. |
| | .2 | Be responsible for damage incurred. |
| <u>1.12 PROTECTION OF BUILDING FINISHES</u> | .1 | Provide protection for finished and partially finished building finishes and equipment during performance of Work. |
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| 1.12 PROTECTION OF BUILDING FINISHES
(Cont'd) | .2 | Provide necessary screens, covers, and hoardings. |
| | .3 | Confirm with Departmental Representative locations and installation schedule 3 days prior to installation. |
| | .4 | Be responsible for damage incurred due to lack of or improper protection. |
| 1.13 PROTECTION OF LIGHTNING PROTECTION SYSTEM | .1 | Provide protection for building lightning protection system and ensure system remains fully operational during performance of Work. |
| | .2 | Provide independant testing and inspection company to test system upon completion of Work to ensure system has been fully reinstated and is operating in its full capacity. |

PART 2 - PRODUCTS

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| <u>2.1 NOT USED</u> | .1 | Not Used. |
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PART 3 - EXECUTION

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| <u>3.1 NOT USED</u> | .1 | Not Used. |
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PART 1 - GENERAL

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| <u>1.1 SECTION INCLUDES</u> | .1 | Product quality, availability, storage, handling, protection, and transportation. |
| | .2 | Manufacturer's instructions. |
| | .3 | Quality of Work, coordination and fastenings. |
| | .4 | Existing facilities. |
| <u>1.2 RELATED SECTIONS</u> | .1 | Section 01 45 00 - Quality Control. |
| <u>1.3 REFERENCES</u> | .1 | Within text of specifications, reference may be made to reference standards. |
| | .2 | Conform to these standards, in whole or in part as specifically requested in specifications. |
| | .3 | If there is question as to whether any product or system is in conformance with applicable standards, Departmental Representative reserves right to have such products or systems tested to prove or disprove conformance. |
| | .4 | The cost for such testing will be born by Departmental Representative in event of conformance with Contract Documents or by Contractor in event of non-conformance. |
| | .5 | Conform to latest date of issue of referenced standards in effect on date of submission of Bids, except where specific date or issue is specifically noted. |
| | .6 | OPSS Ontario Provincial Standard Specifications and OPSD Ontario Provincial Standard Drawings quoted in these specifications are available online at http://www.raqsa.mto.gov.on.ca/techpubs/ops.nsf/OPSHomepage . |
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1.4 QUALITY

- .1 Products, materials, equipment and articles (referred to as products throughout specifications) incorporated in Work shall be new, not damaged or defective, and of best quality (compatible with specifications) for purpose intended. If requested, furnish evidence as to type, source and quality of Products provided.
- .2 Defective products, whenever identified prior to completion of Work, will be rejected, regardless of previous inspections. Inspection does not relieve responsibility, but is precaution against oversight or error. Remove and replace defective products at own expense and be responsible for delays and expenses caused by rejection.
- .3 Should any dispute arise as to quality or fitness of products, decision rests strictly with Departmental Representative based upon requirements of Contract Documents.
- .4 Unless otherwise indicated in specifications, maintain uniformity of manufacture for any particular or like item throughout building.
- .5 Permanent labels, trademarks and nameplates on products are not acceptable in prominent locations, except where required for operating instructions, or when located in mechanical or electrical rooms.

1.5 AVAILABILITY

- .1 Immediately upon signing Contract, review product delivery requirements and anticipate foreseeable supply delays for any items. If delays in supply of products are foreseeable, notify Departmental Representative of such, in order that substitutions or other remedial action may be authorized in ample time to prevent delay in performance of Work.
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<u>1.5 AVAILABILITY (Cont'd)</u>	.2	In event of failure to notify Departmental Representative at commencement of Work and should it subsequently appear that Work may be delayed for such reason, Departmental Representative reserves right to substitute more readily available products of similar character, at no increase in Contract Price or Contract Time.
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<u>1.6 METRIC SIZED MATERIALS</u>	.1	SI metric units of measurement are used exclusively on the drawings and in the specifications for this project.
	.2	The Contractor is required to provide metric products in the sizes called for in the Contract Documents except where a valid claim can be made that a particular product is not available on the Canadian market.
	.3	Claims for exemptions from use of metric sized products shall be in writing and fully substantiated with supportive documentation. Promptly submit application to Departmental Representative for consideration and ruling. Non-metric sized products may not be used unless Contractor's application has been approved in writing by the Departmental Representative.
	.4	Difficulties caused by the Contractor's lack of planning and effort to obtain modular metric sized products which are available on the Canadian market will not be considered sufficient reasons for claiming that they cannot be provided.
	.5	Claims for additional costs due to provision of specified modular metric sized products will not be considered.

<u>1.7 STORAGE, HANDLING AND PROTECTION</u>	.1	Handle and store products in manner to prevent damage, adulteration, deterioration and soiling and in accordance with manufacturer's instructions when applicable.
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- 1.7 STORAGE,
HANDLING AND
PROTECTION
(Cont'd)
- .2 Store packaged or bundled products in original and undamaged condition with manufacturer's seal and labels intact. Do not remove from packaging or bundling until required in Work.
 - .3 Store products subject to damage from weather in weatherproof enclosures.
 - .4 Store cementitious products clear of earth or concrete floors, and away from walls.
 - .5 Keep sand, when used for grout or mortar materials, clean and dry. Store sand on wooden platforms and cover with waterproof tarpaulins during inclement weather.
 - .6 Store sheet materials, lumber and metal panels on flat, solid supports and keep clear of ground. Slope to shed moisture.
 - .7 Store and mix paints in heated and ventilated room. Remove oily rags and other combustible debris from site daily. Take every precaution necessary to prevent spontaneous combustion.
 - .8 Remove and replace damaged products at own expense and to satisfaction of Departmental Representative.
 - .9 Touch-up damaged factory finished surfaces to Departmental Representative's satisfaction. Use touch-up materials to match original. Do not paint over name plates.

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

1.9 MANUFACTURER'S INSTRUCTIONS

- .1 Unless otherwise indicated in specifications, install or erect products in accordance with manufacturer's instructions. Do not rely on labels or enclosures provided with products. Obtain written instructions directly from manufacturers.
- .2 Notify Departmental Representative in writing, of conflicts between specifications and manufacturer's instructions, so that Departmental Representative may establish course of action.
- .3 Improper installation or erection of products, due to failure in complying with these requirements, authorizes Departmental Representative to require removal and re-installation at no increase in Contract Price or Contract Time.

1.10 QUALITY OF WORK

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

1.11 CO-ORDINATION

- .1 Ensure cooperation of workers in laying out Work. Maintain efficient and continuous supervision.
 - .2 Be responsible for coordination and placement of openings, sleeves and accessories.
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- 1.12 CONCEALMENT
- .1 In finished areas, conceal pipes, ducts and wiring in floors, walls and ceilings, except where indicated otherwise.
 - .2 Before installation, inform Departmental Representative if there is interference. Install as directed by Departmental Representative.
- 1.13 REMEDIAL WORK
- .1 Perform remedial work required to repair or replace parts or portions of Work identified as defective or unacceptable. Coordinate adjacent affected Work as required.
 - .2 Perform remedial work by specialists familiar with materials affected. Perform in a manner to neither damage nor put at risk any portion of Work.
- 1.14 LOCATION OF FIXTURES
- .1 Consider location of fixtures, outlets, and mechanical and electrical items indicated as approximate.
 - .2 Inform Departmental Representative of conflicting installation. Install as directed.
- 1.15 FASTENINGS
- .1 Provide metal fastenings and accessories in same texture, colour and finish as adjacent materials, unless indicated otherwise.
 - .2 Prevent electrolytic action between dissimilar metals and materials.
 - .3 Use non-corrosive hot dip galvanized steel fasteners and anchors for securing exterior work, unless stainless steel or other material is specifically requested in affected specification Section.
 - .4 Space anchors within individual load limit or shear capacity and ensure they provide positive permanent anchorage. Wood, or any other organic material plugs are not acceptable.
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| <u>1.15 FASTENINGS
(Cont'd)</u> | .5 | Keep exposed fastenings to a minimum, space evenly and install neatly. |
| | .6 | Fastenings which cause spalling or cracking of material to which anchorage is made are not acceptable. |
| <u>1.16 FASTENINGS -
EQUIPMENT</u> | .1 | Use fastenings of standard commercial sizes and patterns with material and finish suitable for service. |
| | .2 | Use heavy hexagon heads, semi-finished unless otherwise specified. Use No.304 stainless steel for exterior areas. |
| | .3 | Bolts may not project more than one diameter beyond nuts. |
| | .4 | Use plain type washers on equipment, sheet metal and soft gasket lock type washers where vibrations occur. Use resilient washers with stainless steel. |
| <u>1.17 PROTECTION OF
WORK IN PROGRESS</u> | .1 | Prevent overloading of any part of building. Do not cut, drill or sleeve any load bearing structural member, unless specifically indicated without written approval of Departmental Representative. |
| <u>1.18 EXISTING
UTILITIES</u> | .1 | When breaking into or connecting to existing services or utilities, execute Work at times directed by local governing authorities, with minimum of disturbance to Work, and/or building occupants and pedestrian and vehicular traffic. |
| | .2 | Protect, relocate or maintain existing active services. When services are encountered, cap off in manner approved by authority having jurisdiction. Stake and record location of capped service. |
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PART 2 - PRODUCTS

2.1 NOT USED .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED .1 Not Used.

PART 1 - GENERAL

- 1.1 SUBMITTALS
- .1 Submittals: in accordance with Section 01 33 00.
 - .2 Submit written request in advance of cutting or alteration which affects:
 - .1 Structural integrity of elements of project.
 - .2 Integrity of weather-exposed or moisture-resistant elements.
 - .3 Efficiency, maintenance, or safety of operational elements.
 - .4 Visual qualities of sight-exposed elements.
 - .5 Work of Owner or separate contractor.
 - .3 Include in request:
 - .1 Identification of project.
 - .2 Location and description of affected Work.
 - .3 Statement on necessity for cutting or alteration.
 - .4 Description of proposed Work, and products to be used.
 - .5 Alternatives to cutting and patching.
 - .6 Effect on Work of Owner or separate contractor.
 - .7 Written permission of affected separate contractor.
 - .8 Date and time work will be executed.
- 1.2 MATERIALS
- .1 Required for original installation.
 - .2 Change in Materials: Submit request for substitution in accordance with Section 01 33 00.
- 1.3 PREPARATION
- .1 Inspect existing conditions, including elements subject to damage or movement during cutting and patching.
 - .2 After uncovering, inspect conditions affecting performance of Work.
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1.3 PREPARATION
(Cont'd)

- .3 Beginning of cutting or patching means acceptance of existing conditions.
- .4 Provide supports to assure structural integrity of surroundings; provide devices and methods to protect other portions of project from damage.
- .5 Provide protection from elements for areas which are to be exposed by uncovering work; maintain excavations free of water.

1.4 EXECUTION

- .1 Execute cutting, fitting, and patching to complete Work.
- .2 Fit several parts together, to integrate with other Work.
- .3 Uncover Work to install ill-timed Work.
- .4 Remove and replace defective and non-conforming Work.
- .5 Provide openings in non-structural elements of Work for penetrations of mechanical and electrical Work.
- .6 Execute Work by methods to avoid damage to other Work, and which will provide proper surfaces to receive patching and finishing.
- .7 Employ original installer to perform cutting and patching for weather-exposed and moisture-resistant elements, and sight-exposed surfaces.
- .8 Cut rigid materials using masonry saw or core drill. Pneumatic or impact tools not allowed on masonry work without prior approval.
- .9 Restore work with new products in accordance with requirements of Contract Documents.
- .10 Submit proposed materials, finishes and installation method for patching to Departmental Representative for approval, prior to patching.

<u>1.4 EXECUTION</u> <u>(Cont'd)</u>	.11	Refinish surfaces to match adjacent finishes: Refinish continuous surfaces to nearest intersection. Refinish assemblies by refinishing entire unit.
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<u>1.5 WASTE</u> <u>MANAGEMENT AND</u> <u>DISPOSAL</u>	.1	Separate waste materials for reuse, and recycling in accordance with Section 01 74 21.
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PART 2 - PRODUCTS

<u>2.1 NOT USED</u>	.1	Not Used.
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PART 3 - EXECUTION

<u>3.1 NOT USED</u>	.1	Not Used.
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PART 1 - GENERAL

1.1 SECTION
INCLUDES

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

1.2 PROJECT
CLEANLINESS

- .1 Maintain Work in tidy condition, free from accumulation of waste products and debris, other than that caused by Owner or other Contractors.
 - .2 Remove waste materials from site at regularly scheduled times or dispose of as directed by Departmental Representative. Do not burn waste materials on site.
 - .3 Clear snow and ice from access to building, bank/pile snow in designated areas only.
 - .4 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
 - .5 Provide on-site containers for collection of waste materials and debris.
 - .6 Provide and use clearly marked separate bins for recycling. Refer to Section 01 74 21.
 - .7 Remove waste material and debris from site and deposit in waste container at end of each working day.
 - .8 Dispose of waste materials and debris off site.
 - .9 Store volatile waste in covered metal containers, and remove from premises at end of each working day.
 - .10 Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.
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1.2 PROJECT CLEANLINESS (Cont'd)	.11 Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on wet, newly painted surfaces nor contaminate building systems.
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1.3 FINAL CLEANING	.1 When Work is Substantially Performed, remove surplus products, tools, construction machinery and equipment not required for performance of remaining Work.
	.2 Remove waste products and debris other than that caused by others, and leave Work clean and suitable for occupancy.
	.3 Prior to final review, remove surplus products, tools, construction machinery and equipment.
	.4 Remove waste products and debris other than that caused by Owner or other Contractors.
	.5 Remove waste materials from site at regularly scheduled times or dispose of as directed by Departmental Representative. Do not burn waste materials on site.
	.6 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
	.7 Broom clean and wash exterior walks, steps and surfaces; rake clean other surfaces of grounds.
	.8 Remove dirt and other disfiguration from exterior surfaces.
	.9 Clean and sweep roofs, gutters, areaways, and sunken wells.
	.10 Sweep and wash clean paved areas.
	.11 Clean equipment and fixtures to a sanitary condition; clean or replace filters of mechanical equipment.
	.12 Clean roofs, downspouts, and drainage systems.

- | | | |
|---------------------------------------|-----|---|
| <u>1.3 FINAL CLEANING</u>
(Cont'd) | .13 | Remove debris and surplus materials from crawl areas and other accessible concealed spaces. |
| | .14 | Remove snow and ice from access to building. |

PART 2 - PRODUCTS

- | | | |
|---------------------|----|-----------|
| <u>2.1 NOT USED</u> | .1 | Not Used. |
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PART 3 - EXECUTION

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|---------------------|----|-----------|
| <u>3.1 NOT USED</u> | .1 | Not Used. |
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PART 1 - GENERAL

1.1 WASTE
PROCESSING SITES

- .1 Province of: Ontario.
 - .1 Name: Ontario Ministry of Environment,
St. Clair Avenue West, Toronto, ON, M4V 1P5.
 - .2 Telephone: 800-565-4923 or 416-323-4321.
 - .3 Fax: 416-323-4682.
- .2 Recycling Council of Ontario: 51 Wolseley
Street, 2nd Floor, Toronto, ON, M5T 1A4.
 - .1 Telephone: 416-657-2797.
 - .2 Fax: 416-960-8053
 - .3 Email: rco@rco.on.ca.
 - .4 Internet: <http://www.rco.on.ca/>.

1.2 STORAGE,
HANDLING AND
PROTECTION

- .1 Store, materials to be reused, recycled and
salvaged in locations as directed by
Departmental Representative.
 - .2 Unless specified otherwise, materials for
removal do not become Contractor's property.
 - .3 Protect, stockpile, store and catalogue
salvaged items.
 - .4 Separate non-salvageable materials from
salvaged items. Transport and deliver
non-salvageable items to licensed disposal
facility.
 - .5 Protect structural components not removed for
demolition from movement or damage.
 - .6 Support affected structures. If safety of
building is endangered, cease operations and
immediately notify Departmental
Representative.
 - .7 Protect surface drainage, mechanical and
electrical from damage and blockage.
 - .8 Separate and store materials produced during
dismantling of structures in designated areas.
-

1.2 STORAGE, HANDLING AND PROTECTION (Cont'd)	.9	Prevent contamination of materials to be salvaged and recycled and handle materials in accordance with requirements for acceptance by designated facilities. .1 On-site source separation is recommended. .2 Remove co-mingled materials to off-site processing facility for separation. .3 Provide waybills for separated materials.
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1.3 DISPOSAL OF WASTES	.1	Do not bury rubbish or waste materials.
	.2	Do not dispose of waste, volatile materials, mineral spirits, oil, paint thinner, into waterways, storm, or sanitary sewers.
	.3	Keep records of construction waste including: .1 Number and size of bins. .2 Waste type of each bin. .3 Total tonnage generated. .4 Tonnage reused or recycled. .5 Reused or recycled waste destination.
	.4	Remove materials from deconstruction as deconstruction/disassembly Work progresses.
	.5	Prepare project summary to verify destination and quantities on a material-by-material basis as identified in pre-demolition material audit.

1.4 USE OF SITE AND FACILITIES	.1	Execute work with least possible interference or disturbance to normal use of premises.
	.2	Maintain security measures established by existing facility.

1.5 SCHEDULING	.1	Coordinate Work with other activities at site to ensure timely and orderly progress of Work.
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PART 2 - PRODUCTS

2.1 NOT USED	.1	Not Used.
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PART 3 - EXECUTION

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|--|----|---|
| <u>3.1 APPLICATION</u> | .1 | Do Work in compliance with WRW. |
| | .2 | Handle waste materials not reused, salvaged, or recycled in accordance with appropriate regulations and codes. |
| <u>3.2 CLEANING</u> | .1 | Remove tools and waste materials on completion of Work, and leave work area in clean and orderly condition. |
| | .2 | Clean-up work area as work progresses. |
| | .3 | Source separate materials to be reused/recycled into specified sort areas. |
| <u>3.3 DIVERSION OF MATERIALS</u> | .1 | On-site sale of materials is not permitted. |
| <u>3.5 CONSTRUCTION & DEMOLITION WASTE</u> | .1 | Carefully deconstruct and source separate materials/equipment and divert from D&C waste destined for landfill to maximum extent possible. Reuse, recycle or sell material off site for reuse except where indicated otherwise. On site sales are not permitted. |
| | .2 | For construction and demolition projects, even for those not over 2,000 m ² total floor area, source separate waste and maintain waste audits in accordance with the Environmental Protection Act, Ontario Regulation 102/94 and Ontario Regulation 103/94.
.1 Provide facilities for collection, handling and storage of source separated wastes.
.2 Source separate the following waste:
.1 Brick and portland cement concrete.
.2 Corrugated cardboard.
.3 Wood, not including painted or treated wood or laminated wood.
.4 Gypsum board, unpainted. |
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3.5 CONSTRUCTION &
DEMOLITION WASTE
(Cont'd)

- .2 (Cont'd)
.2 (Cont'd)
.5 Steel.

Section 01 35 43 - Environmental Protection. This section has detailed lists of materials to be recycled.

- .3 Submit a waste reduction workplan indicating the materials and quantities of material that will be recycled and diverted from landfill.
.1 Indicate how material being removed from the site will be reused or recycled.
- .4 Submit proof that all waste is being disposed of at a licensed land fill site or waste transfer site. A copy of the disposal/waste transfer site's license and a letter verifying that said landfill site will accept the waste must be supplied to Departmental Representative prior to removal of waste from the demolition site.

PART 1 - GENERAL

- 1.1 INSPECTION AND DECLARATION
- .1 Contractor's Inspection: Contractor and all Subcontractors shall conduct an inspection of Work, identify deficiencies and defects, and repair as required to conform to Contract Documents.
 - .1 Notify Departmental Representative in writing of satisfactory completion of Contractor's Inspection and that corrections have been made.
 - .2 Request Departmental Representative's Inspection.
 - .2 Departmental Representative's Inspection: Departmental Representative and Contractor will perform inspection of Work to identify obvious defects or deficiencies. Contractor to correct Work accordingly.
 - .3 Completion: submit written certificate that following have been performed:
 - .1 Work has been completed and inspected for compliance with Contract Documents.
 - .2 Defects have been corrected and deficiencies have been completed.
 - .3 Equipment and systems have been tested, adjusted and balanced and are fully operational.
 - .4 Certificates required by PWGSC Fire Protection Engineer have been submitted.
 - .5 Operation of systems have been demonstrated to Owner's personnel.
 - .6 Work is complete and ready for final inspection.
 - .4 Final Inspection: when items noted above are completed, request final inspection of Work by Departmental Representative and Contractor. If Work is deemed incomplete by Departmental Representative, complete outstanding items and request reinspection.
- 1.2 CLEANING
- .1 In accordance with Section 01 74 11.
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<u>1.2 CLEANING</u> (Cont'd)	.2	Remove waste and surplus materials, rubbish and construction facilities from the site in accordance with Section 01 74 21.
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PART 2 - PRODUCTS

<u>2.1 NOT USED</u>	.1	Not Used.
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PART 3 - EXECUTION

<u>3.1 NOT USED</u>	.1	Not Used.
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PART 1 - GENERAL

1.1 SECTION
INCLUDES

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

1.2 RELATED
SECTIONS

- .1 Section 01 91 13 - Commissioning - General Requirements.
- .2 Section 01 79 00 - Demonstration and Training.

1.3 SUBMISSION

- .1 Prepare instructions and data using personnel experienced in maintenance and operation of described products.
 - .2 Copy will be returned after final inspection, with Departmental Representative's comments.
 - .3 Revise content of documents as required prior to final submittal.
 - .4 Two weeks prior to Substantial Performance of the Work, submit to the Departmental Representative, four final copies of maintenance manuals and commissioning documentation in English.
 - .5 Ensure spare parts, maintenance materials and special tools provided are new, undamaged or defective, and of same quality and manufacture as products provided in Work.
-

1.3 SUBMISSION
(Cont'd)

- .6 If requested, furnish evidence as to type, source and quality of products provided.
- .7 Defective products will be rejected, regardless of previous inspections. Replace products at own expense.
- .8 Pay costs of transportation.

1.4 FORMAT

- .1 Organize data in the form of an instructional manual.
- .2 Binders: vinyl, hard covered, 3 'D' ring, loose leaf 219 x 279 mm with spine and face pockets.
- .3 When multiple binders are used, correlate data into related consistent groupings. Identify contents of each binder on spine.
- .4 Cover: Identify each binder with type or printed title 'Project Record Documents'; list title of project and identify subject matter of contents.
- .5 Arrange content by systems, under Section numbers and sequence of Table of Contents.
- .6 Provide tabbed fly leaf for each separate product and system, with typed description of product and major component parts of equipment.
- .7 Text: Manufacturer's printed data, or typewritten data.
- .8 Drawings: provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.
- .9 Provide 1:1 scaled CAD files in dwg format. Forward pdf, NMSEdit Professional spp, MS Word, MS Excel, and Autocad dwg files on USB compatible with PWGSC encryption requirements or through email or alternate electronic file sharing service such as ftp, as directed by Departmental Representative.

1.5 CONTENTS - EACH VOLUME

- .1 Table of Contents: provide title of project;
 - .1 Date of submission; names,

- 1.5 CONTENTS - EACH VOLUME
(Cont'd)
- .1 (Cont'd)
 - .2 Addresses, and telephone numbers of Contractor with name of responsible parties;
 - .3 Schedule of products and systems, indexed to content of volume.
 - .2 For each product or system:
 - .1 List names, addresses and telephone numbers of subcontractors and suppliers, including local source of supplies and replacement parts.
 - .3 Product Data: mark each sheet to clearly identify specific products and component parts, and data applicable to installation; delete inapplicable information.
 - .4 Drawings: supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.
 - .5 Typewritten Text: as required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions specified in Section 01 45 00.
 - .6 Training: Refer to Section 01 79 00.
- 1.6 AS-BUILTS AND SAMPLES
SAMPLES
- .1 In addition to requirements in General Conditions, maintain at the site for Departmental Representative one record copy of:
 - .1 Contract Drawings.
 - .2 Specifications.
 - .3 Amendments and addenda.
 - .4 Change Orders and other modifications to the Contract.
 - .5 Reviewed shop drawings, product data, and samples.
 - .6 Field test records.
 - .7 Inspection certificates.
 - .8 Manufacturer's certificates.
 - .2 Store record documents and samples in field office apart from documents used for construction. Provide files, racks, and secure storage.
-

1.6 AS-BUILTS AND
SAMPLES
(Cont'd)

- .3 Label record documents and file in accordance with Section number listings in List of Contents of this Project Manual. Label each document "PROJECT RECORD" in neat, large, printed letters.
- .4 Maintain record documents in clean, dry and legible condition. Do not use record documents for construction purposes.
- .5 Keep record documents and samples available for inspection by Departmental Representative.
- .6 Turn one set, paper copy and electronic copy, of AS-BUILT drawings and specifications over to Departmental Representative on completion of work. Submit files on USB compatible with PWGSC encryption requirements or through email or alternate electronic file sharing service such as ftp, as directed by Departmental Representative.
- .7 If project is completed without significant deviations from Contract drawings and specifications submit to Departmental Representative one set of drawings and specifications marked "AS-BUILT".

1.7 RECORDING
ACTUAL SITE
CONDITIONS

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

1.7 RECORDING
ACTUAL SITE
CONDITIONS
(Cont'd)

- .4 (Cont'd)
 - .3 Measured locations of internal utilities and appurtenances, referenced to visible and accessible features of construction.
 - .4 Field changes of dimension and detail.
 - .5 Changes made by change orders.
 - .6 Details not on original Contract Drawings.
 - .7 References to related shop drawings and modifications.
- .5 Specifications: legibly mark each item to record actual construction, including:
 - .1 Manufacturer, trade name, and catalogue number of each product actually installed, particularly optional items and substitute items.
 - .2 Changes made by Amendments and change orders.
- .6 Other Documents: maintain manufacturer's certifications, inspection certifications, field test records, required by individual specifications sections.

1.8 EQUIPMENT AND
SYSTEMS

- .1 Each Item of Equipment and Each System: include description of unit or system, and component parts. Give function, normal operation characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.
- .2 Panel board circuit directories: provide electrical service characteristics, controls, and communications.
- .3 Include installed colour coded wiring diagrams.
- .4 Operating Procedures: include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.

1.8 EQUIPMENT AND
SYSTEMS
(Cont'd)

- .5 Maintenance Requirements: include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- .6 Provide servicing and lubrication schedule, and list of lubricants required.
- .7 Include manufacturer's printed operation and maintenance instructions.
- .8 Include sequence of operation by controls manufacturer.
- .9 Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- .10 Provide installed control diagrams by controls manufacturer.
- .11 Provide Contractor's coordination drawings, with installed colour coded piping diagrams.
- .12 Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
- .13 Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- .14 Include test and balancing reports as specified in Section 01 45 00 and 01 91 13.
- .15 Additional requirements: As specified in individual specification sections.

1.9 MATERIALS AND
FINISHES

- .1 Building Products, Applied Materials, and Finishes: include product data, with catalogue number, size, composition, and colour and texture designations.
- .2 Instructions for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

1.9 MATERIALS AND
FINISHES
(Cont'd)

- .3 Moisture-protection and Weather-exposed Products: include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- .4 Additional Requirements: as specified in individual specifications sections.

1.10 SPARE PARTS

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

1.11 MAINTENANCE
MATERIALS

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

1.12 SPECIAL TOOLS

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

1.13 STORAGE,
HANDLING AND
PROTECTION

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

1.14 WARRANTIES AND
BONDS

- .1 Separate each warranty or bond with index tab sheets keyed to Table of Contents listing.
- .2 List subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.
- .3 Obtain warranties and bonds, executed in duplicate by subcontractors, suppliers, and manufacturers, within ten days after completion of the applicable item of work.
- .4 Except for items put into use with Owner's permission, leave date of beginning of time of warranty until the Date of Certificate of Substantial Performance is determined.

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|---------------------------------------|----|--|
| 1.14 WARRANTIES AND BONDS
(Cont'd) | .5 | Verify that documents are in proper form, contain full information, and are notarized. |
| | .6 | Co-execute submittals when required. |
| | .7 | Retain warranties and bonds until time specified for submittal. |

PART 2 - PRODUCTS

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| <u>2.1 NOT USED</u> | .1 | Not Used. |
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PART 3 - EXECUTION

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|---------------------|----|-----------|
| <u>3.1 NOT USED</u> | .1 | Not Used. |
|---------------------|----|-----------|

PART 1 - GENERAL

- | | | |
|-----------------------------|----|---|
| <u>1.1 SECTION INCLUDES</u> | .1 | Procedures for demonstration and instruction of equipment and systems to Owner's O&M personnel. |
| | .2 | O&M personnel includes property facility manager, building operators, maintenance staff, security staff and technical specialists, as applicable. |
| <u>1.2 DESCRIPTION</u> | .1 | Demonstrate operation and maintenance of equipment and systems to Departmental Representative's personnel two weeks prior to date of Substantial performance. |
| | .2 | Departmental Representative will provide list of personnel to receive instructions, and will coordinate their attendance at agreed-upon times. |
| <u>1.3 QUALITY CONTROL</u> | .1 | When specified in individual Sections, require manufacturer to provide authorized representative to demonstrate operation of equipment and systems, instruct Owner's personnel, and provide written report that demonstration and instructions have been completed. |
| | .2 | Submit training schedule of time and date for demonstration and training of each item of equipment and each system in accordance with the training plan four weeks prior to designated dates, for Departmental Representative's approval. |
| | .3 | Submit reports within [one week] after completion of demonstration, that demonstration and instructions have been satisfactorily completed. |
| | .4 | Report shall give time and date of each demonstration and training, with list of persons present. |
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|--|----|--|
| <u>1.4 CONDITIONS FOR DEMONSTRATIONS</u> | .1 | Testing, adjusting, and balancing has been performed and equipment and systems are fully operational. |
| | .2 | Provide copies of completed operation and maintenance manuals for use in demonstrations and instructions. |
| <u>1.5 PREPARATION</u> | .1 | Verify that conditions for demonstration and instructions comply with requirements. |
| | .2 | Verify that designated O&M personnel are present. |
| <u>1.6 DEMONSTRATION AND INSTRUCTIONS</u> | .1 | Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, and maintenance of each item of equipment at agreed upon times, at the designated location. |
| | .2 | Instruct personnel in all phases of operation and maintenance using operation and maintenance manuals as the basis of instruction. |
| | .3 | Review contents of manual in detail to explain all aspects of operation and maintenance. |
| | .4 | Prepare and insert additional data in operations and maintenance manuals when the need for additional data becomes apparent during instructions. |
| <u>1.7 TIME ALLOCATED FOR INSTRUCTIONS</u> | .1 | Allow for amount of time required for instruction of each item of equipment or system as required and agreed upon with Departmental Representative. |

PART 2 - PRODUCTS

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|---------------------|----|-----------|
| <u>2.1 NOT USED</u> | .1 | Not Used. |
|---------------------|----|-----------|

PART 3 - EXECUTION

3.1 NOT USED .1 Not Used.

PART 1 - GENERAL

1.1 SUMMARY

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

1.2 GENERAL

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

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|-------------------------------|----|--|
| 1.2 GENERAL
(Cont'd) | .2 | (Cont'd)
.2 During these checks, adjustments to be made to enhance performance to meet environmental or user requirements. |
| | .3 | Design Criteria: as per client's requirements or determined by designer. To meet Project functional and operational requirements. |
| | .4 | AFD managed projects the term Departmental Representative in Cx specifications to be interpreted as AFD Service Provider. |
| 1.3 COMMISSIONING
OVERVIEW | .1 | Refer to Mechanical and Electrical. |
| | .2 | Cx to be a line item of Contractor's cost breakdown. |
| | .3 | Cx activities supplement field quality and testing procedures described in relevant technical sections. |
| | .4 | Cx is conducted in concert with activities performed during stage of project delivery. Cx identifies issues in Planning and Design stages which are addressed during Construction and Cx stages to ensure the built facility is constructed and proven to operate satisfactorily under weather, environmental and occupancy conditions to meet functional and operational requirements. Cx activities includes transfer of critical knowledge to facility operational personnel. |
| | .5 | Departmental Representative will issue Certificate of Substantial Performance when:
.1 Completed Cx documentation has been received, reviewed for suitability and approved by Departmental Representative.
.2 Equipment, components and systems have been commissioned.
.3 O&M training has been completed. |

- 1.4 NON-CONFORMANCE TO PERFORMANCE VERIFICATION REQUIREMENTS
- .1 Should equipment, system components, and associated controls be incorrectly installed or malfunction during Cx, correct deficiencies, re-verify equipment and components within the unfunctional system, including related systems as deemed required by Departmental Representative, to ensure effective performance.
 - .2 Costs for corrective work, additional tests, inspections, to determine acceptability and proper performance of such items to be borne by Contractor. Above costs to be in form of progress payment reductions or hold-back assessments.
- 1.5 PRE-CX REVIEW
- .1 Before Construction:
 - .1 Review contract documents, confirm by writing to Departmental Representative.
 - .1 Adequacy of provisions for Cx.
 - .2 Aspects of design and installation pertinent to success of Cx.
 - .2 During Construction:
 - .1 Co-ordinate provision, location and installation of provisions for Cx.
 - .3 Before start of Cx:
 - .1 Have completed Cx Plan up-to-date.
 - .2 Ensure installation of related components, equipment, sub-systems, systems is complete.
 - .3 Fully understand Cx requirements and procedures.
 - .4 Have Cx documentation shelf-ready.
 - .5 Understand completely design criteria and intent and special features.
 - .6 Submit complete start-up documentation to Departmental Representative.
 - .7 Have Cx schedules up-to-date.
 - .8 Ensure systems have been cleaned thoroughly.
 - .9 Complete TAB procedures on systems, submit TAB reports to Departmental Representative for review and approval.
 - .10 Ensure "As-Built" system schematics are available.
-

- | | | |
|--|----|--|
| <u>1.5 PRE-CX REVIEW
(Cont'd)</u> | .4 | Inform Departmental Representative in writing of discrepancies and deficiencies on finished works. |
| <u>1.6 CONFLICTS</u> | .1 | Report conflicts between requirements of this section and other sections to Departmental Representative before start-up and obtain clarification. |
| | .2 | Failure to report conflict and obtain clarification will result in application of most stringent requirement. |
| <u>1.7 SUBMITTALS</u> | .1 | Submittals: in accordance with Section 01 33 00.
.1 Submit no later than 4 weeks after award of Contract:
.1 Name of Contractor's Cx agent.
.2 Draft Cx documentation.
.3 Preliminary Cx schedule.
.2 Request in writing to Departmental Representative for changes to submittals and obtain written approval at least 8 weeks prior to start of Cx.
.3 Submit proposed Cx procedures to Departmental Representative where not specified and obtain written approval at least 8 weeks prior to start of Cx.
.4 Provide additional documentation relating to Cx process required by Departmental Representative. |
| <u>1.8 COMMISSIONING
DOCUMENTATION</u> | .1 | Departmental Representative to review and approve Cx documentation. |
| | .3 | Provide completed and approved Cx documentation to Departmental Representative. |
| <u>1.9 COMMISSIONING
SCHEDULE</u> | .1 | Provide detailed Cx schedule as part of construction schedule in accordance with Section 01 32 16. |
-

1.9 COMMISSIONING
SCHEDULE
(Cont'd)

- .2 Provide adequate time for Cx activities prescribed in technical sections and commissioning sections including:
 - .1 Approval of Cx reports.
 - .2 Verification of reported results.
 - .3 Repairs, retesting, re-commissioning, re-verification.
 - .4 Training.

1.10 COMMISSIONING
MEETINGS

- .1 Convene Cx meetings following project meetings: Section 01 32 16 and as specified herein.
- .2 Purpose: to resolve issues, monitor progress, identify deficiencies, relating to Cx.
- .3 Continue Cx meetings on regular basis until commissioning deliverables have been addressed.
- .4 At 60% construction completion stage. Section 01 32 16. Departmental Representative to call a separate Cx scope meeting to review progress, discuss schedule of equipment start-up activities and prepare for Cx. Issues at meeting to include:
 - .1 Review duties and responsibilities of Contractor and subcontractors, addressing delays and potential problems.
 - .2 Determine the degree of involvement of trades and manufacturer's representatives in the commissioning process.
- .5 Thereafter Cx meetings to be held until project completion and as required during equipment start-up and functional testing period.
- .6 Meeting will be chaired by Departmental Representative, who will record and distribute minutes.
- .7 Ensure subcontractors and relevant manufacturer representatives are present at 60% and subsequent Cx meetings and as required.

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| <u>1.11 STARTING AND TESTING</u> | .1 | Contractor assumes liabilities and costs for inspections. Including disassembly and re-assembly after approval, starting, testing and adjusting, including supply of testing equipment. |
| <u>1.12 WITNESSING OF STARTING AND TESTING</u> | .1 | Provide 14 days notice prior to commencement. |
| | .2 | Departmental Representative to witness startstart-up and testing. |
| | .3 | Contractor's Cx Agent to be present at tests performed and documented by sub-trades, suppliers and equipment manufacturers. |
| <u>1.13 MANUFACTURER'S INVOLVEMENT</u> | .1 | Factory testing: manufacturer to: <ul style="list-style-type: none"> .1 Coordinate time and location of testing. .2 Provide testing documentation for approval by Departmental Representative. .3 Arrange for Departmental Representative to witness tests. .4 Obtain written approval of test results and documentation from Departmental Representative before delivery to site. |
| | .2 | Obtain manufacturers installation, start-up and operations instructions prior to start-up of components, equipment and systems and review with Departmental Representative. <ul style="list-style-type: none"> .1 Compare completed installation with manufacturer's published data, record discrepancies, and review with manufacturer. .2 Modify procedures detrimental to equipment performance and review same with manufacturer before start-up. |
| | .3 | Integrity of warranties: <ul style="list-style-type: none"> .1 Use manufacturer's trained start-up personnel where specified elsewhere in other divisions or required to maintain integrity of warranty. .2 Verify with manufacturer that testing as specified will not void warranties. |
| | .4 | Qualifications of manufacturer's personnel: <ul style="list-style-type: none"> .1 Experienced in design, installation and operation of equipment and systems. |

- 1.13 MANUFACTURER'S INVOLVEMENT (Cont'd)
- .4 (Cont'd)
- .2 Ability to interpret test results accurately.
- .3 To report results in clear, concise, logical manner.
- 1.14 PROCEDURES
- .1 Verify that equipment and systems are complete, clean, and operating in normal and safe manner prior to conducting start-up, testing and Cx.
- .2 Conduct start-up and testing in following distinct phases:
- .1 Included in delivery and installation:
- .1 Verification of conformity to specification, approved shop drawings and completion of PI report forms.
- .2 Visual inspection of quality of installation.
- .2 Start-up: follow accepted start-up procedures.
- .3 Operational testing: document equipment performance.
- .4 System PV: include repetition of tests after correcting deficiencies.
- .5 Post-substantial performance verification: to include fine-tuning.
- .3 Correct deficiencies and obtain approval from Departmental Representative after distinct phases have been completed and before commencing next phase.
- .4 Document require tests on approved PV forms.
- .5 Failure to follow accepted start-up procedures will result in re-evaluation of equipment by an independent testing agency selected by Departmental Representative. If results reveal that equipment start-up was not in accordance with requirements, and resulted in damage to equipment, implement following:
- .1 Minor equipment/systems: implement corrective measures approved by Departmental Representative.
- .2 Major equipment/systems: if evaluation report concludes that damage is minor, implement corrective measures approved by Departmental Representative.
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- 1.14 PROCEDURES (Cont'd) .5 (Cont'd)
- .3 If evaluation report concludes that major damage has occurred, Departmental Representative shall reject equipment.
- .1 Rejected equipment to be remove from site and replace with new.
- .2 Subject new equipment/systems to specified start-up procedures.
- 1.15 START-UP DOCUMENTATION .1 Assemble start-up documentation and submit to Departmental Representative for approval before commencement of commissioning.
- .2 Start-up documentation to include:
- .1 Factory and on-site test certificates for specified equipment.
- .2 Pre-start-up inspection reports.
- .3 Signed installation/start-up check lists.
- .4 Start-up reports,
- .5 Step-by-step description of complete start-up procedures, to permit Departmental Representative to repeat start-up at any time.
- 1.16 OPERATION AND MAINTENANCE OF EQUIPMENT AND SYSTEMS .1 After start-up, operate and maintain equipment and systems as directed by equipment/system manufacturer.
- .2 With assistance of manufacturer develop written maintenance program and submit Departmental Representative for approval before implementation.
- .3 Operate and maintain systems for length of time required for commissioning to be completed.
- .4 After completion of commissioning, operate and maintain systems until issuance of certificate of interim acceptance.
- 1.17 TEST RESULTS .1 If start-up, testing and/or PV produce unacceptable results, repair, replace or repeat specified starting and/or PV procedures until acceptable results are achieved.
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| <u>1.17 TEST RESULTS
(Cont'd)</u> | .2 | Provide manpower and materials, assume costs for re-commissioning. |
| <u>1.18 START OF
COMMISSIONING</u> | .1 | Notify Departmental Representative at least 21 days prior to start of Cx. |
| | .2 | Start Cx after elements of building affecting start-up and performance verification of systems have been completed. |
| <u>1.19 INSTRUMENTS /
EQUIPMENT</u> | .1 | Submit to Departmental Representative for review and approval:
.1 Complete list of instruments proposed to be used.
.2 Listed data including, serial number, current calibration certificate, calibration date, calibration expiry date and calibration accuracy. |
| | .2 | Provide the following equipment as required:
.1 2-way radios.
.2 Ladders.
.3 Equipment as required to complete work. |
| <u>1.20 COMMISSIONING
PERFORMANCE
VERIFICATION</u> | .1 | Carry out Cx:
.1 Under actual operating conditions, over entire operating range, in all modes.
.2 On independent systems and interacting systems. |
| | .2 | Cx procedures to be repeatable and reported results are to be verifiable. |
| | .3 | Follow equipment manufacturer's operating instructions. |
| | .4 | EMCS trending to be available as supporting documentation for performance verification. |
| <u>1.21 WITNESSING
COMMISSIONING</u> | .1 | Departmental Representative to witness activities and verify results. |
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1.22 AUTHORITIES
HAVING JURISDICTION

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

1.23 EXTRAPOLATION
OF RESULTS

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

1.24 EXTENT OF
VERIFICATION

- .1 Elsewhere:
 - .1 Provide manpower and instrumentation to verify up to 30% of reported results, unless specified otherwise in other sections.
 - .2 Number and location to be at discretion of Departmental Representative.
 - .3 Conduct tests repeated during verification under same conditions as original tests, using same test equipment, instrumentation.
 - .4 Review and repeat commissioning of systems if inconsistencies found in more than 20% of reported results.
 - .5 Perform additional commissioning until results are acceptable to Departmental Representative.
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| <u>1.25 REPEAT VERIFICATIONS</u> | .1 | Assume costs incurred by Departmental Representative for third and subsequent verifications where:
.1 Verification of reported results fail to receive Departmental Representative's approval.
.2 Repetition of second verification again fails to receive approval.
.3 Departmental Representative deems Contractor's request for second verification was premature. |
| <u>1.26 SUNDRY CHECKS AND ADJUSTMENTS</u> | .1 | Make adjustments and changes which become apparent as Cx proceeds. |
| | .2 | Perform static and operational checks as applicable and as required. |
| <u>1.27 DEFICIENCIES, FAULTS, DEFECTS</u> | .1 | Correct deficiencies found during start-up and Cx to satisfaction of Departmental Representative. |
| | .2 | Report problems, faults or defects affecting Cx to Departmental Representative in writing. Stop Cx until problems are rectified. Proceed with written approval from Departmental Representative. |
| <u>1.28 COMPLETION OF COMMISSIONING</u> | .1 | Upon completion of Cx leave systems in normal operating mode. |
| | .2 | Except for warranty and seasonal verification activities specified in Cx specifications, complete Cx prior to issuance of Interim Certificate of Completion. |
| | .3 | Cx to be considered complete when contract Cx deliverables have been submitted and accepted by Departmental Representative. |
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| <u>1.29 ACTIVITIES
UPON COMPLETION OF
COMMISSIONING</u> | .1 | When changes are made to baseline components or system settings established during Cx process, provide updated Cx form for affected item. |
| <u>1.31 MAINTENANCE
MATERIALS, SPARE
PARTS, SPECIAL
TOOLS</u> | .1 | Supply, deliver, and document maintenance materials, spare parts, and special tools as specified in contract. |
| <u>1.32 OCCUPANCY</u> | .1 | Cooperate fully with Departmental Representative during stages of acceptance and occupancy of facility. |
| <u>1.33 INSTALLED
INSTRUMENTATION</u> | .1 | Use instruments installed under Contract for TAB and PV if:
.1 Accuracy complies with these specifications.
.2 Calibration certificates have been deposited with Departmental Representative. |
| | .2 | Calibrated EMCS sensors may be used to obtain performance data provided that sensor calibration has been completed and accepted. |
| <u>1.34 PERFORMANCE
VERIFICATION
TOLERANCES</u> | .1 | Application tolerances:
.1 Specified range of acceptable deviations of measured values from specified values or specified design criteria. Except for special areas, to be within +/-10% of specified values. |
| | .2 | Instrument accuracy tolerances:
.1 To be of higher order of magnitude than equipment or system being tested. |
| | .3 | Measurement tolerances during verification:
.1 Unless otherwise specified actual values to be within +/-2% of recorded values. |
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<u>1.35 OWNER'S PERFORMANCE TESTING</u>	.1	Performance testing of equipment or system by Departmental Representative will not relieve Contractor from compliance with specified start-up and testing procedures.
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PART 2 - PRODUCTS

<u>2.1 NOT USED</u>	.1	Not Used.
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PART 3 - EXECUTION

<u>3.1 NOT USED</u>	.1	Not Used.
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PART 1 - GENERAL

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| <u>1.1 SUMMARY</u> | .1 | Section Includes:
.1 This section is limited to portions of the Building Management Manual (BMM) provided to Departmental Representative by Contractor. |
| | .2 | Acronyms:
.1 BMM - Building Management Manual.
.2 Cx - Commissioning.
.3 HVAC - Heating, Ventilation and Air Conditioning.
.4 PI - Product Information.
.5 PV - Performance Verification.
.6 TAB - Testing, Adjusting and Balancing.
.7 WHMIS - Workplace Hazardous Materials Information System. |
| <u>1.2 GENERAL REQUIREMENTS</u> | .1 | Standard letter size paper 216 mm x 279 mm. |
| | .2 | Methodology used to facilitate updating. |
| | .3 | Drawings, diagrams and schematics to be professionally developed. |
| | .4 | Electronic copy of data to be in a format accepted and approved by Departmental Representative. |
| <u>1.3 APPROVALS</u> | .1 | Prior to commencement, co-ordinate requirements for preparation, submission and approval with Departmental Representative. |
| <u>1.4 GENERAL INFORMATION</u> | .1 | Provide Departmental Representative the following for insertion into appropriate Part and Section of BMM:
.1 Complete list of names, addresses, telephone and fax numbers of Contractor, sub-contractors that participated in delivery of project - as indicated in Section 1.2 of BMM. |
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1.4 GENERAL INFORMATION (Cont'd)	.1 (Cont'd)	
	.2	Summary of architectural, structural, fire protection, mechanical and electrical systems installed and commissioned - as indicated in Section 1.4 of BMM.
	.1	Including sequence of operation as finalized after commissioning is complete as indicated in Section 2.0 of BMM.
	.3	Description of building operation under conditions of heightened security and emergencies as indicated in Section 2.0 of BMM.
	.4	System, equipment and components Maintenance Management System (MMS) identification - Section 2.1 of BMM.
	.5	Information on operation and maintenance of architectural systems and equipment installed and commissioned - Section 2.0 of BMM.
	.6	Information on operation and maintenance of fire protection and life safety systems and equipment installed and commissioned - Section 2.0 of BMM.
	.7	Information on operation and maintenance of mechanical systems and equipment installed and commissioned - Section 2.0 of BMM.
	.8	Operating and maintenance manual - Section 3.2 of BMM.
	.9	Final commissioning plan as actually implemented.
	.10	Completed commissioning checklists.
	.11	Commissioning test procedures employed.
	.12	Completed Product Information (PI) and Performance Verification (PV) report forms, approved and accepted by Departmental Representative.
	.13	Commissioning reports.
1.5 CONTENTS OF OPERATING AND MAINTENANCE MANUAL	.1	For detailed requirements refer to Section 01 78 00.
	.2	Departmental Representative to review and approve format and organization within [12] weeks of award of contract.
	.3	Include original manufactures brochures and written information on products and equipment installed on this project.

1.5 CONTENTS OF OPERATING AND MAINTENANCE MANUAL (Cont'd)	.4	Record and organize for easy access and retrieval of information contained in BMM.
	.5	Include completed PI report forms, data and information from other sources as required.
	.6	Inventory directory relating to information on installed systems, equipment and components.
	.7	Approved project shop-drawings, product and maintenance data.
	.8	Manufacturer's data and recommendations relating: manufacturing process, installation, commissioning, start-up, O&M, shutdown and training materials.
	.9	Inventory and location of spare parts, special tools and maintenance materials.
	.10	Warranty information.
	.11	Inspection certificates with expiration dates, which require on-going re-certification inspections.
	.12	Maintenance program supporting information including: .1 Recommended maintenance procedures and schedule. .2 Information to removal and replacement of equipment including, required equipment, points of lift and means of entry and egress.
1.6 SUPPORTING DOCUMENTATION FOR INSERTION INTO SUPPORTING APPENDICES	.1	Provide Departmental Representative supporting documentation relating to installed equipment and system, including: .1 General: .1 Finalized commissioning plan. .2 WHMIS information manual. .3 Approved "as-built" drawings and specifications. .4 Procedures used during commissioning. .5 Cross-Reference to specification sections. .2 Architectural and structural: .1 Inspection certificates, construction permits.

- 1.6 SUPPORTING DOCUMENTATION FOR INSERTION INTO SUPPORTING APPENDICES
(Cont'd)
- .1 (Cont'd)
 - .2 (Cont'd)
 - .2 Roof anchor log books.
 - .3 PV reports.
 - .3 Fire prevention, suppression and protection:
 - .1 Test reports.
 - .2 Smoke test reports.
 - .3 PV reports.
 - .4 Mechanical:
 - .1 Installation permits, inspection certificates.
 - .2 Piping pressure test certificates.
 - .3 Ducting leakage test reports.
 - .4 TAB and PV reports.
 - .5 Charts of valves and steam traps.
 - .6 Copies of posted instructions.
 - .5 Electrical:
 - .1 Installation permits, inspection certificates.
 - .2 TAB and PV reports.
 - .3 Electrical work log book.
 - .4 Charts and schedules.
 - .5 Locations of cables and components.
 - .6 Copies of posted instructions.
 - .2 Assist Departmental Representative with preparation of BMM.

- 1.7 LANGUAGE
- .1 English and French Language to be in separate binders.

- 1.9 USE OF CURRENT TECHNOLOGY
- .1 Use current technology for production of documentation. Emphasis on ease of accessibility at all times, maintain in up-to-date state, compatibility with user's requirements.
 - .2 Obtain Departmental Representative's approval before starting Work.

PART 2 - PRODUCTS

- 2.1 NOT USED
- .1 Not used.

PART 3 - EXECUTION

3.1 NOT USED .1 Not used.

PART 1 - GENERAL

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| <u>1.1 SECTION INCLUDES</u> | .1 | Methods and procedures for deconstruction of structures and parts of structures. |
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| <u>1.2 REFERENCES</u> | .1 | Canadian Standards Association (CSA International). |
| | .1 | CSA S350-M1980(R2003), Code of Practice for Safety in Demolition of Structures. |
| | .2 | Federal Legislation. |
| | .1 | Canadian Environmental Assessment Act (CEAA), 1992, c. 37. |
| | .2 | Canadian Environmental Protection Act (CEPA), 1999, c. 33. |
| | .3 | Transportation of Dangerous Goods Act (TDGA), 1992, c. 34. |
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| <u>1.3 DEFINITIONS</u> | .1 | Alternate Disposal: reuse and recycling of materials by designated facility, user or receiving organization which has valid Certificate of Approval to operate. Alternative to landfill disposal. |
| | .2 | Deconstruction: systematic dismantling of structure in a manner that achieves safe removal/disposal of hazardous materials and maximum salvage/recycling of materials. |
| | .1 | Ultimate objective is to recover potentially valuable resources while diverting from landfill what has traditionally been significant portion of waste system. |
| | .3 | Demolition: rapid destruction of structure with or without prior removal of hazardous materials. |
| | .4 | Hazardous Materials: dangerous substances, dangerous goods, hazardous commodities and hazardous products, including but not limited to: corrosive agents, flammable substances, ammunition, explosives, radioactive substances, or other material that can endanger human health, well being or environment if handled improperly. |
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1.3 DEFINITIONS
(Cont'd)

- .5 Recycle: process by which waste and recyclable materials are transformed or collected for purpose of being transferred into new products.
- .6 Recycling: process of sorting, cleansing, treating and reconstituting solid waste and other discarded materials for purpose of using in altered form.
 - .1 Recycling does not include burning, incinerating, or thermally destroying waste.
- .7 Reuse: repeated use of product in same form but not necessarily for same purpose. Reuse includes:
 - .1 Salvaging reusable materials from remodelling projects, before demolition stage, for resale, reuse on current project or for storage for use on future projects.
 - .2 Returning reusable items including pallets or unused products to vendors.
- .8 Salvage: removal of structural and non-structural materials from deconstruction/disassembly projects for purpose of reuse or recycling.
- .9 Source Separation: acts of keeping different types of waste materials separate, beginning from first time they became waste.
- .10 Waste Management Coordinator (WMC): contractor representative responsible for supervising waste management activities as well as coordinating related, required submittal and reporting requirements.

1.4 PERFORMANCE
REQUIREMENTS

- .1 Separate materials from waste stream to obtain minimum percentages of division as specified in Section 01 74 21.

1.5 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00.
- .2 Submit pre-demolition audit and deconstruction/disassembly plan prior to starting work.

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| 1.5 SUBMITTALS
(Cont'd) | .3 | Submit copies of certified bills of lading from authorized disposal sites and reuse and recycling facilities for material removed from site to Departmental Representative upon request.
.1 Written authorization from Departmental Representative is required to deviate from facilities listed in Waste Reduction Workplan. |
| | .4 | Include following information:
.1 Time and date of removal.
.2 Description of materials.
.3 Weight, volume, quantity of material.
.4 Breakdown of reuse, recycling and landfill quantities.
.5 End destination of materials. |
| | .5 | Workers, haulers and subcontractors must possess current, applicable permits to remove, handle and dispose of wastes categorized Provincially as hazardous.
.1 Provide proof of compliance within 24 hours upon written request of Departmental Representative. |
| 1.6 QUALITY
ASSURANCE | .1 | Ensure Work is performed in compliance with CEPA, CEAA, TDGA, and applicable provincial regulations. |
| 1.7 STORAGE,
HANDLING AND
PROTECTION | .1 | Do in accordance with Section 01 61 00. |
| 1.8 ENVIRONMENTAL
REQUIREMENTS | .1 | Do Work in accordance with Section 01 35 43. |
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1.9 SITE
CONDITIONS

- .1 Existing Conditions.
 - .1 Should materials resembling spray or trowel applied asbestos or other designated substance listed as hazardous be encountered in course of deconstruction, stop work, take preventative measures, and notify Departmental Representative immediately. Do not proceed until written instructions have been received.
 - .2 Label and package component parts of mechanical and electrical material specified for salvage in accordance with Departmental Representative's instructions to prevent damage or loss.
- .2 Protection.
 - .1 Prevent movement, settlement or damage of adjacent services. Provide bracing as required. Repair damage caused by deconstruction as directed by Departmental Representative.
 - .2 Support affected structures and, if safety of structure being deconstructed or adjacent structures or services appears to be endangered, take preventative measures. Cease operations and immediately notify Departmental Representative.
 - .3 Prevent debris from blocking surface drainage system, elevators, mechanical and electrical systems.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- .1 Leave equipment and machinery running only while in use, except where extreme temperatures prohibit shutting down.
 - .2 Where possible use water efficient wetting equipment/trucks/attachments when minimizing dust.
 - .3 Demonstrate that tools are being used in manner which allows for salvage of materials in best condition possible.
-

PART 3 - EXECUTION

3.1 SITE VERIFICATION OF CONDITIONS

- .1 Determine if Environmental Assessment (EA) is required under requirements of CEAA.
 - .1 If necessary, employ licensed consultant to perform EA.
 - .2 Communicate findings and conclusions in writing to Departmental Representative prior to start of Work.

3.2 PREPARATION

- .1 Disconnect and re-route electrical, telephone and communication service lines entering areas to be deconstructed. Post warning signs on electrical lines and equipment which must remain energized to serve other products during period of demolition.
- .2 Locate and protect utility lines. Do not disrupt active or energized utilities traversing premises.
- .3 Disconnect and cap designated mechanical services.
 - .1 Natural gas supply lines: as directed by Departmental Representative.
 - .2 Sewer and water lines: as directed by Departmental Representative.

3.3 REMOVAL OF HAZARDOUS WASTES

- .1 Prior to start of deconstruction work remove contaminated or hazardous materials as directed by Departmental Representative from site and dispose of at designated disposal facilities in safe manner in accordance with TDGA and other applicable regulatory requirements.

3.4 DISASSEMBLY

- .1 Materials removed from structures are property of Departmental Representative.
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3.4 DISASSEMBLY
(Cont'd)

- .2 Throughout course of deconstruction pay close attention to connections and material assemblies. Employ workmanship procedures which minimize damage to materials and equipment.
- .3 Ensure workers and subcontractors are trained to carry out work in accordance with appropriate deconstruction techniques.
- .4 Project supervisor with previous deconstruction experience must be present on site throughout project.
- .5 Deconstruct in accordance with CSA S350 and other applicable safety standards.
- .6 Workers must utilize adequate fall protection where Departmental Representative considers it necessary.
- .7 Maintain structural integrity of structure.
- .8 Systematically remove finishes, and mechanical and electrical equipment as instructed by Departmental Representative.
- .9 Wherever possible, transfer material assemblies from heights to ground level for easier disassembly. Take appropriate measures to ensure safety.
- .10 Separate from waste stream, material in condition suitable for reuse and/or recycling.
- .11 Remove and store materials to be salvaged, in manner to prevent damage.
 - .1 Store and protect in accordance with requirements for maximum preservation of material.
 - .2 Handle salvaged materials as new materials.
- .12 Source separate for recycling materials that cannot be salvaged for reuse including wood, metal, concrete and asphalt.
- .13 Remove materials that cannot be salvaged for reuse or recycling and dispose of in accordance with applicable codes at licensed facilities.

3.4 DISASSEMBLY
(Cont'd)

.14 Where existing materials are to be re-used in Work, use special care in removal, handling, storage and re-installation to assure proper function in completed work.

3.5 PROCESSING

.1 Designate location for processing of materials which eliminates double handling and provides adequate space to maintain efficient material flow.

.2 Denail, strip, and separate materials to ensure best possible condition of salvaged materials.

.3 Keep processing area clean and free of excess debris.

.4 Supply separate, marked disposal bins for categories of waste material. Notify Departmental Representative prior to removal of bins from site.

.5 Separate processed materials into organized piles for stockpiling. Provide collection area for materials designated for alternate disposal. Pile materials on pallets to facilitate transport off-site or to storage areas.

3.6 STOCKPILING

.1 Label stockpiles, indicating material type and quantity.

.2 Designate appropriate security resources/measures to prevent vandalism, damage and theft.

.3 Locate stockpiled materials convenient for use in new construction. Eliminate double handling wherever possible.

.4 Stockpile materials designated for alternate disposal in location which facilitates removal from site and examination by potential end markets, and which does not impede disassembly, processing, or hauling procedures.

3.7 REMOVAL FROM
SITE

- .1 Transport material designated for alternate disposal to approved facilities listed in waste reduction workplan and in accordance with applicable regulations. Do not deviate from facilities listed in waste reduction workplan without prior written authorization from Departmental Representative.
- .2 Dispose of materials not designated for alternate disposal in accordance with applicable regulations. Disposal facilities must be approved of and listed in waste reduction workplan. Do not deviate from disposal facilities listed in waste reduction workplan without prior written authorization from Departmental Representative.

3.8 CLEANING AND
RESTORATION

- .1 Keep site clean and organized throughout deconstruction.
- .2 Upon completion of project, remove debris, trim surfaces and leave work site clean.
- .3 Upon completion of project, reinstate areas affected by Work to condition which existed prior to beginning of Work.

PWGSC ONTARIO	STRUCTURAL STEEL FOR	SECTION 05 12 23
REGION PROJECT	BUILDINGS	PAGE 1
NUMBER R.064667.004		2016-01-26

PART 1 - GENERAL

1.1 REFERENCES

- .1 All referenced standards to be the current edition or the edition referenced by the applicable Building Code in force at the time of building permit application, as noted on Structural Drawings.
- .2 Canadian Standards Association (CSA International):
 - .1 CSA G40.20-13/G40.21-13, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
 - .2 CSA S16-14, Limit States Design of Steel Structures.
 - .3 CSA S136, North American Specifications for the Design of Cold Formed Steel Structural Members.
 - .4 CSA W47.1, Certification of Companies for Fusion Welding of Steel.
 - .5 CSA W48, Filler Metals and Allied Materials for Metal Arc Welding.
 - .6 CSA W55, Certification of Companies for Resistance Welding of Steel and Aluminum.
 - .7 CSA W59-13, Welded Steel Construction (Metal Arc Welding).
 - .8 CSA W186, Welding of Reinforcing Bars in Reinforced Concrete Construction.
- .3 ASTM International Inc.:
 - .1 ASTM A123/A123M, Standard Specification for Zinc (Hot Dip Galvanized) coating on Iron and Steel Products.
 - .2 ASTM A36/A36M, Standard Specification for Carbon Structural Steel.
 - .3 ASTM A325, Standard Specification for Structural Bolts, Steel, Heat Treated, 830 MPa (120/105 ksi) Minimum Tensile Strength.
 - .4 ASTM A490M, Standard Specification for High-Strength Steel Structural Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints.
 - .5 ASTM A500, Specification for Cold Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
 - .6 ASTM A1011/A1011M, Standard Specifications for Steel, Sheet and Strip, Hot Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability and Ultra High Strength.
 - .7 ASTM A992, Standard Specifications for Structural Steel Shapes.
 - .8 ASTM F1554, Standard Specification for Anchor Bolts, Steel 36, 55 and 105 ksi Yield Strength.

- .4 Canadian Institute of Steel Construction (CISC)/Canadian Paint Manufacturers Association (CPMA):
 - .1 CISC Handbook of Steel Construction.
 - .2 CISC/CPMA Standard 1-73a, A Quick-drying One-coat Paint for Use on Structural Steel.
 - .3 CISC/CPMA Standard 2-75, Quick-drying Primer for Use on Structural Steel.
 - .4 CISC Code of Standard Practice, Appendix I, Architecturally Exposed Structural Steel (AESS).
- .5 The Society for Protective Coatings (SSPC) and National Association of Corrosion Engineers (NACE) International:
 - .1 SSPC-SP 1, Solvent Cleaning.
 - .2 NACE No. 3 / SSPC-SP 6, Commercial Blast Cleaning.
 - .3 NACE No.4 / SSPC-SP 7, Brush Off Blast Cleaning.
 - .4 NACE No.2 / SSPC-SP 10, Near White Blast Cleaning.
 - .5 SSPC Technology Guide No.14 - Guide for the Repair of Imperfections in Galvanized, Organic or Inorganic Zinc-Coated Steel Using Organic Zinc Rich Coating.
 - .6 SSPC Paint Specification No. 20 - Zinc Rich Coating, Type I - Inorganic and Type II - Organic.

1.2 QUALITY ASSURANCE

- .1 Qualifications
 - .1 Structural steel fabricator to be certified by the Canadian Welding Bureau under the requirements of CSA W47.1, Division 1 or 2 for fusion welding and/or CSA W55.3 for resistance welding of structural steel components.
 - .2 Welders to be CWB approved, working under supervision of a CWB approved firm.
 - .3 Engage a Professional Engineer licensed in the place where the project is located to be responsible for design, detailing and installation of all connections related to structural steel work.
 - .4 The Professional Engineer designing connections to hold a Certificate of Authorization, and to carry min. \$1,000,000.00 in liability insurance (per occurrence).

1.3 QUALITY CONTROL

- .1 Submit in accordance with Section 01 45 00 - Quality Control.
- .2 Source Quality Control Submittals:

- .1 Submit mill test reports 4 weeks prior to fabrication of structural steel.
 - .1 Mill test reports to show chemical and physical properties and other details of steel to be incorporated in project.
 - .2 The reports to be correlated to the materials or products to which they pertain
- .3 Tolerances
 - .1 Conform to the fabrication and erection tolerances of CAN/CSA S16.
 - .2 If more stringent tolerances are specified elsewhere to suit interfacing materials or AESS members, the latter shall govern.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop Drawings:
 - .1 Provide drawings stamped and signed by the Professional Engineer responsible for steel connections.
 - .2 Before submitting shop drawings, provide a letter signed and sealed by that Engineer stating that he has been engaged to undertake the responsibility for the above. Also submit a copy of that Engineer's Certificate of Authorization, and proof of his liability insurance.
 - .3 If additional information is required from the Consultant, allow a minimum of five working days for the Structural Engineer to review and respond to the request for information.
 - .4 It is advisable to submit erection diagrams for review before preparing shop details. Copies of plans and section details developed by WSP will not be accepted as erection diagrams.
- .3 Erection drawings:
 - .1 Submit erection drawings indicating details and information necessary for assembly and erection purposes including:
 - .1 Description of erection methods.
 - .2 Sequence of erection.
 - .3 Temporary bracings.
 - .4 Beam sizes (in addition to beam marks).
 - .5 Connections where threads must be excluded from shear plane.
 - .6 Members which are considered AESS and their category.
 - .7 Type and finish of bolts in AESS connections.
 - .8 Side where bolt heads should be placed in AESS connections.

PWGSC ONTARIO	STRUCTURAL STEEL FOR	SECTION 05 12 23
REGION PROJECT	BUILDINGS	PAGE 4
NUMBER R.064667.004		2016-01-26

- .9 Weld grinding, finish and profile in AESS field connections.
- .4 Fabrication drawings:
 - .1 Submit fabrication drawings showing designed assemblies, member sizes, components and connections. Show on drawings:
 - .1 Material specifications.
 - .2 Surface preparation.
 - .3 Shop painting / galvanizing.
 - .4 Section splices.
 - .5 Types of shop and field connections.
 - .6 Net weld lengths.
 - .7 Precautions which will be taken to exclude threads from shear planes of bearing type bolted connections (where applicable).
 - .8 Protected zones.
 - .9 Vent holes required for galvanizing process.
 - .10 Camber.
 - .11 Architectural clearance lines and finishes where connections could encroach other works.
 - .12 Beam and column web holes required for services and reinforcing around them.
 - .2 Substitution of alternative sections will only be allowed provided the new members have equal or greater capacity and stiffness and their dimensions are approved by the Consultant.
- .5 On completion of erection, submit a letter signed and sealed by the Professional Engineer responsible for structural steel connections certifying that the work has been completed in accordance with all contract documents.

PART 2 - PRODUCTS

2.1 DESIGN REQUIREMENTS

- .1 Design details and connections in accordance with requirements of CSA S16 and CSA S136 to resist forces and to allow for movements indicated. Consider load effects due to fabrication, erection and handling.
- .2 When requested, submit sketches and design calculations stamped and signed by the Professional Engineer responsible for connection design.
- .3 Beam end connections:
 - .1 Select beam end connections from CISC "Handbook of Steel Construction" when connection for shear only (standard connection) is required.

- .2 When shears are not indicated, select or design non composite beam end connections to resist reaction due to maximum uniformly distributed load capacity of the beam in bending.
- .3 When shears are not indicated, select or design composite beam end connections to resist one and a half times the reaction due to maximum uniformly distributed load capacity of the non composite beam section in bending.
- .4 Seated beam connections to have top clip angles.
- .5 Provide all spandrel beams and all floor beams not fully braced by floor construction with top and bottom flange connections for torsional restraint.
- .6 Assume that bolt threads are intercepted by shear plane, unless special measures are indicated on shop drawings to exclude threads from shear plane.
- .7 Connection design to include consideration of all pass-through forces, including tension, compression, moment or shear. Provide local reinforcement at connection or joint as required.
- .8 Where axial forces occur in beams framing to opposite sides of a supporting member, design connections for a pass-through force equal to the smaller axial force. If beam sizes differ, assume the axial force is centred in the smaller beam. Where beams frame into columns, connect each beam for the axial force shown.
- .9 Follow conceptual connection details if shown on structural drawings. Do not change without the Consultant's written approval. If welds are defined on drawings, the sizes shown are minimum requirements which might need to be increased to suit connection design.
- .10 Pretension all high-strength bolts used in:
 - .1 All elements resisting crane loads.
 - .2 Connections where bolts are subject to tensile loads.
 - .3 Connections using oversized or slotted holes unless finger-tight bolts are required to accommodate movement.
 - .4 Connections required by CSA S16 to be pre-tensioned.
- .11 Where moment connections are called for but values are not indicated, design for moment capacity of the smaller member in the connection.
- .12 Install web and flange stiffener plates at moment connections as required by connection design and detail but in every case when indicated on the drawings. If the shear generated in column web exceeds its shear capacity, reinforce the web.
- .13 For beams continuous over supports and for beams supporting columns, provide min. 6mm (1/4") stiffener plates at each side of web at point of concentrated load, unless thicker stiffeners are required by connection design or different details are shown on drawings.

- .14 Shape and size gusset plates to accommodate required finishes and clearances, refer to Architectural and Mechanical drawings.
- .15 Design gusset plates and bracing connections for members which are parts of seismic force resisting system to allow ductile rotation and to satisfy requirements of CSA S16. Design gusset plates for other compression members for the force equivalent to twice the specified compression member force, or provide stiffeners to prevent gusset plate buckling.
- .16 Provide moment connections at splices to maintain continuity of cranked beams. Provide header plates or stiffener plates to resist unbalanced flange forces at splices.
- .17 Provide all wall supporting members (shelf angles, hangers, stubs, back braces, etc.) which are attached to floor beams with adjustable connections capable to compensate for the deflection of the floor beams due to self weight of concrete. Anticipate beam deflection to be equivalent to the camber shown, or 20 mm (whichever is more). Alternatively, fabricate based on actual deflected shape of the beams as measured after concrete is poured.
- .18 Provide slotted holes long enough to allow for deflection indicated on drawings plus construction tolerance, assuming bolts are centred in slots. Bolts are to be finger-tight with burred threads to allow for movement during the life of structure without bolts loosening.
- .19 Do not oversize anchor rod holes for site tolerances. Use hole sizes suggested in the CISC Handbook of Steel Construction.
- .20 Connect new steel members to existing concrete using drilled concrete anchors, refer to Post Installed Anchors and Dowels notes on drawings. Do not field weld at connections with adhesive anchors.

2.2 MATERIALS

- .1 Structural steel:
 - .1 Rolled shapes: to CSA G40.21.
 - .2 Hollow structural sections: to ASTM A500 or CSA G40.21.
- .2 Anchor rods: CSA G40.21, Grade 300W, unless ASTM F1554 Grade 105 is indicated on drawings.
- .3 Bolts, nuts and washers: to ASTM A325.
- .4 Welding materials: to CSA W48 and CSA W59, certified by Canadian Welding Bureau.
- .5 Shop paint: to CISC/CPMA 1-73a.
- .6 Shop paint primer: to CISC/CPMA 2-75, solvent reducible alkyd, red oxide, compatible with specified topcoat.
- .7 Zinc-rich coating: to SSPC Paint Specification No.20, compatible with top coat (where specified).

PWGSC ONTARIO	STRUCTURAL STEEL FOR	SECTION 05 12 23
REGION PROJECT	BUILDINGS	PAGE 7
NUMBER R.064667.004		2016-01-26

- .8 Hot dip galvanizing: to ASTM A123/A123M, minimum zinc coating of 600 g/m².

2.3 FABRICATION

- .1 Fabricate structural steel in accordance with CSA S16 and with reviewed shop drawings.
- .2 Install shear studs in accordance with CSA W59.
- .3 Continuously seal members by intermittent welds and plastic filler unless continuous welds are indicated on drawings.
- .4 Provide holes in beam flanges or weld threaded studs as required for attachment of wood nailers.
- .5 Position beams having permissible mill camber so that the camber is up.
- .6 Install stud anchors in shop with end welds in accordance with the recommendations of the stud manufacturer. Lengths of studs given on drawings are the lengths after welding. Replace studs that crack in the weld or shank.
- .7 Increase specified section thickness at no extra cost if required for fabrication (bending) or galvanizing. Alternatively, fabricate curved sections from plates.
- .8 Provide 16mm (5/8") diameter weep holes in base plates of HSS columns which are not made watertight.
- .9 HSS members which require galvanizing to either be per CSA G40.21, grade 350W, Class H, or to be stress relieved prior to galvanizing.
- .10 Provide vent holes in HSS sections where required for galvanizing process. Located so that any water inside HSS will drain away when HSS is in its final position. Maximum size - 16mm (5/8") diameter. Fill holes with vent hole plugs after galvanizing.
- .11 Provide 12 (1/2") dia. holes in HSS columns to be filled with concrete. Locate at opposing column faces 150mm (6") from each end.
- .12 Connect together double beams and double channels at not more than 1200mm (4 ft) centres unless the members are welded toe to toe.
- .13 Connect together axially loaded built-up members in accordance with the requirements of CSA S16. In addition, interconnect compression members for trusses and bracing at least at the one-third points.
- .14 Connect cover plates of built-up members to develop the capacity of the built-up member.
- .15 Provide minimum 200 (8") long bearing for members supported by masonry or concrete.
- .16 Weld beams to bearing plates unless otherwise noted on drawings. Extend beams for full length of bearing plates. Set bearing plates 10mm (3/8") back from edge of support.

PWGSC ONTARIO	STRUCTURAL STEEL FOR	SECTION 05 12 23
REGION PROJECT	BUILDINGS	PAGE 8
NUMBER R.064667.004		2016-01-26

- .17 Anchor roof beams bearing on walls with a minimum of two 16mm (5/8") diameter x 380mm (1'-3") long anchor rods, unless otherwise noted on the Drawings.
- .18 Provide cap plates at tops of columns where required for support of deck, slab, joists, beams or safety anchors.
- .19 Provide connection for tie joist bottom chord at all columns supporting joists, coordinate with joist supplier.
- .20 Provide closure plates for all exposed and for all exterior tubular members.
- .21 Provide diagonal or cantilevered angles at sides of columns where required to support deck or slab.
- .22 Connect steel lintels in masonry walls to columns where openings are adjacent to columns.
- .23 Unless otherwise noted on drawings, provide 102 x 102 x 9.5 (4" x 4" x 3/8") seat angles attached to sides of columns to support masonry lintels adjacent to columns. Length of seat to equal width of lintel minus 25 mm (1").
- .24 Complete welded shop connections prior to galvanizing.
- .25 Mark materials in accordance with CSA G40.20/G40.21. Do not use die stamping. When steel is to be left unpainted, place marking at locations not visible from exterior.
- .26 Match marking: shop mark bearing assemblies and splices for fit and match.
- .27 Where shop inspection is required, do not ship material to the site before it has been inspected.
- .28 Fabricate in stages complex members for which steel inspection is impossible or difficult once completed, and arrange for the Inspection and Testing Agency to do intermediate shop inspections.
- .29 Fabricate AESS with tolerances and surface quality consistent with AESS category.

2.4 SHOP PAINTING

- .1 Clean all members to SSPC-SP 1, Remove loose mill scale, rust, oil, dirt and foreign matter.
- .2 In addition for members receiving shop primer paint: Clean steel to SSPC-SP 7 Brush-Off Blast Cleaning.
- .3 In addition for members receiving intumescent coating: Clean steel to SSPC-SP 6 Commercial Blast Cleaning
- .4 In addition for members receiving zinc-rich coating: Clean steel to SSPC-SP 10 Near White Blast Cleaning.
- .5 Apply one coat of shop paint CISC/CPMA 1-73a to steelwork in the shop with the exception of:

- .1 Members to receive spray fireproofing.
- .2 Members to receive a finish coat of paint on site for which a CISC/CPMA 2-75 shop primer is required.
- .3 Members to receive intumescent coating for which a compatible shop primer is required.
- .4 Members to receive zinc-rich coating.
- .5 Galvanized members.
- .6 Shear connectors and top flanges of composite beams with field welded shear connectors.
- .7 Surfaces encased in or in contact with cast-in-place concrete including top flanges of beams supporting slabs.
- .8 Surfaces and edges to be field welded for a distance of 50 mm (2") from joints.
- .9 Faying surfaces of slip-critical connections.
- .6 Apply one coat of contrasting colour shop paint to all protected zones indicated on structural drawings to clearly delineate their extent.
- .7 Apply one coat of compatible primer paint (CISC/CPMA 2-75) in the shop to steelwork to receive a finish coat of paint on site.
- .8 Apply galvanizing in the shop to all structural steel located beyond the vapour barrier, including:
 - .1 Shelf angles and hangers in exterior walls.
 - .2 Spandrel angles to which precast panels are attached.
 - .3 Lintels in exterior walls.
 - .4 Exposed exterior steel members.
 - .5 Exposed anchor rods.
 - .6 Other steel noted on drawings.
- .9 If galvanized steel is to be painted, use only non passivated galvanizing process (without chromate coating).
- .10 Apply paint under cover, on dry surfaces when surface and air temperatures are above 5°C.
- .11 Maintain dry condition and 5°C minimum temperature until paint is thoroughly dry.
- .12 Strip paint from bolts, nuts, sharp edges and corners before prime coat is dry.

PART 3 - EXECUTION

3.1 GENERAL

PWGSC ONTARIO	STRUCTURAL STEEL FOR	SECTION 05 12 23
REGION PROJECT	BUILDINGS	PAGE 10
NUMBER R.064667.004		2016-01-26

- .1 Structural steel work: in accordance with CSA S16.
- .2 Welding: in accordance with CSA W59.

3.2 CONNECTION TO EXISTING WORK

- .1 Verify dimensions and condition of existing work prior to start of fabrication. Determine any potential interference with existing services. Report discrepancies and potential problem areas to Consultant for direction before commencing work.
- .2 Take precautions to protect existing works from damage. Repair damage to adjacent materials caused by structural steel installation.

3.3 MODIFICATION / REMOVAL OF EXISTING STEEL WORK

- .1 Dismantle and cut existing structural steel as required. Provide temporary shoring and bracing required for these operations. Retain a Professional Engineer to design the temporary shoring and to review this work on site.
- .2 Remove from site existing steel which is dismantled but not designated for reuse.
- .3 Clean existing structural steel, which is affected by the work and is to remain in place, down to bare metal, prior to its inspection so that its condition may be ascertained. Notify Consultant when members are ready for inspection.

3.4 ERECTION

- .1 Erect structural steel in accordance with CSA S16 and reviewed erection drawings.
- .2 Do not field cut or alter any members without the Consultant's approval.
- .3 Make adequate provision for all loads acting on the structure during erection. Provide erection bracing to keep the structure stable, plumb and in true alignment during construction. Bracing members or connections shown on Structural Drawings are those required for the completed structure, and may not be sufficient for erection purposes. Do not remove erection bracings without written approval from the Engineer who designed it.
- .4 Set column base plates to the elevation required for grouting using steel shims or leveling screws attached to sides of base plates. Do not fasten leveling nuts to anchor rods. Alternatively, for base plates equal or smaller than 350mm x 350mm (14" x 14"), leveling plates set with grout and level to within 1.5 mm (1/16") across the plate can be used. Do not erect columns upon plates exceeding this tolerance. Lift base plates for inspection when directed.
- .5 Grout under column base plates and beam bearing plates as soon as steelwork is completed. Do not add load on steelwork until grouting is completed and grout strength has reached at least 20 MPa.
- .6 Do not make permanent connections until structure has been properly aligned.

PWGSC ONTARIO	STRUCTURAL STEEL FOR	SECTION 05 12 23
REGION PROJECT	BUILDINGS	PAGE 11
NUMBER R.064667.004		2016-01-26

- .7 Adjust and finalize connections at wall supporting elements affected by floor beam deflections after concrete is poured.
- .8 Report ill-fitting connections to the Consultant before taking corrective measures.
- .9 When welding after galvanizing is in place, grind away galvanizing at areas to be welded.
- .10 Do not weld in an ambient temperature below -17°C. Preheat material adjacent to welding areas when ambient temperature is between -17°C and +4°C.
- .11 Remove slag from all completed welds so that they may be visually inspected.
- .12 Seal members by continuous welds where indicated.
- .13 AESS members:
 - .1 Erect using softened slings or other methods to prevent damage.
 - .2 Provide padding as required to protect while rigging and aligning.
 - .3 Weld tabs for temporary bracings and safety cabling only at points concealed from view in the complete structure or where approved by the Consultant.
 - .4 Remove all field connection aids added to allow alignment, fit up and welding.
 - .5 Remove welds at run-out tabs to match adjacent surface.
 - .6 Plug weld holes for erection bolts.

3.5 FIELD QUALITY CONTROL

- .1 Refer to Section 01 45 00 Quality Control
- .2 Bring to the attention of the Consultant any defects or deficiencies in the work together with a proposal for remedy. The Consultant will decide what corrective action may be taken, and will issue the necessary instructions.
- .3 Construction Review:
 - .1 General review during construction by the Consultant will be carried out by examination of representative samples of the work.
 - .2 Construction review reports will outline any deficiencies found.
- .4 Inspection and testing:
 - .1 An Inspection and Testing Agency (certified to CSA W178.1 & 2) will be appointed to carry inspection and testing of all structural steel.
 - .2 Do not commence fabrication until details of inspection have been worked out with the Agency.

PWGSC ONTARIO	STRUCTURAL STEEL FOR	SECTION 05 12 23
REGION PROJECT	BUILDINGS	PAGE 12
NUMBER R.064667.004		2016-01-26

.3 The Inspection Agency will submit reports to the Consultant, Structural Engineer, Contractor and Municipal Authorities covering the Work inspected and provide details of errors or deficiencies observed.

.4 Work will be inspected in the shop and when erected. Store fabricated members in the shop so that they are accessible for inspection. Items to be cast into concrete will be inspected on site before being installed.

.5 Inspection will include:

.1 Checking that the mill test certificates or producer's certificates are properly correlated to materials and products supplied for the project or that legible markings were made on the material and products by the producers in accordance with the applicable standards. Where this is not possible, notify the Consultant and if requested carry out sample tests as described below.

.2 Confirming that all materials meet specifications.

.3 Sampling fabrication and erection procedures for general conformity with the requirements of the Contract.

.4 Checking welders' CWB Certification.

.5 Checking fabricated members against specified member shapes.

.6 Checking fabricated members against allowable mill sweep and camber.

.7 Checking fabricated members against specified camber.

.8 Visual inspection of all welded connections including spot checking of joint preparation and fit up.

.9 Sample checking bolted joints.

.10 Sample checking stud anchors.

.11 Sample checking drilled concrete and masonry anchors.

.12 Sample checking that tolerances are not exceeded during erection including fit-up of field welded joints.

.13 Inspection of field cutting.

.14 Inspection of sliding bearings.

.15 Inspection of surface preparation, shop paint and field touch-up.

.16 Inspection of galvanizing and field touch-up.

.17 Inspection of grouting under base plates and bearing plates.

.18 Checking levelness of leveling plates.

.6 Arrange for the Inspector to be present during welding of 10% of moment connections and 10% of butt welds in direct tension.

PWGSC ONTARIO	STRUCTURAL STEEL FOR	SECTION 05 12 23
REGION PROJECT	BUILDINGS	PAGE 13
NUMBER R.064667.004		2016-01-26

- .7 Sample testing: When required, test coupons will be taken and tested in accordance with CSA G40.20 to establish identification. Cut samples from member locations selected by Structural Engineer and provide to the Inspection and Testing Agency. Make good the locations if requested, at no extra cost, by adding new plates and welds acceptable to the Structural Engineer. The Agency will have the samples tested for mechanical properties and for chemical composition and will classify the steel as to specification.
- .8 Arrange for the Inspector to start field inspection as soon as each section of the Work is completed, plumbed, bolts tightened and field welding finished.
- .9 The Inspector will check the specified camber of all beams. Do not place steel deck until this has been done and approved in writing by the inspector.
- .10 The Inspector will visually check all bolts in bearing connections. Where erection drawings indicate bolts with threads excluded from the shear plane, he will remove nuts from 1% of all bearing bolts and check that thread is excluded from the shear planes.
- .11 The Inspector will visually check all stud shear connectors on composite steel beams. At least on stud in every 150 and all studs which do not have a complete end weld, which are repaired by welding or which show less than the normal reduction in height due to welding will be bent 15 degrees from their axis towards the nearest support, as specified in CSA-W59. Bent studs that show no sign of failure will be accepted and shall remain in the bent position. Studs that crack in weld, base metal or shank will be rejected. Studs with end welds covering less than 85% of the perimeter will be rejected even if they pass the bend test.
- .12 The Inspector will provide full time inspection during installation of post installed adhesive anchors subject to sustained tension loads.
- .13 The Inspector will randomly select and pull test 5% of all types and sizes of post installed anchors installed on a weekly basis, but not less than one anchor of each type, size and orientation. Pull test to twice the allowable tensile load, or 1.5 times the factored resistance of the anchor given by the manufacturer. Choose anchor locations where proximity to concrete edge does not affect anchor capacity, or use reduced anchor loads per manufacturer's recommendation. Submit reports to Consultant within one week of testing. Reports to indicate each anchor location, test load and mode of failure, if applicable. Notify Consultant immediately if any anchor fails the pull test.
- .14 The Inspector will visually check all the adjustable connections at wall supporting members to ensure the connections have been finalized after the concrete is poured.

3.6 FIELD PAINTING

- .1 Touch up damaged surfaces with the same paint as the shop primer.
- .2 Repair any galvanized or zinc rich painted surfaces which have been damaged or field welded in accordance with SSPC Technology Guide No.14.

PWGSC ONTARIO	STRUCTURAL STEEL FOR	SECTION 05 12 23
REGION PROJECT	BUILDINGS	PAGE 14
NUMBER R.064667.004		2016-01-26

- .3 Clean and prepare surfaces of bolts, which will receive a finished coat of paint in the same manner as the connected steelwork.

END OF SECTION 05 12 23

PART 1 - GENERAL

1.1 REFERENCES

- .1 American Society for Testing and Materials International, (ASTM):
 - .1 ASTM A123/A123M-13, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - .2 ASTM A307-14, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60000 PSI Tensile Strength.
 - .3 ASTM A653/A653M-15, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- .2 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating
- .3 Canadian Standards Association (CSA):
 - .1 CSA G40.20-13/G40.21-13, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
 - .2 CAN/CSA-W59-13, Welded Steel Construction (Metal Arc Welding).
- .4 The Master Painters Institute (MPI) / Architectural Painting Specification Manual - February 2004.
 - .1 MPI #79 - Primer, Alkyd, Anti-Corrosive for Metal.

1.2 SUBMITTALS

- .1 Submit shop drawings and product data of each item specified in accordance with Sections 01 33 00 and 01 78 00.
 - .1 Indicate materials, core thicknesses, finishes, connections, joints, method of anchorage, number of anchors, supports, reinforcement, details and accessories.
 - .2 Indicate each item's conformance with CSA B651.
 - .3 Each shop drawing submission shall bear signature and stamp of qualified professional engineer registered or licensed in province of Ontario.

PART 2 - PRODUCTS

2.1 MATERIALS

- .1 Steel: to CSA G40.20/G40.21, Grade 300W, minimum 30% recycled content.
- .2 Galvanized sheet steel: ASTM A653/A653M Grade A, Z275 Commercial Quality zinc coating, size and shape as shown.
- .3 Steel bar grating: Bearing bar sizes and spacing as indicated on drawings. Grating as manufactured by Borden Metal Products Ltd., Fisher & Ludlow Ltd. or McNichols Co.
- .4 Alkyd primer: to MPI #79, E3 environmental rating.
- .5 Galvanizing: hot dip, unpassivated, to ASTM A123/A123M, Coating Grade 85, minimum 600 g/m².
- .6 Zinc rich primer for galvanized surfaces: zinc rich, readymix to CAN/CGSB-1.181, Ecologo certified.
- .7 Fasteners: Conforming to ASTM A307, Grade A, in areas not exposed to view, use unfinished bolts with hexagon heads and nuts. In areas exposed to view, use bolts, nuts, washers, rivets, lock washers, anchor bolts, machine screws and machine bolts Z275 zinc coated in accordance with ASTM A653/A653M. Supply bolts of lengths required to suit thickness of material being joined, but not projecting more than 6 mm beyond nut, without the use of washers.
- .8 Grout: non-shrink, non-metallic, flowable, 24 h, 15 MPa, pullout strength 7.9 MPa.

2.2 FABRICATION

- .1 Verify dimensions of existing Work before commencing fabrications and report any discrepancies to the Consultant.
 - .2 Weld to CSA W59. File or grind welds smooth and flush with adjoining surface.
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2.2 FABRICATION
(Cont'd)

- .3 Use self-tapping shake-proof screws on items requiring assembly by screws or as indicated. Use screws for interior metal work. Use welded connections for exterior metal Work unless otherwise found acceptable by the Consultant.
- .4 Fit and assemble Work in shop where possible. Execute Work in accordance with details and reviewed shop drawings.
- .5 Assemble members without twists or open joints. Draw mechanical joints to hairline tightness and seal countersunk screw and access holes for locking screws with metal filler where these occur on exposed surfaces.

2.3 SHOP PAINTING

- .1 Clean steel to SSPC SP6 and remove loose mill scale, weld flux and splatter.
- .2 Shop prime steel with one coat of primer paint to dry film thickness of 0.07 mm. Paint on dry surfaces, free from rust, scale, grease. Do not paint when temperature is lower than 7 deg C. Paint items under cover and leave under cover until primer is dry. Follow paint manufacturer's recommendations regarding application methods, equipment, temperature, and humidity conditions.
- .3 Shop prime galvanized steel in accordance with CGSB 85-GP-16M.

2.4 HOT DIP
GALVANIZING

- .1 After fabrication, hot dip galvanize specific miscellaneous steel items as indicated in accordance with ASTM A123 and ASTM A153. After galvanizing, plug relief vents air tight with appropriate aluminum plugs as suitable and required for intended metal fabricated item. Straighten shapes and assemblies true to line and plane after galvanizing. Repair damaged galvanized surfaces with zinc rich primer in accordance with manufacturer's printed directions.

PART 3 - EXECUTION

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|-----------------------------------|----|---|
| <u>3.1 INSTALLATION</u> | .1 | Supply other sections with templates, instructions and built-in items. |
| | .2 | Install work straight, plumb and level to a tolerance of 1:600. |
| | .3 | Provide required reinforcing and anchorage. |
| | .4 | Touch-up burnt, scratched or chipped primer. |
| <u>3.2 STEEL FRAMING SUPPORTS</u> | .1 | Supply miscellaneous steel framing supports as required for the support of existing elements. |
| | .2 | Predrill as necessary. |
| | .3 | Galvanize after fabrication. |
| <u>3.3 STEEL HANDRAILS</u> | .1 | Design handrails to withstand minimum horizontal and vertical loads as required to meet requirements of authorities having jurisdiction. In no instance shall load design of railings be less than 3.0 kN/m horizontally and 1.5 kN/m vertically. |
| | .2 | Close open ends of steel handrails with 1.9 mm thick closure neatly welded. Fabricate railings, handrails, and guardrails as shown on drawings. |
| | .3 | Handrail bracket: Fabricate as shown. After fabrication, galvanized bracket in accordance with ASTM A123. |
| <u>3.4 GRATING</u> | .1 | Fabricate steel grating platforms to sizes shown. Pressure lock bars to form rigid panels of required size. Band open ends of bars. |
| | .2 | Fabricate, finish and assemble items in shop where possible, consistent with size and shipping. Minimize field assembly. |
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- 3.5 STEEL LADDER
- .1 Fabricate complete with steel stiffeners, rungs, grating, angle rails, bent plate straps or angle brackets as shown.
 - .2 Ladders over metal siding shall be bracketed from structural steel behind siding.
 - .3 Provide safety cages around ladders where indicated on Drawings, in accordance with Ministry of Labour requirements.

PART 1 - GENERAL

<u>1.1 SAMPLES</u>	.1	Submit one 600 x 600 mm size samples of siding and material, of colour and profile specified, in accordance with Sections 01 33 00 and 01 78 00.
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<u>1.2 PRODUCT DATA</u>	.1	Submit product data sheets in accordance with Sections 01 33 00 and 0 78 00.
	.2	Indicate dimensions, profiles, attachment methods, schedule of wall elevations, trim and closure pieces, related work.
	.3	Indicate conformance with CAN/CSA-S136-12 Package.

PART 2 - PRODUCTS

<u>2.1 MATERIALS</u>	.1	Steel: minimum 30% total recycled content.
	.2	Steel siding: ASTM A653/A653M-15, galvanized steel, profile, thickness, and sizes to match existing, prefinished to CSSBI Technical Bulletin No. 7, October 1979, 10000 Series paint system, colour to match existing.
	.3	Z-bars or sub-girts, drip closures and notched steel closures: 1.26 mm thick galvanized steel to ASTM A653/A653M-15, Z275 zinc coating designation.
	.4	Flashing and accessories: exposed trim, metal closures, cap pieces, etc. of same material and colour as siding.
	.5	Fasteners: self tapping screws, zinc coated steel, prepainted head colour to match siding, neoprene washers.
	.6	Sealant: one component, elastomeric, chemical curing, to CAN/CGSB-19.13-M87 or ASTM C920-14a, Ecologo certified, SWRI validated, colour to match siding.

PART 3 - EXECUTION

- 3.1 INSTALLATION
- .1 Attach sub-girts to structural supports as indicated.
 - .2 Install starter strips, inside corners, continuous outside corners, edgings, and drip, cap and sill flashings.
 - .3 Install siding and attachments sequentially from starter strips up, to manufacturer's instructions.
 - .4 Install facing where indicated.
 - .5 Install exterior corners, fillers and closure strips with individually formed and profiled work using concealed fasteners.
 - .6 Maintain joints in exterior sheets, true to line, tight fitting.
 - .7 Apply sealant where detailed, at junction with other materials, around door and window perimeters and at metal flashings.
 - .8 Wash down surfaces with mild detergent.

PART 1 - GENERAL

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| <u>1.1 SHOP DRAWINGS
AND PRODUCT DATA
SHEETS</u> | .1 | Submit shop drawings of tapered insulation layout in accordance with Sections 01 33 00 and 01 78 00. |
| | .2 | Submit product data sheets for bitumen, primer, vapour retardant, vapour retardant adhesive, insulation, base sheet, cap sheet, plastic cement, roof drain, sheet metal and sealant in accordance with Sections 01 33 00 and 01 78 00. |
| <u>1.2 ENVIRONMENTAL
CHOICE PROGRAM</u> | .1 | Provide insulation, adhesive and sealant products bearing the 'Ecologo' of the Environmental Choice Program, Department of the Environment, Canadian Environmental Protection Act, Environmental Choice Product Guidelines ECP/PCE-40-91 for Building Materials: Thermal Insulation; ECP/PCE-35-91 for Building Materials: Acoustical Products; ECP/PCE-44-92 for Adhesives, ECP/PCE-45-92 for Sealants and Caulking Compounds. |
| | .2 | Submit one copy of the licensing criteria statements and the verification of compliance with Sections 3(a) and 3(b) of the ECP to the Departmental Representative. For primers, adhesives and sealants, indicate VOC in g/L. |
| <u>1.3 ENVIRONMENTAL
CONDITIONS</u> | .1 | Weather and surfaces dry. |
| | .2 | Imminent weather forecast, dry. |
| <u>1.4 WARRANTY</u> | .1 | For the work of this Section 07 52 16 the 12 month warranty period prescribed in General Conditions GC3.13 is extended to two years. |
| | .2 | Repair leaks in roofing assembly and membrane flashing within 48 hours of notification. |
| | .3 | Inspect roof 30 days before expiry of warranty period and correct defects within 15 days of inspection. |
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1.5 GUARANTEE .1 Provide a manufacturer's written material guarantee stating that the roofing membrane and membrane flashing will remain free of manufacturing defects and deterioration for a period of ten years from the date of Certificate of Completion.

1.6 PROTECTION .1 Protect surrounding surfaces from bitumen splatter, cover walls in hoisting and pumping areas with tarpaulins.

.2 Locate kettles so smoke shall not enter buildings or discolour surfaces.

.3 Protect finished roofing at work areas or access to work areas with minimum 12 mm plywood extending 3 m beyond area.

.4 Prevent bitumen, precipitation and debris entering openings and drains during work.

1.7 FIELD QUALITY CONTROL .1 48 hours before commencing work, provide Departmental Representative with date each phase of work will begin.

1.8 DELIVERY AND STORAGE .1 To manufacturer's instructions.

.2 Do not store material on roof.

.3 Under cover on elevated platform.

.4 In original package, labels intact.

.5 Remove and replace damaged, wet or broken material.

.6 Stand rolls on end with the lap edge side up; protect edges.

.7 Away from open flame or ignition sources.

PART 2 - PRODUCTS

2.1 MATERIAL

- .1 Asphalt primer: to CGSB 37-GP-9Ma.
- .2 Asphalt: to CAN/CSA-A123.4-04(R2008), Type III.
- .3 Tapered insulation: Tapered mineral wool fibre board with bitumen and sanded top surface conforming to ASTM C726.
- .4 Base sheet membrane on insulation panel: Styrene Butadiene Styrene (SBS) to CGSB 37-GP-56M, polyester reinforcing with thermofusible surface laminated to polyisocyanurate board, minimum 12.7 mm thick.
- .5 Base sheet flashing: Styrene Butadiene Styrene (SBS) to CGSB 37-GP-56M, polyester scrim/glass mat composite reinforcing, minimum 3.0 mm thick, self-adhesive with silicone release film and thermofusible plastic film top face.
- .6 Cap flashing: Styrene Butadiene Styrene (SBS) to CGSB 37-GP-56M, 3-ply system; 1st ply, Type 2a, Class C, Grade 1, composite reinforcing, minimum 4.0 mm thick, thermofusible plastic film for torch application. Coloured granule surface in colour to be selected by Departmental Representative.
- .7 Adhesive for base sheet insulation panel and tapered insulation: Low-rise, two-component polyurethane adhesive.
- .8 Insulation: Rigid extruded polystyrene complete with drainage channel on underside for use on roofs. Insulation to conform to CAN/ULC S701.
- .9 Roof drain:
 - .1 Reuse existing as requested.
 - .2 Provide new where required; Spun aluminum body, heavy duty cast aluminum strainer dome and clamping ring. Drain flange to have depressed sump area to facilitate water drainage. provide mechanical watertight connection to PVC or cast iron pipes.
- .10 Pitch pocket: prefabricated polyurethane curb system, interlocking pocket, size indicated.

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| 2.1 MATERIAL
(Cont'd) | .10 (Cont'd) |
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| | .1 Sealant: single component elastomeric polyurethane, isocyanate free. |
| | .2 Mastic: fast setting, solvent free. |
| | .11 Plastic cement: asphalt type to CAN/CGSB-37.5-M89. |
| | .12 Ballast reducing fabric: High density polyethylene filter fabric with UV inhibitors for use under ballast. |
| | .13 Ballast: Reuse existing where possible and provide new to match existing as required. |
| | .14 Precast concrete pavers: to CSA A231.1-06, plain face, 50 mm thick. |
| | .15 Levelling pads: purpose made for pavers, adjustable. |

PART 3 - EXECUTION

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| 3.1 PREPARATION | .1 Remove water and condensation from deck. |
| | .2 Clean deck of foreign and bituminous substances. |
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| 3.2 BLOCKING AND CURBS | .1 Secure treated wood blocking to deck at entire perimeter of roof and at projections and penetrations. |
| | .2 Treat surfaces cut after pressure treatment with wood preservative. |
| | .3 Secure plywood to horizontal and vertical surfaces as indicated. Support end and fasten to substrate at rate on one fastener per 0.2 m ² . |
| | .4 Match height of blocking with height of insulation. |
| | .5 Securely anchor blocking and curbs to substrate at 300 mm o.c. |
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3.3 GENERAL APPLICATION

- .1 In accordance with manufacturer's recommendations and CRCA SBS Modified Bituminous Membrane Specifications.
 - .1 Concrete deck: Fully Adhered, Protected Membrane Assembly, January 1997, Two Ply Modified Bitumen Membrane, Slope Range: 1:50 to 1:6.
 - .2 Steel deck: Fully Adhered, Protected Membrane Assembly, January 1997, Two Ply Modified Bitumen Membrane, Slope Range: 1:50 to 1:6.
- .2 Complete roofing membrane to each day's termination point and install temporary water cut-off.
- .3 Remove water cut-off when work resumes only if directed by Departmental Representative.
- .4 Fasteners: as recommended by membrane and sheet metal manufacturer.

3.4 INSULATION PANEL WITH MEMBRANE

- .1 Apply adhesive to substrate and install insulation panel with base sheet roofing membrane.
- .2 Install boards with long dimensions across flutes and edges supported on deck flanges.
- .3 Stagger end joints and butt boards in moderate contact.

3.5 TAPERED INSULATION

- .1 Adhere tapered insulation to existing concrete deck.
- .2 Taper insulation board at roof drains for a minimum of 600 mm beyond the opening.
- .3 Tapered roof insulation: provide 2% slope.
- .4 Joints in moderate contact. End joints staggered.

3.6 ROOF MEMBRANE

- .1 Install to CGSB 37-GP-56M+Amdt-Dec-85, Appendix, double-layer system and to manufacturer's instructions.
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- 3.6 ROOF MEMBRANE
(Cont'd)
- .2 Adhere base layer to substrate.
 - .3 Torch on top (cap) layer to manufacturer's instructions.
 - .4 Pull taut and wrinkle free.
 - .5 Lap side and end joints.
 - .6 Seal joints to manufacturer's instructions.
 - .7 Sprinkle granules on asphalt seepage and embed while the asphalt is hot.
- 3.7 MEMBRANE FLASHING
- .1 Apply asphalt primer to vertical concrete and masonry surfaces to receive bitumen or metal flashing and allow to cure prior to application.
 - .2 Install to:
 - .1 CGSB 37-GP-56M+Amdt-Dec-85, Appendix, double-layer system.
 - .2 Manufacturer's instructions.
 - .3 CRCA flashing guidelines for modified bitumen membrane.
 - .3 Install pitch pockets and accessories in accordance with manufacturer's written instructions.
- 3.8 INSULATION
- .1 Loose lay insulation in moderately tight contact at joints between boards and abutting surfaces.
 - .2 When cutting insulation board, cut completely through board thickness, do not break or tear to fit a detail. Areas of insulation system having voids will be rejected.
 - .3 Install insulation in straight parallel rows. Stagger end joints of insulation boards in adjacent rows 50%.
- 3.9 PROJECTIONS
- .1 Cut the membrane around the projection.
 - .2 Set flange in plastic cement.
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3.9 PROJECTIONS
(Cont'd)

- .3 Flash around the flange with membrane flashing.
- .4 Extend cap sheet 225 mm beyond the flange and torch on.
- .5 Seal joints of the cap sheet and upstand of metal with sealant.

3.10 BALLAST
REDUCING FABRIC

- .1 Position fabric over insulation, black side up, and overlap all edges a minimum 300 mm.
- .2 Extend fabric up 50 to 75 mm above ballast at perimeter and penetrations.

3.11 BALLAST

- .1 Install at a minimum rate of 50 kg/m² progressively as membrane, insulation, and fabric is laid. Carefully respread existing ballast to an even thickness over areas as indicated.

3.12 PAVERS

- .1 Install pavers on levelling pads, one at corner, in locations shown butted tightly.

PART 1 - GENERAL

- 1.1 REFERENCES
- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A653/A653M-15, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .2 ASTM D523-14, Standard Test Method for Specular Gloss.
 - .2 Canadian Roofing Contractors Association (CRCA)
 - .1 Roofing Specifications Manual 2012.
 - .3 Canadian Standards Association (CSA International)
 - .1 CSA B111-1974(R2003), Wire Nails, Spikes and Staples.
- 1.2 SUBMITTALS
- .1 Provide submittals in accordance with Section 01 33 00.
 - .2 Product Data:
 - .1 Submit manufacturer's printed product literature for sheet metal flashing systems materials, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit two copies WHMIS MSDS - Material Safety Data Sheets.
 - .3 Shop Drawings:
 - .1 Shop drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
 - .4 Samples:
 - .1 Submit duplicate 50 x 50 mm samples of each type of sheet metal material, finishes and colours.
 - .5 Quality assurance submittals: submit following in accordance with Section 01 45 00.
 - .1 Manufacturer's Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, and cleaning procedures.
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| <u>1.3 DELIVERY,
STORAGE AND
HANDLING</u> | .1 | Deliver, store and handle materials in accordance with Section 01 61 00. |
| | .2 | Waste Management and Disposal:
.1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21.
.2 Materials and Resources Credit: prepare Construction Waste Management plan in accordance with Section 01 74 21. |

PART 2 - PRODUCTS

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| <u>2.1 SHEET METAL
MATERIALS</u> | .1 | Zinc coated steel sheet: 0.6 mm thickness, commercial quality to ASTM A653/A653M, with Z275 designation zinc coating. |
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| <u>2.2 PREFINISHED
STEEL SHEET</u> | .1 | Prefinished steel with factory applied polyvinylidene fluoride.
.1 Class F2S.
.2 Colour selected by Departmental Representative from manufacturer's standard range.
.3 Specular gloss: 30 units +/- in accordance with ASTM D523.
.4 Coating thickness: not less than 22 micrometres.
.5 Resistance to accelerated weathering for chalk rating of 8, colour fade 5 units or less and erosion rate less than 20% to ASTM D822/D822M as follows:
.1 Outdoor exposure period 2500 hours.
.2 Humidity resistance exposure period 5000 hours. |
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| <u>2.3 ACCESSORIES</u> | .1 | Isolation coating: alkali resistant bituminous paint. |
| | .2 | Plastic cement: to CAN/CGSB-37.5. |
| | .3 | Sealants: In accordance with Section 07 92 00. |
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| <u>2.3 ACCESSORIES</u>
(Cont'd) | .4 | Fasteners: of same material as sheet metal, to CSA B111, flat head roofing nails of length and thickness suitable for metal flashing application. |
| | .5 | Washers: of same material as sheet metal, 1 mm thick with rubber packings. |
| | .6 | Touch-up paint: as recommended by prefinished material manufacturer. |

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| <u>2.4 FABRICATION</u> | .1 | Fabricate metal flashings and other sheet metal work as indicated. |
| | .2 | Form pieces in 2400 mm maximum lengths.
.1 Make allowance for expansion at joints. |
| | .3 | Hem exposed edges on underside 12 mm.
.1 Mitre and seal corners with sealant. |
| | .4 | Form sections square, true and accurate to size, free from distortion and other defects detrimental to appearance or performance. |
| | .5 | Apply isolation coating to metal surfaces to be embedded in concrete or mortar. |

PART 3 - EXECUTION

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| <u>3.1 MANUFACTURER'S INSTRUCTIONS</u> | .1 | Compliance: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets. |
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| <u>3.2 INSTALLATION</u> | .1 | Install sheet metal work as detailed. |
| | .2 | Use concealed fastenings except where approved before installation. |
| | .3 | Provide underlay under sheet metal.
.1 Secure in place and lap joints 100 mm. |
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| <u>3.2 INSTALLATION</u>
(Cont'd) | .4 | Counterflash bituminous flashings at intersections of roof with vertical surfaces and curbs.
.1 Flash joints using S-lock forming tight fit over hook strips, as detailed. |
| | .5 | Lock end joints and caulk with sealant. |
| | .6 | Caulk flashing at cap flashing with sealant. |
| | .7 | Install pans, where shown around items projecting through roof membrane. |
| <u>3.3 FIELD QUALITY CONTROL</u> | .1 | Manufacturer's Field Services:
.1 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions. |
| <u>3.4 CLEANING</u> | .1 | Proceed in accordance with Section 01 74 11. |
| | .2 | On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment. |
| | .3 | Leave work areas clean, free from grease, finger marks and stains. |

PART 1 - GENERAL

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| <u>1.1 ENVIRONMENTAL CHOICE PROGRAM</u> | .1 | Provide sealant products bearing the 'Ecologo' of the Environmental Choice Program, Department of the Environment, Canadian Environmental Protection Act, Environmental Choice Product Guidelines ECP/PCE-45-92 for Sealants and Caulking Compounds, except maximum VOC 60 g/L during application and curing. |
| | .2 | For primers and sealants, indicate VOC in g/L during application and curing. |

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| <u>1.2 PRODUCT DATA</u> | .1 | Submit manufacturer's literature indicating recommended surface preparation, sealant selection and primer for each substrate in accordance with Sections 01 33 00 and 01 78 00. |
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PART 2 - PRODUCTS

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| <u>2.1 SEALANTS</u> | .1 | Provide sealant products bearing Ecologo to ECP/PCE-45-92 with maximum VOC 60 g/L. |
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| <u>2.2 SEALANT MATERIAL DESIGNATIONS</u> | .1 | Silicones One Part.
.1 To ASTM C920-14a, primerless, Type S, Grade NS, Class 50, SWRI validated. |
| | .2 | Preformed compressible and non-compressible back-up materials '10', CFC free.
.1 Polyethylene, urethane, neoprene or vinyl foam. Extruded open cell foam backer rod. Size: oversize 30 to 50%.
.2 Neoprene or butyl rubber. Round solid rod, Shore A hardness 70.
.3 High density foam. Extruded closed cell polyvinyl chloride (PVC) or extruded polyethylene, closed cell, Shore A hardness 20, tensile strength 140 to 200 kPa, extruded polyolefin foam, 32 kg/m ³ density, or neoprene foam backer, size as recommended by manufacturer. |
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<u>2.2 SEALANT MATERIAL DESIGNATIONS</u> (Cont'd)	.2 (Cont'd) .4 Bond breaker tape. Polyethylene bond breaker tape which will not bond to sealant.
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<u>2.3 JOINT CLEANER</u>	.1 Non-corrosive and non-staining type, compatible with joint forming materials and sealant recommended by sealant manufacturer. .2 Primer: to manufacturer's recommendations.
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PART 3 - EXECUTION

<u>3.1 PREPARATION OF JOINT SURFACES</u>	.1 Examine joint sizes and conditions to establish correct depth to width relationship for installation of backup materials and sealants. .2 Clean bonding joint surfaces of harmful matter substances including dust, rust, oil grease, and other matter which may impair work. .3 Do not apply sealants to joint surfaces treated with sealer, curing compound, water repellent, or other coatings unless tests have been performed to ensure compatibility of materials. Remove coatings as required. .4 Ensure joint surfaces are dry and frost free. .5 Prepare surfaces in accordance with manufacturer's directions.
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<u>3.2 BACKUP MATERIAL</u>	.1 Apply bond breaker tape where required to manufacturer's instructions. .2 Install joint filler to achieve correct joint depth and shape with approximately 30% compression.
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<u>3.3 MIXING</u>	.1 Mix materials in accordance with sealant manufacturer's instructions.
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3.4 APPLICATION

- .1 Sealant.
 - .1 Protect installed work of other trades from staining or contamination.
 - .2 Apply sealant in accordance with manufacturer's application manual and written instructions.
 - .3 Mask edges of joint where irregular surface or sensitive joint border exists to provide neat joint. remove tape after sealant applied.
 - .4 Apply sealant in continuous beads.
 - .5 Apply sealant using gun with proper size nozzle.
 - .6 Use sufficient pressure to fill voids and joints solid.
 - .7 Form surface of sealant with full bead, smooth, free from ridges, wrinkles, sags, air pockets, embedded impurities.
 - .8 Tool exposed surfaces before skinning begins to give slightly concave shape.
- .2 Curing.
 - .1 Cure sealants in accordance with sealant manufacturer's instructions.
 - .2 Do not cover up sealants until proper curing has taken place.
- .3 Cleanup.
 - .1 Clean adjacent surfaces immediately and leave work neat and clean.
 - .2 Remove excess and droppings, using recommended cleaners as work progresses.
 - .3 Remove masking tape after initial set of sealant.

PART 1 - GENERAL

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| <u>1.1 CERTIFICATES</u> | .1 | Submit certificate stating that suspended ceiling systems provide adequate support for electrical fixtures, as required by current bulletin of Electrical Inspection Department of Ontario Hydro. |
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PART 2 - PRODUCTS

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| <u>2.1 MATERIALS</u> | .1 | Heavy duty system to ASTM C635/C635M-13a. |
| | .2 | Acoustic tile: Salvage existing acoustic tile for reinstallation. |
| | .3 | Suspension system: non-fire rated, one two directional exposed tee bar grid, including wall moulding. |
| | .4 | Exposed tee bar grid components for ACU: cold rolled steel, zinc coated, shop painted, satin sheen, white, interlocking, main and cross tee of double web with rectangular bulb, depth governed by span, 25 mm exposed face. |
| | .5 | Hangers: 3.6 mm galvanized soft annealed steel wire. |
| | .6 | Accessories: splices, clips, wire ties, retainers and wall moulding flush, to complement suspension system components, as recommended by system manufacturer. |
| | .7 | Retroclip: 0.9 mm thick (20 gauge) steel clip for attaching cross Tees to main tees after the cross tee tongue has been removed. |

PART 3 - EXECUTION

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| <u>3.1 INSTALLATION</u> | .1 | Install in accordance with ASTM C636/C636M-13 except where specified otherwise. |
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3.1 INSTALLATION
(Cont'd)

- .2 Co-ordinate suspension system with related components.
- .3 Cut acoustic units to fit adjacent work. Butt joints tight, terminate edges with moulding.
- .4 Support suspension system main runners at 1200 mm oc maximum with hangers from structure. Assembly shall support super-imposed loads. Maximum permissible deflection, 1/360th of span to ASTM C635/C635M-13a deflection test.
- .5 Attach cross member to main runner to provide rigid assembly.
- .6 Install suspension assembly to manufacturer's written instructions.
- .7 Install flush edge moulding at junction of acoustic unit ceiling and other materials around entire length of joint.

PART 1 - GENERAL

1.1 RELATED
SECTIONS

- .1 Section 01 51 00 - Temporary Utilities.
- .2 Temporary Facilities.

1.2 USE OF SYSTEMS

- .1 Use of new and or existing permanent heating and or ventilatingsystems for supplying temporary heat or ventilation is not permitted permitted only under the following conditions:
 - .1 Entire system is complete, pressure tested, cleaned, flushed out.
 - .2 Specified water treatment system has been commissioned, water treatment is being continuously monitored.
 - .3 Building has been closed in, areas to be heated/ventilated are clean and will not thereafter be subjected to dust-producing processes.
 - .4 There is no possibility of damage from any cause.
 - .5 Supply ventilation systems are protected by 60% filters, which shall be inspected daily, changed every week 2 weeks or more frequently as required.
 - .6 Return systems have approved filters over all openings, inlets, outlets.
 - .7 All systems will be:
 - .1 operated as per manufacturer's recommendations or instructions.
 - .2 operated by Contractor.
 - .3 monitored continuously by Contractor.
 - .8 Warranties and guarantees are not thereby relaxed.
 - .9 Regular preventive and all other manufacturers recommended maintenance routines are performed by Contractor at his own expense and under supervision of Departmental Representative Consultant.
 - .10 Before static completion, entire system to be refurbished, cleaned internally and externally, restored to "as- new" condition, filters in air systems replaced.
 - .2 Filters referred to herein are over and above those specified elsewhere in this specification.
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<u>1.2 USE OF SYSTEMS</u> <u>(Cont'd)</u>	.3	Exhaust systems are not included in any approvals for temporary heating ventilation.
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PART 2 - PRODUCTS

<u>2.1 NOT USED</u>	.1	Not Used.
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PART 3 - EXECUTION

<u>3.1 NOT USED</u>	.1	Not Used.
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PART 1 - GENERAL

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| <u>1.1 EQUIPMENT LIST</u> | .1 | Complete list of equipment and materials to be used on this project and forming part of bid documents by adding manufacturer's name, model number and details of materials, and submit for approval. |
| | .2 | Submit for approval within 10 days after Award of Contract. |
| | | |
| <u>1.2 TRIAL USAGE</u> | .1 | Departmental Representative Owner may use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing. |
| | | |
| <u>1.3 PROTECTION OF OPENINGS</u> | .1 | Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system. |
| | | |
| <u>1.4 PAINTING</u> | .1 | Prime and touch up marred finished paintwork to match original. |
| | .2 | Restore to new condition, finishes which have been damaged too extensively to be merely primed and touched up. |
| | | |
| <u>1.5 DEMONSTRATION AND OPERATING AND MAINTENANCE INSTRUCTIONS</u> | .1 | Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance. |
| | .2 | Where specified elsewhere in Mechanical Divisions, manufacturers to provide demonstrations and instructions. |
| | .3 | Use operation and maintenance manual, as-built drawings, audio visual aids, etc. as part of instruction materials. |
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1.5 DEMONSTRATION
AND OPERATING AND
MAINTENANCE
INSTRUCTIONS
(Cont'd)

- .4 Instruction duration time requirements as specified in appropriate sections.
- .5 Where deemed necessary, Departmental Representative Owner may record these demonstrations on video tape for future reference.

1.6 CLOSEOUT
SUBMITTALS

- .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00.
 - .2 Operation and maintenance manual to be approved by, and final copies deposited with, Departmental Representative before final inspection.
 - .3 Operation data to include:
 - .1 Control schematics for each system including environmental controls.
 - .2 Description of each system and its controls.
 - .3 Description of operation of each system at various loads together with reset schedules and seasonal variances.
 - .4 Operation instruction for each system and each component.
 - .5 Description of actions to be taken in event of equipment failure.
 - .6 Valves schedule and flow diagram.
 - .7 Colour coding chart.
 - .4 Maintenance data shall include:
 - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
 - .2 Data to include schedules of tasks, frequency, tools required and task time.
 - .5 Performance data to include:
 - .1 Equipment manufacturer's performance data sheets with point of operation as left after commissioning is complete.
 - .2 Equipment performance verification test results.
 - .3 Special performance data as specified elsewhere.
 - .4 Testing, adjusting and balancing reports as specified in Section 23 05 93.
 - .6 Approvals:
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1.6 CLOSEOUT
SUBMITTALS
(Cont'd)

- .6 (Cont'd)
 - .1 Submit 2 copies of draft Operation and Maintenance Manual to Departmental Representative for approval. Submission of individual data will not be accepted unless so directed by Departmental Representative.
 - .2 Make changes as required and re-submit as directed by Departmental Representative.
- .7 Additional data:
 - .1 Prepare and insert into operation and maintenance manual when need for same becomes apparent during demonstrations and instructions specified above.

1.7 SHOP DRAWINGS
AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00.
- .2 Shop drawings and product data shall show:
 - .1 Mounting arrangements.
 - .2 Operating and maintenance clearances. eg. access door swing spaces.
- .3 Shop drawings and product data shall be accompanied by:
 - .1 Detailed drawings of bases, supports, and anchor bolts.
 - .2 Acoustical sound power data, where applicable.
 - .3 Points of operation on performance curves.
 - .4 Manufacturer to certify as to current model production.
 - .5 Certification of compliance to applicable codes.
- .4 In addition to transmittal letter referred to in Section 01 33 00: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.

1.8 CLEANING

- .1 Clean interior and exterior of all systems including strainers. Vacuum interior of ductwork and air handling units.

1.9 AS-BUILT
DRAWINGS

- .1 Site records:
 - .1 Departmental Representative will provide one (1) set of reproducible mechanical drawings. Provide sets of white prints as required for each phase of the work. Mark there on all changes as work progresses and as changes occur. This shall include changes to existing mechanical systems, control systems and low voltage control wiring.
 - .2 On a weekly basis, transfer information to reproducibles, revising reproducibles to show all work as actually installed.
 - .3 Use different colour waterproof ink for each service.
 - .4 Make available for reference purposes and inspection at all times.
 - .2 As-built drawings:
 - .1 Prior to start of Testing, Adjusting and Balancing (TAB), finalize production of as-built drawings.
 - .2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (date).
 - .3 Submit to Departmental Representative for approval and make corrections as directed.
 - .4 TAB to be performed using as-built drawings.
 - .5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.
 - .3 Submit copies of as-built drawings for inclusion in final TAB report.
 - .4 as-built drawings for inclusion in final TAB report.
 - .5 As-built drawings shall be all converted to AutoCAD with PWGSC layering system.
 - .6 Submit as-built AutoCAD and PDF CD/DVD/Flash Drive. Allow for minimum two (2) sets.
 - .7 All TAB reports shall be in PDF format and copied to CD/DVD/Flash Drive and folder prints.
-

1.10 WASTE
MANAGEMENT AND
DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 11 01.
- .2 Divert unused metal and wiring materials from landfill to metal recycling facility approved by Departmental Representative.
- .3 Dispose of unused paint material at official hazardous material collections site approved by Departmental Representative.
- .4 Do not dispose of unused paint material into sewer system, into streams, lakes, onto ground or in other locations where it will pose health or environmental hazard.
- .5 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .6 Dispose of corrugated cardboard, polystyrene, plastic packaging material in appropriate on-site bin for recycling in accordance with site waste management program.

1.11 EXAM SITE

- .1 Examine the site and the local conditions and Conditions affecting the work during tender process. Examine carefully the Architectural, Structural, and Mechanical, Electrical and all other drawings and the complete specifications to ensure that the work can be satisfactorily carried out as shown.
- .2 Before commencing work, examine the work of the other Divisions and report at once any defect or interference affecting the work, the completion, or the guarantee of the work of this Division. No allowance will be made later for any expenses incurred through the failure to make these examinations or to report any such discrepancies in writing to the Department Representative.

1.12 CODES, PERMITS
FEES ANC CONNECTIONS

- .1 Conform to Federal, Provincial and Municipal regulations and perform work in accordance with requirements of By Laws and Regulations in force in area where the building is to be erected.

1.12 CODES, PERMITS
FEES ANC CONNECTIONS
(Cont'd)

- .2 Apply for, obtain, and pay for permits, fees and service connections for the work of this Division and the inspections required by Authorities having jurisdiction in the area where the building is to be erected.
- .3 For information, a specific code or standard might be mentioned. This information must not be taken as the only code or standard applicable.
- .4 When part of equipment does not bear the required UL label, the contractor shall obtain UL approval on site, when that part of the equipment is an electric component, a special approval shall be obtained and the Contractor shall pay the applicable fees.
- .5 Furnish necessary certificates as evidence that the work installed conforms with laws and regulations of Authorities having jurisdiction. Changes in work requested by an Authority having jurisdiction shall be carried out without charge.
- .6 Apply to TSSA for high pressure application. Ensure all systems are tested to TSSA satisfaction.

1.13 INSTALLATION
OF WORK

- .1 Coordinate with other trades and schedule all work to suit the date for the substantial performance established in the construction contract.
- .2 Furnish items to be "built up" in ample time and give necessary information and assistance in connection with the building in of the same.
- .3 Provide drawings showing all sleeving and openings required. Notify the Construction Manager of the size and location of recesses, openings and chases before walls, floors, etc., are erected.
- .4 Proceed with the work as quickly as practical so that construction may be completed in as short a time as possible and in accordance with the building schedule. Ensure that all health, safety and environmental conditions are maintained.

1.13 INSTALLATION
OF WORK
(Cont'd)

- .5 Ensure that all equipment and material is ordered in time to meet the building schedule. Provide a schedule of equipment deliveries to the Construction Manager within the time limit stipulated.
- .6 Furnish promptly information required for the construction schedule.
- .7 Manufactured products supplied with instructions for their installation shall be installed in strict accordance with those instructions.

1.14 WORK IN
EXISTING BUILDINGS

- .1 Prior to working on any of exiting systems, contact Departmental Representative and provide with at least 5 working days notice .
- .2 Do not disturb any hydraulic piping without through examination to ensure it is safe and empty. Ensure isolating valves are operational prior to carrying out any work.
- .3 Freeze lines if required to make required connections.

1.15 SLEEVES

- .1 Use cast iron sleeve or steel pipe sleeves with annular fin continuously welded at midpoint.
- .2 For pipes passing through roofs, use cast iron sleeves with caulking recess and flashing clamp device. Anchor sleeves in roof construction; caulk between sleeve recess and pipe; fasten roof flashing to clamp device; make water tight durable joint.
- .3 Fill voids around pipes
 - .1 For sleeves and pipe in foundation walls and below grade floors, provide "link seal@ clamp manufactured by Thunderline or Innerlynx.
 - .2 Where sleeves pass through walls or floors, caulk space between insulation and sleeve or between pipe (duct) and sleeve with waterproof fire retardant non hardening mastic. Seal space at each end of sleeve with waterproof, fire retardant, non hardening mastic.
 - .3 Ensure no contact between copper tube or pipe and ferrous sleeve.

1.15 SLEEVES
(Cont'd)

- .3 (Cont'd)
- .4 Fill future use sleeves with easily removable fire stop filler.
- .5 Coat exposed exterior surfaces of ferrous sleeves with heavy application of zinc rich paint.
- .4 All sleeves shall be as detailed on drawings.
- .5 All sleeve locations including dimensions shall be submitted to the Department Representative.

1.16 TESTS

- .1 Do not insulate or conceal work until tested and approved. Follow construction schedule and arrange for tests.
- .2 Inform the Department Representative when tests will be conducted. All tests are to be documented test results submitted and included in the maintenance manuals. Refer to attached Appendix A for the format to be utilized for the test reports.
- .3 Bear costs including retesting and making good.
- .4 Prior to tests, isolate all equipment or other parts which are not designed to withstand test pressures.

1.17 SUMMARY OF
COMMISSIONING

- .1 Commissioning (Cx) is a systematic quality process of ensuring that building systems perform and interact according to the Owner's and the Design Engineers' Project Requirements and contract documents.
 - .2 Desired Outcomes
 - .1 A commissioned building provided optimized energy and occupant comfort, and sets the stage for minimal operation and maintenance costs. It serves as a tool for both the Owner and the Contractor to minimize post-occupancy remedial work.
 - .3 Commissioning Goals
-

1.17 SUMMARY OF
COMMISSIONING
(Cont'd)

- .3 (Cont'd)
.1 The Commissioning Process for a project typically focuses on systems and assemblies having to do with the performance objectives meeting the Owner's Project Requirements (OPR). Contractors, associated Sub-Contractors, equipment and material Suppliers are to support and ensure the requirements for commissioning are met in their respective work.

1.18 DEFINITIONS

- .1 Owner's Project Requirements (OPR)
.1 The documentation of the functional performance requirements of the facility and the Owner's expectations of how it will be used and operated. This document is analogous to what has traditionally been referred to as the Owner Program.
- .2 Basis of Design (BOD)
.1 A project-specific set of assumptions and design parameters for system and product selections to meet the OPR and applicable regulatory requirements.
- .3 Commissioning Agent (CxA)
.1 An Owner designated member, not otherwise associated with the Architectural and Engineering Teams or the Contractor's Team. The CxA facilitates and coordinates the commissioning activities. Involvement of CxA shall not void any guarantees or warranties nor shall it relieve the Contractor of any contractual responsibilities.
- .4 Deficiency/Issue
.1 A condition in the installation or function of a component or system that is not in compliance with the construction contract documents and/or Owner's requirements.
- .5 Start-up/Pre-Functional The initial starting or activating of dynamic equipment, including the checkout of components and devices and completing static installation checklists.
- .6 Functional Performance Testing (FPT)
-

1.18 DEFINITIONS (Cont'd)	.6	(Cont'd) .1 Testing performed by the Construction Team to verify that specific components, assemblies, systems, and integrated systems function and perform in accordance with the Owner's objectives and the contract documents. Tests are generally performed after the Contractor's start-up and initial checkouts are completed.
1.19 COMMISSIONING PLAN	.1	The CxA will develop a Commissioning Plan unique to the project.
	.2	The Commissioning Plan identifies the strategies, aspects, and responsibilities within the commissioning process for all project team members.
	.3	The Commissioning Plan contains the following information: .1 Commissioning Program Overview .1 Goals and objectives .2 General project information .3 Systems to be commissioned. .2 Commissioning Team .1 Team members, roles, and responsibilities. .2 Communication protocol, coordination, meetings, and management. .3 Commissioning Process Activities .1 Documenting the owner's project requirements. .2 Preparing the basis of design. .3 Developing systems functional performance test procedures. .4 Verifying systems performance. .5 Reporting deficiencies and the resolution process. .4 List of systems and assemblies to be commissioned. .5 The Contractor and the Sub-Contractors shall carryout commissioning activities as per the Commissioning Plan.
1.20 COMMISSIONING DOCUMENTATION	.1	The Commissioning Process includes a significant documentation and paper component. Commissioning documents include but are not limited to: .1 Drawings and Specifications. .2 Shop Drawings.

- 1.20 COMMISSIONING .1 (Cont'd)
DOCUMENTATION .3 Pre-Functional Check Sheets.
(Cont'd) .4 OEM/Contractor Start Up/Test Forms and
Records.
.5 As Built Drawings.
.6 Functional Performance Test Plans and
Results.

PART 2 - PRODUCTS

- 2.1 NOT USED .1 Not Used.

PART 3 - EXECUTION

- 3.1 CUTTING AND .1 Cutting and patching shall be in accordance
PATCHING with the following:
.1 No openings shall be permitted through the
completed structure without the written
approval of the Department Representative. Any
openings which are required through structure
must be clearly and accurately shown. Exact
locations, elevations and size of the proposed
opening must be identified and submitted to the
Department Representative for review, well in
advance of doing the work.
.2 All cutting and patching shall be done by
the trades specializing in the materials to be
cut and is covered by the appropriate Divisions
of this specification. Prepare drawings in
conjunction with all trades concerned, showing
sleeves and openings for passage through
structure and all insert sizes and locations.
.3 Supporting members of any floor, wall or
the building structure shall be cut only in
such a location and manner as approved by the
Department Representative in writing.
.4 Scan and x-ray floors prior to carrying
out any openings. Rebars shall not be cut.

PART 1 - GENERAL

1.1 GENERAL

- .1 The following is the strategy for Commissioning. Commissioning is a process in which the Commissioning Team Members, the Design Consultants, the PWGSC Project Manager, PWGSC Design and Quality Assurance Authority, PWGSC Commissioning Manager, the Owner, Commissioning Manager, General Contractor and the Mechanical Contractor and their Sub Contractors execute the commissioning process. The Owner has a skilled team of building staff and operators who can competently run a building provided they are given the appropriate background information, training and documentation.
 - .2 This specification section must be read in close conjunction with the noted commissioning sections below:
 - .1 Section 01 91 13 - General Commissioning (Cx) Requirements
 - .2 Section 01 91 31 - Commissioning (Cx) Plan.
 - .3 Section 01 91 33 - Commissioning Forms.
 - .4 Section 01 91 41 - Commissioning Training.
 - .5 Section 01 91 51 - Building Management Manual (BMM).
 - .3 The Mechanical Contractor shall meet all additional requirements noted in the referenced documents above as well as the work identified within the related sections below.
 - .4 Acronyms:
 - .1 AFD - Alternate Forms of Delivery, service provider.
 - .2 BMM - Building Management Manual.
 - .3 EMCS - Energy Monitoring and Control Systems (BAS)
 - .4 O & M - Operation and Maintenance
 - .5 ICL Installation Check Lists
 - .6 PI - Product Information (Forms)
 - .7 PV - Performance Verification (Forms)
 - .8 FPT - Functional Performance Test (Plans)
 - .9 TAB - Testing, Adjusting and Balancing.
 - .10 OEM - Original Equipment Manufacturer
 - .11 BAS - Building Automation System (EMCS)
 - .12 LSC - Life Safety Compliance
 - .13 SOP - Standard Operating Procedures
 - .14 M&E - Mechanical and Electrical
 - .15 M&E DB - Mechanical and Electrical Database
-

1.1 GENERAL
(Cont'd)

- .4 (Cont'd)
 - .16 WHMIS - Workplace Hazardous Materials Information System
 - .17 MSDS - Material Safety Data Sheet
 - .18 OPR - Owners Project Requirements

1.2 RELATED
SECTIONS

- .1 Section 01 91 13 - General Commissioning (Cx) Requirements
- .2 Section 01 91 31 - Commissioning (Cx) Plan.
- .3 Section 01 91 33 - Commissioning Forms.
- .4 Section 01 91 41 - Commissioning Training.
- .5 Section 01 91 51 - Building Management Manual (BMM).
- .6 Division 21 / 22 / 23 / 25 Specification Sections

1.3
RESPONSIBILITIES

- .1 The following are the general responsibilities for commissioning of the Mechanical Contractor.
 - .1 Mechanical Contractor- Construction:
 - .1 General:
 - .1 The Mechanical Contractor shall be responsible for the commissioning process detailed within the Mechanical Specifications Sections.
 - .2 The Mechanical Contractor shall conform to the commissioning requirements detailed in Mechanical Specification and the Commissioning Specification in Division 01.
 - .3 The Mechanical Contractor shall coordinate and cooperate with the Electrical Contractor as detailed in Specification sections of the Mechanical and Electrical Specifications and as required to meet all commissioning requirements.
 - .4 Assign a Commissioning Coordinator who will have the required decision making authority / commissioning expertise and who is dedicated to the commissioning process.

1.3
RESPONSIBILITIES
(Cont'd)

.1 (Cont'd)

.1 (Cont'd)

.5 Explain and ensure all Sub Contractors understand the commissioning requirements. The Mechanical Contractor shall schedule all commissioning tasks required to be completed by their Sub Contractors.

.6 If the project has phases the Record Drawings shall be submitted at the completion of each phase. The Mechanical Contractor shall at the end of the project submit a full consolidated set of recordings.

.7 Cooperate as required.

.2 Meetings:

.1 Throughout the Construction Schedule the Mechanical Contractor / Commissioning shall attend all commissioning and punch list meetings.

.3 Equipment Start up:

.1 The Mechanical Contractor shall provide notification of the scheduled date of completion for mechanical equipment and systems in writing to the Commissioning Manager and Design Consultant a minimum of ten (10) working days prior to Start Up.

.2 Prior to providing notification of completion, the Mechanical Contractor shall review the work site and ensure all of the above are complete. In addition all labeling must be complete.

.3 Upon notice of scheduled completion separate walkthroughs shall be scheduled with the Commissioning Manager.

.4 The Mechanical Contractor shall participate in construction complete walkthroughs for each system, sub-system or key item of mechanical equipment. Any items found to be not complete will be documented on a punch list. Items that are deemed to be essential for test run must be completed prior to the equipment or system being turned on.

1.3
RESPONSIBILITIES
(Cont'd)

.1 (Cont'd)

.1 (Cont'd)

.5 The Mechanical Contractor shall participate in Health and Safety walkthroughs for each system, sub-system or key item of mechanical equipment prior to the equipment being started.

.4 Commissioning Test Forms:

.1 Rectify deficiencies documented in the PI, installation, start up, or functional performance verification (PV) test forms.

.2 Complete forms for PI, installation, start-up, and PV testing with Commissioning Manager.

.3 Complete form(s) for all integrated system(s) performance testing with Commissioning Manager.

.4 Update, create and complete forms as specified.

.5 Mechanical Contractor Testing:

.1 The Commissioning Manager will develop lists of tasks and schedules for building systems performance testing and demonstration.

.2 Working with the Commissioning Manager the Mechanical Contractor shall schedule testing of the mechanical equipment and systems in accordance with the Contract Documents and the Program established by the Commissioning Manager. A detailed schedule shall be provided a minimum of two (2) weeks prior to the equipment or system being turned on. Schedule shall break down the testing into individual components, equipment, sub systems, and systems. The schedule shall provide adequate time for testing and commissioning of each system.

.3 During the testing of systems the Mechanical Contractor shall make available skilled tradesmen to effect trouble shooting and effect repairs. During start up and performance testing same day repair and trouble shooting of equipment shall be provided.

1.3
RESPONSIBILITIES
(Cont'd)

.1 (Cont'd)

.1 (Cont'd)

.4 The Mechanical Contractor shall conduct tests as detailed by the Commissioning Manager in the installation, start-up, functional performance verification (PV) and integrated building system(s) test forms. The test forms shall be filled out by the Mechanical Contractor and shall be witnessed by the Commissioning Manager.

.5 The Mechanical Contractor shall document the results of all tests conducted during the construction and the post construction phase and shall fill out documentation in accordance with Commissioning Manager's requirements.

.6 The Mechanical Contractor shall ensure that Sub Contractors' testing is performed and complete in accordance with the Commissioning Manager's requirements.

.6 Progress Payments:

.1 Set aside in billing breakdown funds for commissioning, testing, manuals, demonstration training, and all other commissioning activities.

.7 Sub trades and Outside Design Consultants:

.1 Understand quality standards contained in the specifications and ensure by inspections, site visits and document revisions that they are being met by the Sub Contractors.

.2 The Mechanical Contractor shall keep records of their testing in accordance with Commissioning Manager's requirements.

.8 Maintenance Manuals:

.1 Assemble documentation; manuals, record drawings, commissioning forms, prior to turn over and training.

.2 Maintenance manuals shall be put together immediately upon completion of the submittal of shop drawings.

.3 All maintenance manuals shall be formatted as per PWGSC Standards - Commissioning Standard.

- 1.3 RESPONSIBILITIES (Cont'd)
- .1 (Cont'd)
- .4 Provide any information required to satisfy the requirements of Section 01 91 51 Building Management Manual (BMM) and as requested by Commissioning Manager for completion of the BMM.
- .9 Building Turnover and Staff Training - Mechanical Contractor:
- .1 Arrange training sessions with the Design Consultant, Commissioning Manager and PWGSC Project Manager.
- .2 Schedule clear interface between construction and Owner's operation of equipment.
- .3 Testing and turnover procedures to be approved by the Commissioning Manager and a minimum of three (3) weeks prior to the first test / system or equipment scheduled turnover.
- .10 Commissioning Manager:
- .1 The Commissioning Manager will be generating the PI, PV and integrated systems commissioning test forms that are to be completed by the Mechanical Contractor.

- 1.4 COMMISSIONING REQUIREMENTS OVERVIEW
- .1 Project equipment and systems as per existing contract documents.

Specification Section	Item Description	Product Information Forms (PI)1	Installation Check Forms1	Operation / Performance Checks (PV)
23 73 11	AHUs	Y	Y	Y
23 73 11	Humidifiers	Y	Y	Y
23 34 00	Fans	Y	Y	Y
23 21 23	Pumps	Y	Y	Y
23 21 13	Heaters	Y	Y	Y
23 52 00	Boilers	Y	Y	Y
23 42 01	Backflow Preventers	Y	Y	Y
23 21 13	Convectors	Y	Y	Y
23 64 19	Chillers	Y	Y	Y
23 05 01	BAS	Y	Y	Y

1.4 COMMISSIONING
REQUIREMENTS
OVERVIEW
(Cont'd)

- 1 PI forms only to new components and equipment.

1.5 INTEGRATED
BUILDING SYSTEMS
(IBS) PERFORMANCE
TESTING

- .1 If there is a requirement for detailed Performance Verification Testing of Integrated Building Systems the Construction Team shall execute the testing as required. The detail of these simulated performance verification tests of integrated / interconnected systems will be developed during the construction period of the project. The Mechanical Contractor will play a major role in supporting and participating in these performance verification tests of integrated / interconnected systems.
- .2 The integrated / interconnected system performance tests are in addition to the Performance Verification Tests (PV).
- .3 Integrated / interconnected performance testing may include the following integrated /interconnected systems:
 - .1 HVAC and associated systems forming part of integrated HVAC systems.
 - .2 Indoor air quality.
 - .3 Environmental space conditions.
 - .4 Fire alarm systems.
 - .5 Emergency lighting systems.

1.6 BUILDING
MANAGEMENT MANUAL
(BMM)

- .1 The Mechanical Contractor shall participate in the preparation of materials of this manual as directed by the General Contractor. Mechanical Contractor requirements are defined in Section 01 91 51 and associated specifications.

1.7 DEVELOPMENT OF
SYSTEMS OPERATION
AND MAINTENANCE

- .1 Standard Operating Procedures (SOP) Manual
 - .1 Mechanical SOP Manual will be developed for each system within that discipline, containing information:
 - .1 relating to the detailed description of each system,
 - .2 relating to day-to-day operation of the system,

1.7 DEVELOPMENT OF .1
SYSTEMS OPERATION
AND MAINTENANCE
(Cont'd)

(Cont'd)

.1 (Cont'd)

.3 Permitting the operating personnel to make decisions which are in complete agreement with the Client's requirements within the limits of the installed system.

.2 Development: The Mechanical Contractor cooperates and supports the Design Consultant by providing all required data and information, identifying changes in set points of operating, limit and safety controls during start-up, verification, commissioning, and adjustments in operating procedures.

.3 Development: The SOP Manual is produced by the Design Consultant based upon the format established by the generic SOP document.

.1 Phase 1 - Design Stage - the SOP Manual to include:

.1 The area and its function served by the mechanical system,

.2 Floor plans indicating zoning of electrical systems.

.3 Drawings, schematics and descriptions of the system, sub systems, equipment, components, functions and input/output parameters of each controller, start-up and shut down procedures.

.4 Brief narrative description of the sequence of operations and its components.

.2 Phase 2 - Contract Documents to be 90% complete & include:

.1 Detailed narrative descriptions of the sequence of operations.

.2 Necessary emergency procedures for the electrical systems.

.3 Details of its relationship to all other systems.

.3 Phase 3 - Construction, the Design Consultant to bring the SOP Manual to 99% completion prior to pre start up inspections.

.4 Phase 4 - Development Construction - Commission Stage, the SOP Manual is brought to 100% completion at least six (6) weeks prior to issuance of the Interim Certificate of Completion, using data obtained during start-up, verification and commissioning. This will include:

.1 Documenting control systems as finally set,

1.7 DEVELOPMENT OF .1
SYSTEMS OPERATION .3
AND MAINTENANCE
(Cont'd)

(Cont'd)

.3 (Cont'd)

.2 Instructions for operating under normal and emergency conditions.

.3 Details of response to emergency situations.

.5 Phase 5 - Development Operation, it may be necessary to make further changes to reflect operation under varying conditions of occupancy.

.4 Organizations of the SOP Manual: In general, the contents required are as follows:

.1 Section 1: Information directory: To provide easy access to all information, it should include:

.1 table of contents listing all systems in the building,

.2 list of equipment for each system, cross-referenced to the Operating and Maintenance Manual.

.2 Section 2: Drawings, schematics, diagrams, areas served, sketches, wiring diagrams and system description. To include, but not necessarily limited to:

.1 Drawings, schematics, diagrams, chart identifying all systems and the area(s) served by each system.

.2 For each Mechanical system:

.1 drawings, schematics, diagrams, and narrative description,

.2 operational tolerances of systems, equipment and components,

.3 manufacturers' recommendations for operation under all normal and emergency conditions,

.4 cross-references to the approved TAB and PV reports for each system.

.3 Section 3: Operating standards, operating logs, operating routines, procedures, BAS data: To be clearly understandable to building operators and the Property Manager and to include, but not necessarily limited to:

.1 required standards of performance,

.2 operating logs to monitor performance,

1.7 DEVELOPMENT OF .1
SYSTEMS OPERATION .4
AND MAINTENANCE
(Cont'd)

(Cont'd)

.4 (Cont'd)

.3 reporting requirements for all
licensing and inspections as
applicable,

.4 identity of all activities
associated with normal and abnormal
operation,

.5 details of load-shedding
procedures,

.6 operating checklists,

.7 seasonal start-up and shut-down
procedures,

.8 BAS data to include system
schematics, input/output summaries,
complete with alarm limits for each
device, copy of the actual program
language.

.9 all special or codified (i.e.
Labour Canada regulations and
amendments) procedures relating to
environmental control, health and
safety, and productive work
environment.

.4 Section 4: BAS Controls Interface
Information: To include:

.1 system schematics, graphical and
mechanical drawings, and devices,

.2 narrative description of the
control programming, point names,
safety features, reset schedules,

.3 input/output summaries, complete
with alarm limits for each device,

.4 copy of the actual program
language.

.5 wiring diagram.

.5 Section 5: Troubleshooting
Information: This may include:

.1 elementary questionnaires,

.2 simple walk-through inspections,

.3 sophisticated diagnostic or
expert analysis (depending upon the
complexity of the system and the
technical expertise of the O&M
personnel). The intent is to allow
Users of this manual to isolate
probable causes in an orderly and
efficient manner.

1.8 THE
COMMISSIONING
PROCESS

.5 The Commissioning Process consists of the following:

- .1 Processing and completion of Shop Drawings and Record Drawings.
- .2 Installation inspection of all Mechanical Equipment and completion of all associated testing.
- .3 Independent Testing Contractor's participation and documentation.
- .4 Performance Testing of Mechanical Equipment and Systems.
- .5 Performance Testing of Integrated / Interconnected Systems.
- .6 Participation in all Commissioning and Punch List Meetings.
- .7 Participation in the completion of Operating and Maintenance Manuals.
- .8 Participate in the completion of Systems Operating Manuals.
- .9 Staff Operating Training.
- .10 Preparation and Completion of all Commissioning Forms.
- .11 Warranties.

.2 Installation Inspection and Equipment Verification/Checks:

- .1 The Mechanical Contractor shall coordinate with the Commissioning Manager and the PWGSC Project Manager who will be inspecting the mechanical installation.
- .2 The Mechanical Contractor shall notify the Commissioning Manager when each piece of equipment is ready for inspection for PI, installation, start up and performance (PV) testing. The Mechanical Contractor shall provide a detailed schedule for each system, subsystem and each piece of equipment.
- .3 The Mechanical Contractor shall rectify any deficiencies found by the Commissioning Manager or Design Consultant during the commissioning process.

.3 Testing of Equipment and Systems:

1.8 THE
COMMISSIONING
PROCESS
(Cont'd)

- .3 (Cont'd)
- .1 The Mechanical Contractor shall be responsible for all tests detailed in the Contract Documents, BAS Sequences of Operation, and those tests required by a manufacturer as part of their installation requirements. The Mechanical Contractor shall be responsible for completing the PI, installation, start-up and functional performance (PV) test forms in accordance with the Contract Documents and BAS Sequences of Operation under the guidance of the Commissioning Manager.
- .2 The Mechanical Contractor shall only utilize employees with previous experience in Testing Procedures as they relate to a particular subject.
- .3 The Mechanical Contractor shall inform the Commissioning Manager, in writing, who they intend to use along with a list of relevant experience and projects completed. The Commissioning Manager retains the right to accept or reject the proposed individual.
- .4 The Mechanical Contractor shall hire the manufacturers' technicians who will conduct required start-up and/or programming and testing on their equipment.
- .5 The Mechanical Contractor shall cooperate with any Independent Testing Mechanical Contractors to provide assistance during the testing procedures.
- .6 All tests shall be witnessed by the Commissioning Manager as they see fit. If tests are not witnessed and forms are not signed, the tests shall be repeated at the Mechanical Contractor's expense.
- .7 Commissioning Meetings and Reporting:
- .1 The Mechanical Contractor shall include the schedule for all tests in the Construction Schedule.
- .2 The commissioning meetings will be held as separate meetings from the regular construction meetings. The testing schedules and the results of all tests shall be reviewed.
- .8 All testing forms and reports associated with the mechanical systems shall be directed to the General Contractor with copies to the Design Consultant and Commissioning Team members as required.
- .9 The forms and reports to be issued shall include:
-

1.8 THE
COMMISSIONING
PROCESS
(Cont'd)

- .3 (Cont'd)
 - .1 Shop drawings issued and accepted.
 - .2 Equipment Product Information (PI) Forms.
 - .3 Installation Check Lists (ICL).
 - .4 Performance Verification (PV) Test Forms.
 - .5 Integrated System Test Forms.
 - .6 Reports resulting from tests.
 - .7 Testing Schedule.
 - .8 Minutes of commissioning meetings.
 - .9 Manufacturers' Certificates, Verification and Test results.
 - .10 Operating and Maintenance Manuals.
 - .4 Staff and Operator Training:
 - .1 The Mechanical Contractor and equipment manufacturers shall provide operator training for each system and its associated equipment.
 - .2 The training shall be executed on a construction phase by phase basis as per construction schedule.
 - .3 The training shall be provided by qualified technicians and shall be conducted in a classroom, and at the equipment or system.
 - .4 The training sessions shall be scheduled, coordinated by the General Contractor and turned over to the PWGSC Project Manager as per specifications.(video tapping as per PWGSC written request).
 - .5 Each training session shall be structured to cover the following:
 - .1 Operating and Maintenance Manual.
 - .2 Operating Procedures and BAS Sequences of Operation.
 - .3 Maintenance Procedures.
 - .4 Trouble shooting Procedures.
 - .5 The manufacturers or service representatives name, address and phone number.
 - .6 Submit a course outline to the Commissioning Manager, the Design Consultant, and the PWGSC Project Manager before training commences. Provide course documentation for up to ten (10) people.
 - .5 System Demonstration and Building Turnover:
-

1.8 THE
COMMISSIONING
PROCESS
(Cont'd)

- .5 (Cont'd)
 - .1 The system demonstration and building turnover to Owner's staff shall occur when:
 - .1 The installation is complete.
 - .2 The acceptance test and period conducted by the Commissioning Manager and the Design Consultant has been 100% completed successfully.
 - .3 Training has been completed.
 - .2 Equipment Operating and Maintenance Manuals have been accepted:
 - .1 Shop drawings have been updated.
 - .2 Record drawings have been 100% completed.
 - .3 The Commissioning process has been 100% completed successfully and the system operation accepted by the Commissioning Manager.
 - .4 The Deficiency Punch Lists have been completed in their entirety.
 - .3 The systems demonstration shall be conducted by the Mechanical Contractor and manufacturers. The demonstration shall cover all sequences of operation, maintenance requirements and a physical demonstration of equipment installation and operation.
 - .6 Test Forms:
 - .1 The Mechanical Contractor and manufacturers shall fill out the forms and check lists prepared by the Commissioning Manager during PI, installation, start-up and performance verification (PV) testing.
 - .2 The Commissioning Index of Forms shall be maintained by the Commissioning Manager in order to track the progress of the Commissioning process.
 - .7 Warranties:
 - .1 Equipment and system warranties shall not begin until the system demonstration and turnover has been conducted successfully and accepted by the PWGSC Project Manager. The Mechanical Contractor shall fill out the Warranty Form(s) listing the equipment and systems and the start and finishing dates for the Warranty period.
 - .2 Refer to the Specifications for the requirements during the Warranty period.
-

1.8 THE
COMMISSIONING
PROCESS
(Cont'd)

- .7 (Cont'd)
 - .3 The Design Consultant and the Commissioning Manager will review the performance of the systems in accordance with the BAS Sequences of Operation. If the performance is satisfactory, then no further action needs to be taken. If unsatisfactory, then the Mechanical Contractor will be instructed to correct all deficiencies, at his cost, to the satisfaction of the three parties.
- .8 Commissioning Phases (Phase 1 to 6):
 - .1 Commissioning process spans various phases:
 - .1 Commissioning Phase 1
 - .1 The planning phase, where the risks, uncertainties and vulnerabilities are assessed.
 - .2 Establishes the extent of commissioning, time and budget for commissioning.
 - .3 Occurs during project at start of Contract Documents.
 - .2 Commissioning Phase 2
 - .1 Establishes technical requirements such as test requirements and standards
 - .2 Finalization of mechanical equipment and systems.
 - .3 Occurs during latter stage of the Contract Documents.
 - .3 Commissioning Phase 3
 - .1 The implementation phase where documentation for commissioning is developed.
 - .2 Mechanical Contractor should have made available all finalized shop drawings.
 - .3 The quality and extent of commissioning is determined and finalized in agreement with the client.
 - .4 A master index is developed with all elements of the mechanical systems.
 - .5 Commissioning forms / check lists such as PI, installation, start-up and performance verification (PV) test forms are developed in this phase.
 - .6 Occurs early in the Contract Administration Stage.
 - .4 Commissioning Phase 4

1.8 THE
COMMISSIONING
PROCESS
(Cont'd)

.8 (Cont'd)

- .1 The verification and commissioning before the equipment is turned over to Owner.
- .2 All equipment received is checked against approved PI, installation, start-up and functional performance (PV) test forms.
- .3 It is important to check in this phase that the equipment received has gone through the necessary factory tests.
- .4 A Design Consultant would have witnessed some of the factory tests carried out to ensure that the tests are conducted in accordance with the required standards.
- .5 Start-up and operation instructions received from the equipment manufacturers are reviewed in this phase.
- .6 All deficiencies are reported to the Mechanical Contractor and rectified before equipment is turned over to Owner for beneficial use.
- .7 Occurs later on in the Contract Administration phase.

.5 Commissioning Phase 5

- .1 The performance verification of the complete mechanical system functionally integrated with all the other systems in operation within the facility.
- .2 Optimization, fine-tuning and post-occupancy commissioning is done in this phase.
- .3 Occurs later on in the Contract Administration phase.

.6 Commissioning Phase 6

- .1 Final Commissioning Report is submitted for review by the Commissioning Manager.
-

1.8 THE
COMMISSIONING
PROCESS
(Cont'd)

.8 (Cont'd)

Project Design & Construction Phases	Commissioning Phases	Activities	Remarks
Design Development		No Commissioning Activities	
Start of Contract Documents	Phase 1	Define commissioning scope and complete the detailed commissioning plan.	
Latter Stage of Contract Documents	Phase 2	Development of Commissioning Forms and Test Procedures	This information will be integrated into Contract documents. Also at this stage, the system performance requirements are identified, which will be verified during Phase 5 of the Commissioning Process.
		completed for all Contractors prior to Bid/Tender Closing.	briefing will detail commissioning scope and task requirements

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1.8 THE
COMMISSIONING
PROCESS
(Cont'd)

.8 (Cont'd)

tests, Equipment completed as
start-up and turn over part of
to Owner. Phase 4
Commissioning
procedure.

Phase 5 Mechanical
Systems Performance
Verification This confirms
that the
systems are
operating as
per the
specified
requirements.

evaluation report is compiled
for submission to into the
the Design Consultant Final
for review and Commissioning
acceptance by evaluation
the PWGSC. report.

.1 All equipment in the mechanical system
is grouped into systems and subsystems for
commissioning purposes. Documentation for
PI, installation, start-up and performance
(PV) will encompass all equipment in a
given system.

.10 Documentation Guidelines:

.1 The Mechanical Contractor completing
the PI, installation, startup and
performance (PV) test forms shall follow a
consistent approach. Good documentation
practice is essential in realizing the
objectives of commissioning and to keep
track of all commissioning related
activities.

.11 Documentation shall be:

- .1 Completed in permanent black ink only.
 - .2 Legible - can be easily read.
 - .3 Accurate - all information is correct.
 - .4 Timely - done at the appropriate time.
 - .5 Clear - can be understood by anyone
who reads it.
 - .6 Consistent - done the same way each
time.
 - .7 Complete - all required entries are
made.
 - .8 Factual - what is written shall be
what actually occurred.
-

1.8 THE
COMMISSIONING
PROCESS
(Cont'd)

.12 Correcting Mistakes: When mistakes are made accidentally while documenting, there shall be a standard way to correct the mistakes. Correct notation for documenting an entry error is to note Entry Error. Steps to follow:

.1 Cross out the error with a single line.

.2 Write the correct entry above the incorrect entry.

.3 Initial the correction.

.13 Before passing on the documentation, it shall be checked to make sure that it is timely, accurate, permanent, legible, complete, clear, consistent and factual.

.14 Submitted documentation which has not been reviewed will be rejected in its entirety by the Design Consultant.

.15 Roles and Responsibilities:

.16 Activities, roles and responsibilities are clearly defined in commissioning plans.

Commissioning activities, coordinated with all other activities in the project, will optimize the benefits of commissioning. The participants in commissioning activities have the roles and responsibilities, as given in the following Table.

SUMMARY OF ROLES AND RESPONSIBILITIES

Commissioning Activities	Manufacturer	Mechanical Contractor	Design Consultant
Developing Commissioning Plan			Reviews
Developing Commissioning Test Forms			Reviews
Formulating Test Procedures			Reviews
Briefing Contractors on the Commissioning Plan	Participates	Participates	Participates
Finalizing Equipment		Selects as per	Accepts

1.8 THE
COMMISSIONING
PROCESS

(Cont'd)

(Bid/Tender)

specifications

Factory Tests

Executes
Tests

Coordinate
Testing

Witnesses and
Approves

Verifying
Equipment
Received

Executes PI
Forms

Verifies

Installation
Checks on
Equipment

Participates

Executes
Installation
Test Forms

Verifies

Equipment
Start-up

Participates

Completes
Start-up
check forms
and rectifies
deficiencies

Witness and
Sign-off/
Accepts

Performance
Verification

Participates

Executes
Performance
check forms
and rectifies
deficiencies

Witness and
Sign-off/
Accepts

Preparation of
Operation and
Maintenance
Manuals

Supplies
Information

Obtains
information
and prepares
manuals

Reviews
Manuals

Owners
Training

Provides

Participates/
Provides

Reviews
Training
Program

Integrated
Performance
Tests

Participates

Executes
performance
forms and
rectifies
deficiencies

Witness and
Sign-off/
Accepts

Post
Occupancy
Evaluation

Participates

Participates

Reviews

1.8 THE
COMMISSIONING
PROCESS
(Cont'd)

SUMMARY OF ROLES AND RESPONSIBILITIES (Cont'd)

	PWGSC Design and Quality Assurance Authority	Commissioning Manager
Developing Commissioning Plan	Reviews and Accepts	Develops
Developing Commissioning Test Forms	Reviews and Accepts	Develops
Formulating Test Procedures and	Reviews and Accepts	Develops
Briefing Contractors on the Commissioning Plan	Reviews and Accepts	Presents and Briefs
Finalizing Equipment (Bid/Tender)	Reviews and Approves	Reviews
Factory Tests	Requests	Witnesses and Approves
Verifying Equipment Received	Accepts	Reviews

1.8 THE
COMMISSIONING
PROCESS
(Cont'd)

Installation Checks on Equipment	Accepts	Reviews
Equipment Start-up	Accepts	Witness and Sign-off
Performance Verification	Accepts	Witness and Sign-off
Preparation of Operation and Maintenance Manuals	Reviews Manuals	Reviews Manuals
Owners Training	Receives Training	Reviews Training Program
Integrated Performance Tests	Accepts	Witness and sign-off
Post Occupancy Evaluation	Reviews	Leads

PART 1 - GENERAL

- | | | |
|--|----|---|
| <u>1.1 REFERENCES</u> | .1 | Canadian General Standards Board (CGSB)
.1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating. |
| <u>1.2 ACTION AND INFORMATIONAL SUBMITTALS</u> | .1 | Provide submittals in accordance with Section 01 33 00. |
| <u>1.3 DELIVERY, STORAGE AND HANDLING</u> | .1 | Deliver, store and handle in accordance with Section 01 61 00. |
| | .2 | Deliver materials to site in original factory packaging, labelled with manufacturer's name, address. |

PART 2 - PRODUCTS

- | | | |
|---------------------|----|-----------|
| <u>2.1 NOT USED</u> | .1 | Not Used. |
|---------------------|----|-----------|

PART 3 - EXECUTION

- | | | |
|-------------------------------------|----|--|
| <u>3.1 APPLICATION</u> | .1 | Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets. |
| <u>3.2 CONNECTIONS TO EQUIPMENT</u> | .1 | In accordance with manufacturer's instructions unless otherwise indicated. |
| | .2 | Use valves and either unions or flanges for isolation and ease of maintenance and assembly. |
| | .3 | Use double swing joints when equipment mounted on vibration isolation and when piping subject to movement. |
-

3.3 CLEARANCES

- .1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer.
- .2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer or as indicated (whichever is greater) without interrupting operation of other system, equipment, components.

3.4 DRAINS

- .1 Install piping with grade in direction of flow except as indicated.
- .2 Install drain valve at low points in piping systems, at equipment and at section isolating valves.
- .3 Pipe each drain valve discharge separately to above floor drain. Discharge to be visible.
- .4 Drain valves: NPS 3/4 ball valves unless indicated otherwise, with hose end male thread, cap and chain.

3.5 AIR VENTS

- .1 Install manual air vents at high points in piping systems.
- .2 Install isolating valve at each automatic air valve.
- .3 Install drain piping to approved location and terminate where discharge is visible.

3.6 DIELECTRIC COUPLINGS

- .1 General: compatible with system, to suit pressure rating of system.
 - .2 Locations: where dissimilar metals are joined.
 - .3 NPS 2 and under: isolating unions or bronze valves.
 - .4 Over NPS 2: isolating flanges.
-

3.7 PIPEWORK
INSTALLATION

- .1 Screwed fittings jointed with Teflon tape.
- .2 Protect openings against entry of foreign material.
- .3 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.
- .4 Assemble piping using fittings manufactured to ANSI standards.
- .5 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
- .6 Install concealed pipework to minimize furring space, maximize headroom, conserve space.
- .7 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
- .8 Install, except where indicated, to permit separate thermal insulation of each pipe.
- .9 Group piping wherever possible and as indicated.
- .10 Ream pipes, remove scale and other foreign material before assembly.
- .11 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
- .12 Provide for thermal expansion as indicated.
- .13 Valves:
 - .1 Install in accessible locations.
 - .2 Remove interior parts before soldering.
 - .3 Install with stems above horizontal position unless otherwise indicated.
 - .4 Valves accessible for maintenance without removing adjacent piping.
 - .5 Install globe valves in bypass around air handling unit control valves.
 - .6 Use ball or butterfly valves at branch take-offs for isolating purposes except where otherwise specified.
 - .7 Install butterfly valves on chilled water only.
 - .8 Install butterfly valves between weld neck flanges to ensure full compression of liner.

3.7 PIPEWORK
INSTALLATION
(Cont'd)

- .13 (Cont'd)
 - .9 Install plug cocks or ball valves for glycol service.
 - .10 Use chain operators on valves NPS 2 1/2 and larger where installed more than 2400 mm above floor in Mechanical Rooms.
- .14 Check Valves:
 - .1 Install silent check valves on discharge of pumps and in vertical pipes with downward flow and elsewhere as indicated.
 - .2 Install swing check valves in horizontal lines on discharge of pumps and elsewhere as indicated.

3.8 SLEEVES

- .1 General: install where pipes pass through masonry, concrete structures, fire rated assemblies, and elsewhere as indicated.
- .2 Material: schedule 40 black steel pipe.
- .3 Construction: foundation walls and where sleeves extend above finished floors to have annular fins continuously welded on at mid-point.
- .4 Sizes: 6 mm minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation.
- .5 Installation:
 - .1 Concrete, masonry walls, concrete floors on grade: terminate flush with finished surface.
 - .2 Other floors: terminate 25 mm above finished floor.
 - .3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.
- .6 Sealing:
 - .1 Foundation walls and below grade floors:
 - .1 fire retardant, waterproof non-hardening mastic.
 - .2 Elsewhere: Provide space for firestopping. Maintain fire rating integrity.
 - .3 Ensure no contact between copper pipe or tube and sleeve.

- 3.9 ESCUTCHEONS
- .1 Install on pipes passing through walls, partitions, floors, and ceilings in finished areas.
 - .2 Construction: one piece type with set screws. Chrome or nickel plated brass or type 302 stainless steel.
 - .3 Sizes: outside diameter to cover opening or sleeve. Inside diameter to fit around pipe or outside of insulation if so provided.
- 3.10 PREPARATION FOR FIRE STOPPING
- .1 Material and installation within annular space between pipes, ducts, insulation and adjacent fire separation.
 - .2 Uninsulated unheated pipes not subject to movement: No special preparation.
 - .3 Uninsulated heated pipes subject to movement: wrap with non-combustible smooth material to permit pipe movement without damaging fires topping material or installation.
 - .4 Insulated pipes and ducts: ensure integrity of insulation and vapour barriers.
- 3.11 FLUSHING OUT OF PIPING SYSTEMS
- .1 Flush system in accordance with Section 23 08 02.
 - .2 Before start-up, clean interior of piping systems in accordance with requirements of Section 01 74 11 supplemented as specified in relevant mechanical sections.
 - .3 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.
- 3.12 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK
- .1 Advise Departmental Representative 48 hours minimum prior to performance of pressure tests.
 - .2 Pipework: test as specified in relevant sections of heating, ventilating and air conditioning work.
-

3.12 PRESSURE
TESTING OF
EQUIPMENT AND
PIPEWORK

(Cont'd)

- .3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant mechanical sections.
- .4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.
- .5 Conduct tests in presence of Departmental Representative.
- .6 Pay costs for repairs or replacement, retesting, and making good. Departmental Representative to determine whether repair or replacement is appropriate.
- .7 Insulate or conceal work only after approval and certification of tests by Departmental Representative.

3.13 EXISTING
SYSTEMS

- .1 Connect into existing piping systems at times approved by Departmental Representative.
- .2 Request written approval 10 days minimum, prior to commencement of work.
- .3 Be responsible for damage to existing plant by this work.
- .4 Ensure daily clean-up of existing areas.

3.14 CLEANING

- .1 Clean in accordance with Section 01 74 11.
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.

PART 1 - GENERAL

1.1 REFERENCES

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ANSI/ASHRAE 90.1-2010, SI; Energy Standard for Buildings Except Low-Rise Residential Buildings (ANSI/ASHRAE/IES).
- .2 Electrical Equipment Manufacturers' Advisory Council (EEMAC)

1.2 SECTIONS
INCLUDES

- .1 Electrical work to conform to Electrical Divisions including the following:
 - .1 Supplier and installer responsibility is indicated in Motor, Control and Equipment Schedule on electrical drawings and related mechanical responsibility is indicated on Mechanical Equipment Schedule on mechanical drawings.
 - .2 Control wiring and conduit is specified in Division 26 except for conduit, wiring and connections below 50 V which are related to control systems specified in Division 23. Refer to Division 26 for quality of materials and workmanship.

1.3 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00.

1.4 CLOSEOUT
SUBMITTALS

- .1 Provide maintenance data for motors, drives and guards for incorporation into manual specified in Section 01 33 00.

1.5 WASTE
MANAGEMENT AND
DISPOSAL

- .1 Refer to Section 01 74 20.
-

PART 2 - PRODUCTS

2.1 GENERAL

- .1 Motors to be high efficiency, in accordance with local Hydro company standards and the requirements of ASHRAE 90.1.

2.2 MOTORS

- .1 Provide motors for mechanical equipment as specified.
- .2 Replace motor for existing return fan, as indicated on the drawings.
- .3 If delivery of specified motor will delay delivery or installation of equipment, install motor approved by Departmental Representative for temporary use. Final acceptance of equipment will not occur until specified motor is installed.
- .4 Motors under 373 W (1/2 HP): speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120 V, unless otherwise specified or indicated.
- .5 Motors 373 W (1/2 HP) and larger: EEMAC Class B, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 40 ° C, 3 phase, 600 V, unless otherwise specified or indicated.
- .6 All motors shall be 1750 rpm unless otherwise noted.
- .7 All motors shall be high efficiency, suitable for full voltage starting, rated for the voltage indicated in the schedule and shall have a service factor of 1.15. For the VFD applications motors shall be inverter duty, rated for service factor of 1.25.
- .8 All motors shall have minimum NEMA Class F insulation systems or be rated for VFD application (when applicable). All motors shall be capable of supplying nameplate and service factor horsepower ratings on a continuous basis without exceeding the 105°C temperature rise in a 40°C ambient temperature.

2.2 MOTORS
(Cont'd)

- .9 The temperature rises described above are based upon measurements by the resistance method. These limits shall not be exceeded when the voltage and frequency applied to motors are within the limitations of NEMA MG1.
- .10 All motors shall have copper stator windings and motor leads.
- .11 Aluminum die-cast rotor assemblies shall be provided, if available.
- .12 Where aluminum die-cast rotor assemblies are not provided, rotor bars and conducting end rings shall be made of copper or copper alloys, with the bars welded or brazed to the rings. No phosphorous brazing materials may be used.
- .13 Motors 3 HP and above shall be constructed to IEEE 841 standards and shall carry IEEE 841 certifications. Motors without IEEE 841 certifications and labeling shall be replaced by the contractor at their costs.

2.3 TEMPORARY
MOTORS

- .1 If delivery of specified motor will delay completion or commissioning work, install motor approved by Departmental Representative for temporary use. Work will only be accepted when specified motor is installed.

2.4 BELT DRIVES

- .1 Fit reinforced belts in sheave matched to drive. Multiple belts to be matched sets.
- .2 Use cast iron or steel sheaves secured to shafts with removable keys unless otherwise specified.
- .3 For motors under 7.5 kW (10 HP): standard adjustable pitch drive sheaves, having plus or minus 10% range. Use mid-position of range for specified r/min.
- .4 For motors 7.5 kW (10) HP and over: sheave with split tapered bushing and keyway having fixed pitch unless specifically required for item concerned. Provide sheave of correct size to suit balancing.

2.4 BELT DRIVES
(Cont'd)

- .5 Correct size of sheave to be determined during commissioning.
- .6 Minimum drive rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.
- .7 Motor slide rail adjustment plates to allow for centre line adjustment.
- .8 Supply one set of spare belts for each set.

2.5 DRIVE GUARDS

- .1 Provide guards for unprotected drives.
- .2 Guards for belt drives;
 - .1 Expanded metal screen welded to steel frame.
 - .2 Minimum 1.2 mm thick sheet metal tops and bottoms.
 - .3 38 mm dia holes on both shaft centres for insertion of tachometer.
 - .4 Removable for servicing.
- .3 Provide means to permit lubrication and use of test instruments with guards in place.
- .4 Install belt guards to allow movement of motors for adjusting belt tension.
- .5 Guard for flexible coupling:
 - .1 "U" shaped, minimum 1.6 mm thick galvanized mild steel.
 - .2 Securely fasten in place.
 - .3 Removable for servicing.
- .6 Unprotected fan inlets or outlets:
 - .1 Wire or expanded metal screen, galvanized, 19 mm mesh.
 - .2 Net free area of guard: not less than 80% of fan openings.
 - .3 Securely fasten in place.
 - .4 Removable for servicing.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Fasten securely in place.

3.1 INSTALLATION (Cont'd)	.2 Make removable for servicing, easily returned into, and positively in position.
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PART 1 - GENERAL

1.1 REFERENCES

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ASHRAE 90.1-2013, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA cosponsored; ANSI approved; Continuous Maintenance Standard).
- .2 Electrical Equipment Manufacturers' Association Council (EEMAC)
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
- .4 Material Safety Data Sheets (MSDS).
- .5 All drives shall be certified by cUL or CSA/UL approved.

1.2 DEFINITIONS

- .1 Supplier and installer responsibility indicated in Motor, Control and Equipment Schedule on electrical drawings and related mechanical responsibility is indicated on Mechanical Equipment Schedule on mechanical drawings.
- .2 Control wiring and conduit is specified in Division 26 except for conduit, wiring and connections below 120 V which are related to control systems specified in Division 22 and 23. Refer to Division 26 for quality of materials and workmanship

1.3 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.

- | | | |
|---|----|---|
| 1.3 SUBMITTALS
(Cont'd) | .2 | (Cont'd) |
| | .2 | Submittals to include following: |
| | .1 | Control schematics and external connection diagram showing function and identification of all terminals requiring field connections |
| | .2 | Technical description including list of options being provided. |
| | .3 | Quality Control: in accordance with Section 01 45 00 - Quality Control. |
| | .1 | Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties. |
| | .2 | Instructions: submit manufacturer's installation instructions. |
| | .1 | Departmental Representative will make available 1 copy of systems supplier's installation instructions. |
| | .4 | Closeout Submittals |
| | .1 | Provide maintenance data for motors, drives and guards for incorporation into manual specified in Section 01 78 00 - Closeout Submittals. |
| 1.4 QUALITY
ASSURANCE | .1 | Regulatory Requirements: work to be performed in compliance with CEPA, CEAA, TDGA, and applicable Provincial regulations. |
| | .2 | Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements. |
| 1.5 DELIVERY,
STORAGE, AND
HANDLING | .1 | Packing, shipping, handling and unloading: |
| | .1 | Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements. |
| | .2 | Deliver, store and handle materials in accordance with manufacturer's written instructions. |
| | .2 | Waste Management and Disposal: |

1.5 DELIVERY,
STORAGE, AND
HANDLING
(Cont'd)

- .2 (Cont'd)
.1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse, recycling and/or disposal in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

PART 2 - PRODUCTS

2.1 VARIABLE
FREQUENCY DRIVES
GENERAL

- .1 Furnish complete variable frequency drives (VFD) for the following: All standard and optional features shall be included within the VFD enclosure. VFD enclosure shall be in heavy gauge metal NEMA 1. The entire package shall be UL and CSA approved.
.1 hot water heating.
.2 pumps P-1 and P-2.
.3 AHU SF-1 and RF-1.
- .2 The VFD shall convert three-phase, 60 HZ utility power to adjustable voltage and frequency, three phase power for stepless motor speed control. The input voltage shall be as specified on the drawing schedules.
- .3 The VFD shall include a converter and an inverter section. The converter section shall convert fixed frequency and voltage AC utility power to DC voltage. All VFD's shall include input line reactors.
- .4 The inverter section of the VFD shall invert the DC voltage into a quality output waveform with adjustable voltage and frequency for stepless motor speed control. The VFD shall maintain a constant V/HZ. ratio.
- .5 Power line noise shall be limited to a voltage distortion factor and line notch depth as defined in IEEE Standard 519-19851, Guide for Harmonic Control. The total voltage distortion shall not exceed 5%. The total current harmonic distortion shall be less than 10 percent.

2.1 VARIABLE
FREQUENCY DRIVES
GENERAL
(Cont'd)

- .6 VFD's shall include filtration to limit Electromagnetic Interference and eliminate compatibility issues with sensitive computer equipment. All VFD's shall be provided in all metal enclosures to limit Radio Frequency Interference. The VFD shall not emit radiated RFI in excess of the limitations set forth in the FCC Rules, Part 15 for Class A computing devices. PWM drives shall include RFI filters.
- .7 The VFD drive shall have the ability of trending the faults (Data log) for troubleshooting and the trouble history. These information shall be stored with sufficient information to draw conclusions on the cause of diverse faults.
- .8 Supplied VFD's shall be match existing drives on site. Existing drives are all Alan Bradley Power Flex 70.
- .9 Standard of Acceptance: Dafoss Graham, ABB.

2.2 PROTECTIVE
FEATURES

- .1 Motor overload protection for each motor controlled.
- .2 Protection against:
 - .1 Input power under and over voltage, phase loss.
 - .2 Output current overload and instantaneous over current.
 - .3 Over temperature within VFD enclosure.
 - .4 Over voltage on the DC bus.
 - .5 Sustained power or phase loss.
 - .6 Line side voltage distortion not to exceed 3 percent.
 - .7 Line side current distortion not to exceed 8%.
- .3 Automatically reset faults due to under voltage, phase loss, over voltage and Over temperature.
- .4 Protection against output short circuit and motor winding shorting to cause faults, as defined by UL508.
- .5 Status lights or digital display (English & French language to be selected on the control panel) of individual faults.
- .6 Controller capable of operating without a motor to facilitate start-up and troubleshooting.

2.2 PROTECTIVE
FEATURES
(Cont'd)

- .7 Input and output line reactors shall be provided to minimize harmonics reduced to the AC line and to provide protection to AC line transients.
- .8 Motors
 - .1 All motors operated by VFD drives shall meet the NEMA MG1, Part 31 standards for operation without filtration. If VFD output exceeds MG1, Part 31 standards additional LC filter Networks shall be included with each VFD.
- .9 Fire Alarm Connection
 - .1 Provide contact for fire alarm shut down and fire alarm start up in case of fire alarm, for connection from the fire alarm panel.
- .10 Interface Features:
 - .1 Door mounted Hand/Off/Auto selector switch.
 - .2 Door mounted, interlocked, padlockable disconnect switch. This disconnect switch shall disconnect the drive from the input power line.
 - .3 Local/Remote selector switch. In the remote position motor speed is determined by the follower signal. In the local position motor speed is determined by a manual switch mounted on the panel faceplate.
 - .4 Power "ON" light.
 - .5 Fault lights to indicate that the VFD has tripped on a fault condition.
 - .6 Digital meter to indicate percent speed and percent load.
 - .7 Form C dry contacts to indicate when the VFD is in the run mode and to indicate when the VFD is in the fault mode.
 - .8 A 0-10 Vdc signal proportional to the speed.
 - .9 Safety shutdown from safety contacts (smoke, freeze) in drive or bypass mode.
 - .10 VFD shall accept 4 - 20ma, 0-10 Vdc control signal.
 - .11 All alarms shall read out in full English & French language to be selected on the control panel coded messages are not acceptable.
- .11 Adjustments
 - .1 Maximum speed (50-100% base), minimum (0-50% base).
 - .2 Acceleration time, adjustable 3 to 300 sec.
 - .3 Deceleration time, adjustable 3 to 300 sec.
 - .4 Current limit, adjustable 0 to 105%.
 - .5 Overload trip setpoint.
 - .6 Offset and gain to condition the input speed signal.

2.2 PROTECTIVE
FEATURES
(Cont'd)

- .12 Service Conditions
 - .1 Ambient temperature -10 to 40 deg. C. Units located in non-heated areas shall be provided with thermostically controlled heater weather enclosure.
 - .2 0 to 95% RH non condensing.
 - .3 Elevation to 1000 meters without derating.
 - .4 AC line voltage variation, -10 to +10% nominal.
 - .13 Quality Assurance
 - .1 To ensure quality the complete VFD shall be tested at the manufacturer's factory. The VFD shall operate a dynamometer at full load and the speed shall be cycled during the test.
 - .2 All optional features shall be functionally tested at the factory for proper operation.
 - .14 Automatic Bypass
 - .1 Provide by-pass for systems supply and return.
 - .2 Provide bypass consisting of a door interlocked main fused disconnect padlockable in the off position, a built in motor starter and a four position DRIVE/OFF/LINE/TEST switch controlling three contactors. In the DRIVE position the motor the motor shall be operated at an adjustable speed from the drive. In the OFF position the motor and drive are disconnected. In the LINE position, the motor is operated at full speed from the AC power line and power is disconnected from the drive. In the TEST position, the motor is operated at full speed from the AC line power. This allows the drive to be given an operating test while continuing to run the motor at full speed in bypass. Provide required fuses for bypass.
 - .3 Remote safety contacts shall be interlocked with the VFD's safety trip circuitry to stop the motor whether in the DRIVE OR BYPASS mode in case of an external safety fault.
 - .4 For all Variable Frequency Drives over 50 HP provide a soft start in the bypass starter.
 - .5 When the disconnect switch for the variable speed drive is shut off it shall not disconnect the power from the bypass.
 - .15 Communication With The BAS
 - .1 The variable frequency drives shall communicate with the Building Automation System (BAS) utilizing BACNET and/or Modbus RTU. Decision to be finalized at shop drawing stage.
-

2.2 PROTECTIVE
FEATURES
(Cont'd)

- .15 (Cont'd)
- .2 All items other than the signal to speed up / slow down the variable frequency drive shall be provided either through the BACNET connection or Modbus RTU. The signal to speed up / slow down the drive shall be controlled by a hard wired connection from the BAS.
- .3 The following points for the drive shall be provided at the EMCAS.
- .1 Binary Inputs to Drive
 - .1 Remote Start/Stop command
 - .2 Analog Outputs from Drive
 - .1 Reference (% speed)
 - .2 Frequency (Hz)
 - .3 Motor Current (Amps)
 - .4 Power (KW)
 - .5 Hours Run
 - .3 Binary Outputs from Drive
 - .1 KWH Counter (KW consumption)
 - .2 Motor Run Status
 - .3 Tripped Status
 - .4 External Fault (Safety Interlock)
 - .4 Minimum Speed Settings
 - .1 The minimum speed setpoints for the variable speed drives shall be as follows:
 - .2 Motor in the Airstream - 30%
 - .3 Motor out of the Airstream - 40%

PART 3 - EXECUTION

3.1 MANUFACTURER'S
INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install in accordance with manufacturers recommendations.
- .2 Properly ground the electrical system as per manufacturer's instructions.
- .3 Provide a separate steel conduit/shielded wiring for all supply, line load and control wiring.
- .4 For wiring and scope of work refer to Section 26 05 01 and Section 21 05 01.

<u>3.2 INSTALLATION (Cont'd)</u>	.5	Install the drive not more than 10 metres from the motor. The length of wiring connection shall not exceed 10 metres. Provide support for the variable frequency drive in the vicinity of the motor as required.
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<u>3.3 START-UP SERVICE</u>	.1	The manufacturer shall provide start-up commissioning of the variable frequency drive and its optional circuits by a factory trained certified technician. The commissioning personnel shall be the same personnel that will provide service and warranty repairs at the customer's site.
	.2	The manufacturer shall provide minimum of four session each four hours of customer operator training on operation and service diagnostics at the time of equipment commissioning.
	.3	Drive manufacturer shall provide as much assistance is required to the air and hydronic balance contractor to set the drives to provide the specified air flow.

<u>3.4 DISCONNECT SWITCHES</u>	.1	Disconnect switches wired between the VFD and the motor shall be provided with auxiliary contacts which shall be wired into the VFD's safety trip circuitry such that the VFD shall de-energize when the switch is opened. When the switch is closed the VFD shall energize and go through normal start up routines.
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<u>3.5 FIELD QUALITY CONTROL</u>	.1	Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report as described in Section 01 78 00 - Closeout Submittals.
	.2	Manufacturer's Field Services: .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.

3.5 FIELD QUALITY CONTROL (Cont'd)	.2	(Cont'd) .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions. .3 Schedule site visits, to review Work, as directed in Section 01 78 00 - Closeout Submittals.
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3.6 CLEANING	.1	Proceed in accordance with Section 01 74 11 - Cleaning.
	.2	Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

PART 1 - GENERAL

- | | | |
|--|----|---|
| <u>1.1 REFERENCES</u> | .1 | American Society of Mechanical Engineers (ASME) |
| | .1 | ASME B40.100-2005, Pressure Gauges and Gauge Attachments. |
| | .2 | ASME B40.200-2008, Thermometers, Direct Reading and Remote Reading. |
| | .2 | Canadian General Standards Board (CGSB) |
| | .1 | CAN/CGSB-14.4-M88, Thermometers, Liquid-in-Glass, Self Indicating, Commercial/Industrial Type. |
| | .2 | CAN/CGSB-14.5-M88, Thermometers, Bimetallic, Self-Indicating, Commercial/Industrial Type. |
| | .3 | Efficiency Valuation Organization (EVO) |
| | .1 | International Performance Measurement and Verification Protocol (IPMVP) |
| | .1 | IPMVP 2007 Version. |
| <u>1.2 ACTION AND INFORMATIONAL SUBMITTALS</u> | .1 | Submit in accordance with Section 01 33 00. |
| | .2 | Product Data: |
| | .1 | Submit manufacturer's instructions, printed product literature and data sheets for thermometers and pressure gauges and include product characteristics, performance criteria, physical size, finish and limitations. |
| <u>1.3 DELIVERY, STORAGE AND HANDLING</u> | .1 | Deliver, store and handle materials in accordance with Section 01 61 00 and with manufacturer's written instructions. |
| | .2 | Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address. |

PART 2 - PRODUCTS

- | | | |
|--------------------|----|--|
| <u>2.1 GENERAL</u> | .1 | Design point to be at mid-point of scale or range. |
| | .2 | Ranges: as indicated. |
-

- | | | |
|--|----|---|
| <u>2.2 DIRECT READING THERMOMETERS</u> | .1 | Industrial, variable angle type, mercury-free, liquid filled, 125 mm scale length: to CAN/CGSB-14.4.
.1 Resistance to shock and vibration. |
| <u>2.3 REMOTE READING THERMOMETERS</u> | .1 | 100 mm diameter mercury-free liquid filled vapour activated dial type: to CAN/CGSB-14.5, accuracy within one scale division, brass movement, stainless steel capillary, stainless steel spiral armour, stainless steel bulb and polished brass or stainless steel case for wall mounting. |
| <u>2.4 THERMOMETER WELLS</u> | .1 | Copper pipe: copper or bronze. |
| | .2 | Steel pipe: brass or stainless steel. |
| <u>2.5 PRESSURE GAUGES</u> | .1 | 112 mm, dial type: to ASME B40.100, Grade 2A, stainless steel phosphor bronze bourdon tube having 0.5% accuracy full scale unless otherwise specified. |
| | .2 | Provide:
.1 Snubber for pulsating operation.
.2 Gasketed pressure relief back with solid front.
.3 Bronze stop cock.
.4 Oil filled for high vibration applications. |

PART 3 - EXECUTION

- | | | |
|------------------------|----|---|
| <u>3.1 EXAMINATION</u> | .1 | Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for installation in accordance with manufacturer's written instructions.
.1 Visually inspect substrate in presence of Departmental Representative.
.2 Inform Departmental Representative of unacceptable conditions immediately upon discovery. |
|------------------------|----|---|
-

- | | |
|------------------------------------|---|
| <u>3.1 EXAMINATION</u>
(Cont'd) | .1 (Cont'd)
.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative. |
| <u>3.2 GENERAL</u> | .1 Install thermometers and gauges so they can be easily read from floor or platform.
.1 If this cannot be accomplished, install remote reading units.

.2 Install between equipment and first fitting or valve. |
| <u>3.3 THERMOMETERS</u> | .1 Install in wells on piping. Include heat conductive material inside well.

.2 Install in locations as indicated and on inlet and outlet of:
.1 Heat exchangers.
.2 Water heating and cooling air handling coils.
.3 Where indicated on schematics.

.3 Install wells as indicated only for balancing purposes.

.4 Use extensions where thermometers are installed through insulation. |
| <u>3.4 PRESSURE GAUGES</u> | .1 Install in locations as follows:
.1 Suction and discharge of pumps.
.2 Upstream and downstream of PRV's.
.3 Upstream and downstream of air handling unit control valves.
.4 Inlet and outlet of air handling unit coils.
.5 In other locations as indicated on schematics.

.2 Install gauge cocks for balancing purposes, elsewhere as indicated.

.3 Use extensions where pressure gauges are installed through insulation. |

<u>3.5 NAMEPLATES</u>	.1	Install engraved lamicaid nameplates in accordance with Section 23 05 53.01, identifying medium.
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<u>3.6 CLEANING</u>	.1	Progress Cleaning: clean in accordance with Section 01 74 11.
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<u>3.7 PROTECTION</u>	.1	Protect installed products and components from damage during construction.
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PART 1 - GENERAL

1.1 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B1.20.1-1983(R2006), Pipe Threads, General Purpose (Inch).
 - .2 ASME B16.18-2001, Cast Copper Alloy Solder Joint Pressure Fittings.
- .2 ASTM International
 - .1 ASTM A276-10, Standard Specification for Stainless Steel Bars and Shapes.
 - .2 ASTM B62-09, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .3 ASTM B283/B283M-11a, Standard Specification for Copper and Copper Alloy Die Forgings (Hot-Pressed).
 - .4 ASTM B505/B505M-11, Standard Specification for Copper-Base Alloy Continuous Castings.
- .3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)
 - .1 MSS SP-25-2008, Standard Marking System for Valves, Fittings, Flanges and Unions.
 - .2 MSS SP-80-2008, Bronze Gate Globe, Angle and Check Valves.
 - .3 MSS SP-110-2010, Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and data sheets for equipment and systems and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit WHMIS MSDS - Material Safety Data Sheets.

1.3 CLOSEOUT SUBMITTALS

- .1 Provide maintenance data for incorporation into manual specif Section 01 78 00.

1.4 DELIVERY,
STORAGE AND
HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements:
 - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Refer to Section 01 74 20.

PART 2 - PRODUCTS

2.1 MATERIALS

- .1 Valves:
 - .1 Except for specialty valves, to be single manufacturer.
 - .2 Products to have CRN registration numbers.
- .2 End Connections:
 - .1 Connection into adjacent piping/tubing:
 - .1 Steel pipe systems: screwed ends to ANSI/ASME B1.20.1.
 - .2 Copper tube systems: solder ends grooved ends to ASME B16.18.
- .3 Gate Valves:
 - .1 Requirements common to gate valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Bonnet: union with hexagonal shoulders.
 - .3 Connections: screwed with hexagonal shoulders.
 - .4 Inspection and pressure testing: to MSS SP-80. Tests to be hydrostatic.
 - .5 Packing: non-asbestos.
 - .6 Handwheel: non-ferrous.
 - .7 Handwheel Nut: bronze to ASTM B62.
 - .2 NPS 2 and under, non-rising stem, solid wedge disc, Class 12.5
 - .1 Body: with long disc guides, screwed bonnet with stem retaining nut.
 - .2 Operator: Handwheel.
 - .3 NPS 2 and under, non-rising stem, solid wedge disc, Class 150:
 - .1 Body: with long disc guides, screwed bonnet with stem retaining nut.
 - .2 Operator: handwheel.
 - .4 NPS 2 and under, rising stem, split wedge disc, Class 125:

2.1 MATERIALS

(Cont'd)

.3 (Cont'd)

.4 (Cont'd)

- .1 Body: with long disc guides, screwed bonnet.
- .2 Disc: split wedge, bronze to ASTM B283/B283M, loosely secured to stem.
- .3 Operator: handwheel lockshield.
- .5 NPS 2 and under, rising stem, solid wedge disc, Class 125:
 - .1 Body: with long disc guides, screwed bonnet.
 - .2 Operator: handwheel.
- .6 NPS 2 and under, rising stem, solid wedge disc, Class 150:
 - .1 Body: with long disc guides, screwed union bonnet.
 - .2 Operator: handwheel.

.4 Globe Valves:

- .1 Requirements common to globe valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Bonnet: union with hexagonal shoulders.
 - .3 Connections: screwed with hexagonal shoulders.
 - .4 Pressure testing: to MSS SP-80. Tests to be hydrostatic.
 - .5 Stuffing box: threaded to bonnet with gland follower, packing nut, high grade non-asbestos packing.
 - .6 Handwheel: non-ferrous.
 - .7 Handwheel Nut: bronze to ASTM B62.
- .2 NPS 2 and under, composition disc, Class 125:
 - .1 Body and bonnet: screwed bonnet.
 - .2 Disc and seat: renewable rotating PTFE disc composition to suit service conditions, regrindable bronze seat, loosely secured to bronze stem to ASTM B505/B505M.
 - .3 Operator: handwheel lockshield.
- .3 NPS 2 and under, composition disc, Class 150:
 - .1 Body and bonnet: union bonnet.
 - .2 Disc and seat: renewable rotating PTFE disc in easily removable disc holder, regrindable bronze seat, loosely secured to bronze stem to ASTM B505/B505M.
 - .3 Operator: handwheel lockshield.
- .4 NPS 2 and under, plug disc, Class 150, screwed ends:
 - .1 Body and bonnet: union bonnet.

2.1 MATERIALS

(Cont'd)

- .4 (Cont'd)
 - .4 (Cont'd)
 - .2 Disc and seat ring: tapered plug type with disc stem ring of AISI S420 stainless steel to ASTM A276, loosely secured to stem.
 - .3 Operator: handwheel.
 - .5 Angle valve, NPS 2 and under, composition disc, Class 150:
 - .1 Body and bonnet: union bonnet.
 - .2 Disc and seat: renewable rotating PTFE disc in slip-on easily removable disc holder having integral guides, regrindable bronze seat, loosely secured to stem.
 - .3 Operator: handwheel lockshield.
- .5 Check Valves:
 - .1 Requirements common to check valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Connections: screwed with hexagonal shoulders.
 - .2 NPS 2 and under, swing type, bronze disc, Class 125:
 - .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
 - .2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.
 - .3 NPS 2 and under, swing type, bronze disc:
 - .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
 - .2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.
 - .4 NPS 2 and under, swing type, composition disc, Class 200:
 - .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
 - .2 Disc: renewable rotating disc of number 6 composition to suit service conditions, bronze two-piece hinge disc construction.
 - .5 NPS 2 and under, horizontal lift type, composition disc, Class 150:
 - .1 Body: with integral seat, union bonnet ring with hex shoulders, cap.
 - .2 Disc: renewable PTFE no. 6 composition rotating disc in disc holder having guides top and bottom, of bronze to ASTM B62.
 - .6 NPS 2 and under, vertical lift type, bronze disc, Class 125:

2.1 MATERIALS

(Cont'd)

- .5 (Cont'd)
- .6 (Cont'd)
 - .1 Disc: rotating disc having guides top and bottom, disc guides, retaining rings.
- .6 Silent Check Valves:
 - .1 NPS 2 and under:
 - .1 Body: cast high tensile bronze to ASTM B62 with integral seat.
 - .2 Pressure rating: Class 125.
 - .3 Connections: screwed ends to ANSI/ASME B1.20.1 and with hex. shoulders.
 - .4 Disc and seat: renewable rotating disc.
 - .5 Stainless steel spring, heavy duty.
 - .6 Seat: regrindable.
- .7 Ball Valves:
 - .1 NPS 2 and under:
 - .1 Body and cap: cast high tensile bronze to ASTM B62.
 - .2 Pressure rating: Class 125 2760-kPa CWP 4140-kPa CWP, 860 kPa steam.
 - .3 Connections: screwed ends to ASME B1.20.1 and with hexagonal shoulders solder ends to ANSI.
 - .4 Stem: tamperproof ball drive.
 - .5 Stem packing nut: external to body.
 - .6 Ball and seat: replaceable stainless steel hard chrome solid ball and Teflon seats.
 - .7 Stem seal: TFE with external packing nut.
 - .8 Operator: removable lever handle.
- .8 Butterfly Valves:
 - .1 NPS 2 1/2 through NPS 6, 2068 kPa with grooved ends.
 - .1 Body: cast bronze, with copper-tube dimensioned grooved ends.
 - .2 Disc: elastomer coated ductile iron with integrally cast stem.
 - .3 Operator: lever or handwheel.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Install rising stem valves in upright position with stem above horizontal.
- .2 Remove internal parts before soldering.

- | | | |
|-------------------------------------|----|--|
| <u>3.1 INSTALLATION</u>
(Cont'd) | .3 | Install valves with unions at each piece of equipment arranged to allow servicing, maintenance, and equipment removal. |
| <u>3.2 CLEANING</u> | .1 | Clean in accordance with Section 01 74 11.
.1 Remove surplus materials, excess materials, rubbish, tools and equipment. |

PART 1 - GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Valves, gate, globe, and check.
- .2 Sustainable requirements for construction and verification.
- .3 Related Sections:
 - .1 Section 01 47 15 - Sustainable Requirements: Construction.
 - .2 Section 01 47 17 - Sustainable Requirements: Contractor's Verification.
 - .3 Section 01 35 29.06 - Health and Safety Requirements.
 - .4 Section 23 05 01 - Installation of Pipework.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME).
 - .1 ANSI/ASME B16.1-2005, Cast Iron Pipe Flanges and Flanged Fittings.
- .2 American Society for Testing and Materials International (ASTM).
 - .1 ASTM A49-01(2006) , Specification for Heat-Treated Carbon Steel Joint Bars.
 - .2 ASTM A126-04, Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - .3 ASTM B61-08, Specification for Steam or Valve Bronze Castings.
 - .4 ASTM B62-09, Specification for Composition Bronze or Ounce Metal Castings.
 - .5 ASTM B85/B85M-09, Specification for Aluminum-Alloy Die Castings.
 - .6 ASTM B209-10, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- .3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).
 - .1 MSS SP-70-2006, Gray Iron Gate Valves, Flanged and Threaded Ends.
 - .2 MSS SP-71-2005, Gray Iron Swing Check Valves, Flanged and Threaded Ends.
 - .3 MSS SP-82-1992, Valve Pressure Testing Methods.
 - .4 MSS SP-85-2002, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

<u>1.2 REFERENCES (Cont'd)</u>	.4	American Petroleum Institute (API).
	.1	API 598-2009, Valve Inspection and Testing.
<u>1.3 SUBMITTALS</u>	.1	Submittals in accordance with Section 01 33 00.
	.2	Product Data: submit WHMIS MSDS - Material Safety Data Sheets.
	.1	Submit shop drawings and product data in accordance with Section 01 33 00.
	.2	Submit data for valves specified in this section.
	.3	Closeout Submittals:
	.1	Submit maintenance data for incorporation into manual specified in Section 01 78 00.
<u>1.4 QUALITY ASSURANCE</u>	.1	Health and Safety:
	.1	Do construction occupational health and safety in accordance with Section 01 35 29.06.
<u>1.5 DELIVERY STORAGE AND DISPOSAL</u>	.1	Refer to Section 01 74 20.
<u>1.6 MAINTENANCE</u>	.1	Extra Materials:
<u>PART 2 - PRODUCTS</u>		
<u>2.1 MATERIAL</u>	.1	Valves:
	.1	Except for specialty valves, to be of single manufacturer.
	.2	Standard specifications:
	.1	Gate valves: MSS SP-70.
	.2	Globe valves: MSS SP-85.
	.3	Check valves: MSS SP-71.
	.3	Requirements common to valves, unless specified otherwise:
	.1	Body, bonnet: cast iron to ASTM B209 Class B.

2.1 MATERIAL
(Cont'd)

- .3 (Cont'd)
 - .2 Connections: flanged ends plain face with 2 mm raised face with serrated finish to ANSI B16.1.
 - .3 Inspection and pressure testing: to MSS SP-82.
 - .4 Bonnet gasket: non-asbestos.
 - .5 Stem: to have precision-machined Acme or 60 degrees V threads, top screwed for handwheel nut.
 - .6 Stuffing box: non-galling two-piece ball-jointed packing gland, gland bolts and nuts.
 - .7 Gland packing: non-asbestos.
 - .8 Handwheel: Die-cast aluminum alloy to ASTM B85 or malleable iron to ASTM A49. Nut of bronze to ASTM B62.
 - .9 Identification tag: with catalogue number, size, other pertinent data.
- .4 All products to have CRN registration numbers.

2.2 GATE VALVES

- .1 NPS 2 1/2 - 8, non rising stem, inside screw, bronze iron trim, solid wedge disc:
 - .1 Body and multiple-bolted bonnet: with bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly. Class 125.
 - .2 Disc: solid offset taper wedge, bronze to ASTM B62.
 - .3 Seat rings: renewable bronze to ASTM B62, screwed into body.
 - .4 Stem: bronze to ASTM B62.
 - .5 Disc: solid offset taper wedge, cast iron to ASTM A126 Class B, secured to wrought steel stem.
 - .6 Seat: Integral with body.
 - .7 Stem: wrought steel.
 - .8 Operator: Handwheel.
 - .9 Bypass: complete with union and NPS gate globe valve as Section 23 05 23.01.
- .2 NPS 2 1/2-8, outside screw and yoke (OS&Y), bronze iron trim, solid wedge disc:
 - .1 Body and multiple-bolted bonnet: with bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly, yoke, yoke hub, yoke sleeve and nut. Class 125.

2.2 GATE VALVES

(Cont'd)

.2

(Cont'd)

- .2 Disc: solid offset taper wedge, bronze to ASTM B62 up to NPS 3, cast iron with bronze disc rings on other sizes, secured to stem through integral forged T-head disc-stem connection.
- .3 Seat rings: renewable bronze screwed into body.
- .4 Stem: nickel-plated steel manganese-bronze.
- .5 Disc: solid offset taper all-cast iron, secured to stem through integral forged T-head disc-stem connection.
- .6 Seat rings: integral with body.
- .7 Stem: nickel-plated steel.
- .8 Pressure-lubricated operating mechanism.
- .9 Operator: Handwheel.
- .10 Bypass: complete with union and NPS gate globe valve.

2.3 UNDERWRITERS

APPROVED GATE VALVE

.1

NPS 2 1/2 - 14, OS&Y:

- .1 Approvals: UL and FM approved for fire service.
- .2 UL and FM Label: on valve yoke.
- .3 Body, Bonnet: cast iron to ASTM A126 Class B. Wall thicknesses to ANSI B16.1 and ULC 262 (B).
- .4 Bonnet bushing, yoke sleeve: bronze, to FM requirements.
- .5 Packing gland: bronze.
- .6 Stem: manganese bronze. Diameter to ULC C-262 (B).
- .7 Stuffing box dimensions, gland bolt diameter: to ULC C-262 (B).
- .8 Bosses for bypass valve, drain: on NPS 4 and over.
- .9 Disc: solid taper wedge. Up to NPS 3: bronze. NPS 4 and over: cast iron with bronze disc rings.
- .10 Disc seat ring: self-aligning, Milwood undercut on NPS 3 - 12.
- .11 Pressure rating:
 - .1 NPS 2-1/2 - 12: 1.7 Mpa CWP.
 - .2 NPS 14-1.2: 1.2 MPa CWP.
- .12 Operator: handwheel.
- .13 Bypass: complete with union and NPS gate globe valve as Section 23 05 23.01, paragraph.

2.4 GLOBE VALVES

.1

NPS 2 1/2 - 10, OSY:

- .1 Body: with multiple-bolted bonnet.
- .2 WP: 860 kPa steam, 1.4 MPa CWP.

2.4 GLOBE VALVES

(Cont'd)

- ```
.1 (Cont'd)
 .3 Bonnet-yoke gasket: non-asbestos.
 .4 Disc: bronze to ASTM B62, fully guided from
bottom, securely yet freely connected to stem
for swivel action and accurate engagement with
disc.
 .5 Seat ring: renewable, regrindable, screwed
into body.
 .6 Stem: bronze to ASTM B62.
 .7 Operator: Handwheel.
 .8 Bypass: complete with union and NPS gate
globe valve.
```

## 2.5 BYPASSES FOR GATE AND GLOBE VALVES

- .1 Locations: on valves as indicated.
- .2 Position of bypass valve on main valves.
- .3 Size of bypass valve:
  - .1 Main valve up to NPS 8: NPS 3/4.
  - .2 Main valve NPS 10 and over: NPS 1.
- .4 Type of bypass valves:
  - .1 On gate valve: globe, with composition bronze disc, bronze trim, to Section 23 05 23.01. Pressure rating to match main valve.
  - .2 On globe valve: globe, with composition bronze disc, bronze trim, to Section 23 05 23.01. Pressure rating to match main valve.

## 2.6 VALVE OPERATORS

- .1 Install valve operators as follows:
  - .1 Handwheel: on valves except as specified.
  - .2 Handwheel with chain operators: on valves installed more than 2400 mm above floor in boiler rooms and mechanical equipment rooms.

## 2.7 CHECK VALVES

- .1 Swing check valves, Class 125:
  - .1 Body and bolted cover: with tapped and plugged opening on each side for hinge pin. Flanged ends: plain faced with smooth finish.
    - .1 Up to NPS 16: cast iron to ASTM A126 Class B.
    - .2 NPS 18 and over: cast iron to ASTM A126 Class C.
  - .2 Ratings:

2.7 CHECK VALVES  
(Cont'd)

- .1 (Cont'd)
  - .2 (Cont'd)
    - .1 NPS 2 1/2 - 12: 860 kPa steam; 1.4 MPa CWP.
    - .2 NPS 14 - 16: 860 kPa steam; 1.03 MPa CWP.
    - .3 NPS 18 and over: 1.03 MPa CWP.
  - .3 Disc: rotating for extended life.
    - .1 Up to NPS 6: bronze to ASTM B62.
    - .2 NPS 8 and over: bronze-faced cast iron.
  - .4 Seat rings: renewable bronze to ASTM B62 screwed into body.
  - .5 Hinge pin, bushings: renewable bronze to ASTM B62.
  - .6 Disc: ASTM A126 Class B, secured to stem, rotating for extended life.
  - .7 Seat: cast iron, integral with body.
  - .8 Hinge pin: exelloy; bushings: malleable iron.
  - .9 Identification tag: fastened to cover.
  - .10 Hinge: galvanized malleable iron.
- .2 Swing check valves, NPS 2 1/2 - 8 Class 250:
    - .1 Body and bolted cover: cast iron to ASTM A126 Class B with tapped and plugged opening on each side for hinge pin.
    - .2 Flanged ends: 2 mm raised face with serrated finish.
    - .3 Rating: 250 psi steam; 500 psi CWP.
    - .4 Disc: rotating for extended life.
      - .1 Up to NPS 3: bronze to ASTM B61.
    - .5 Seat rings: renewable bronze to ASTM B61, screwed into body.
    - .6 Hinge pin, bushings: renewable, bronze to ASTM B61.
    - .7 Hinge: galvanized malleable iron.
    - .8 Identification tag: fastened to cover.

2.8 SILENT CHECK  
VALVES

- .1 Construction:
  - .1 Body: malleable or ductile iron with integral seat.
  - .2 Pressure rating: class 125, WP = 860 kPa.
  - .3 Connections: grooved ends.
  - .4 Disc: bronze or stainless steel renewable rotating disc.
  - .5 Seat: renewable, EPDM.
  - .6 Stainless steel spring, heavy duty.

PART 3 - EXECUTION

- 3.1 INSTALLATION .1 Install rising stem valves in upright position  
with stem above horizontal.

## PART 1 - GENERAL

### 1.1 REFERENCES

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME).
  - .1 ANSI/ASME B1.20.1-1983(R2001), Pipe Threads, General Purpose (Inch).
  - .2 ANSI/ASME B16.1-2005, Cast Iron Pipe Flanges and Flanged Fittings.
  - .3 ANSI/ASME B16.5-2009, Pipe Flanges and Flanged Fittings.
  - .4 ANSI/ASME B16.11-2009, Forged Fittings, Socket-Welding and Threaded.
  - .5 ANSI/ASME B16.25-2007, Buttwelding Ends.
  - .6 ANSI/ASME B16.34-2009 and 2009 supplement, Valves - Flanged, Threaded and Welding Ends.
- .2 American National Standards Institute (ANSI)/American Petroleum Institute (API).
  - .1 ANSI/API 609-2009, Lug- and Water-Type Butterfly Valves.
- .3 American Society for Testing and Materials International, (ASTM).
  - .1 ASTM A126-04, Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
  - .2 ASTM B62-09, Specification for Composition Bronze or Ounce Metal Castings.
  - .3 ASTM B209M-10, Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
- .4 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).
  - .1 MSS SP-67-2002a, Butterfly Valves.

### 1.2 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00.
- .2 Product Data: submit WHMIS MSDS - Material Safety Data Sheets.
  - .1 Submit shop drawings and product data in accordance with Section 01 33 00.
  - .2 Submit product data in accordance with Section 01 33 00.
  - .3 Submit data for valves specified this section.
- .3 Closeout Submittals:
  - .1 Submit maintenance data for incorporation into manual specified in Section 01 78 00.

1.3 QUALITY  
ASSURANCE

- .1 Health and Safety:
  - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06.

1.4 DELIVERY  
STORAGE AND  
DISPOSAL

- .1 Refer to Section 01 74 20.

PART 2 - PRODUCTS

2.1 BUTTERFLY  
VALVES - RESILIENT  
SEAT - 200 PSIG

- .1 Except to specialty valves, to be of single manufacturer.
- .2 To be suitable for dead-end service.
- .3 CRN registration number required for products.
- .4 Sizes: Wafer Lug type: NPS 2 to 30.
- .5 Pressure rating for tight shut-off at temperatures up to maximum for seat material.
  - .1 NPS 2 - 12: 200 psig.
- .6 Minimum seat temperature ratings to 135°C.
- .7 Application: on-off operation.
- .8 Full lug body (threaded).
- .9 Operators:
  - .1 NPS 2 - 6: Handles capable of locking in any of ten (10) positions - 0 degrees to 90 degrees. Handle and release trigger - ductile iron. Return spring and hinge pin: carbon steel. Latch plate and mounting hardware: cadmium plated carbon steel. Standard coating: black laquer.
- .10 Designed to comply with MSS SP-67 and API 609.
- .11 Compatible with ANSI Class 125/Class 150 flanges.
- .12 Construction:
  - .1 Body ductile iron ss aluminum bronze.
  - .2 Disc: aluminum bronze 316 SS.
  - .3 Seat: EPDM Buna-N Viton EPT.
  - .4 Shaft: 316 416 stainless steel.



2.1 BUTTERFLY  
VALVES - RESILIENT  
SEAT - 200 PSIG  
(Cont'd)

- .12 (Cont'd)
- .5 Taper pin: 316 SS Monel.
- .6 Key: carbon steel stainless.
- .7 O-Ring: Buna-N.
- .8 Bushings: Luberized bronze Teflon.

2.2 BUTTERFLY  
VALVES - RESILIENT  
SEAT - 285 PSIG

- .1 Sizes: Lug type: NPS 2 to 48.
- .2 Pressure rating: 285 psig at 135°C.
- .3 Lug body: 150 ANSI bolt pattern.
- .4 Full lug body (threaded).
- .5 Application: for on-off service.
- .6 Operators:
  - .1 NPS 2 - 6: Handles capable of locking in any of ten (10) positions - 0 degrees to 90 degrees. Handle and release trigger - ductile iron. Return spring and hinge pin: carbon steel. Latch plate and mounting hardware: cadmium plated carbon steel.
  - .2 Install parallel or perpendicular to pipeline.
- .7 Designed to comply with MSS SP-67 and API 609.
- .8 Compatible with ANSI B16.1 Class 125 (iron) and ANSI B16.5 Class 150 (steel) flanges.
- .9 Construction:
  - .1 Body: ductile iron.
  - .2 Disc: aluminum bronze 316 SS.
  - .3 Seat: EPDM Buna-N Viton EPT.
  - .4 Refer to manufacturer's literature for additional materials.
  - .5 Shaft: NPS 2 - 12: 416 stainless steel NPS 14 - 48, 316 stainless steel.
  - .6 Taper pin: 316 SS Monel.
  - .7 Blowout proof stem.
  - .8 O-Ring: Buna-N.
  - .9 Bushings: teflon.
  - .10 Disc shall not be pinned to shaft.
  - .11 Bubble tight shutoff with downstream flanges removed, class 6 shutoff.

2.3 MOUNTING  
FLANGES

- .1 Class 125 cast iron to ANSI B16.1 or Class 150 steel to B16.5 pipe flanges.

2.4 PNEUMATIC  
ACTUATORS

- .1 Operation: rack and pinion to provide linear torque-stroke proportion in compact package.
  - .1 Select torque to suit application. Refer to manufacturer's data sheets.
  - .2 Housing and end caps: hard anodized aluminum, complete with guide and Delrin wear pads for long service life.
  - .3 Actuators internally lubricated to ensure long service life.

2.5 ELECTRIC  
ACTUATORS

- .1 Refer to Division 25.

PART 3 - EXECUTION

3.1 PREPARATION

- .1 Valve and mating flange preparation.
  - .1 Inspect adjacent pipeline, remove rust, scale, welding slag, other foreign material.
  - .2 Ensure that valve seats and pipe flange faces are free of dirt or surface irregularities which may disrupt flange seating and cause external leakage.
  - .3 Install butterfly valves with disc in almost closed position.
  - .4 Inspect valve disc seating surfaces and waterway and eliminate dirt or foreign material.

3.2 INSTALLATION OF  
VALVES

- .1 Install in accordance with manufacturer's instructions.
- .2 Do not use gaskets between pipe flanges and valves unless instructed otherwise by valve manufacturer.
- .3 Verify suitability of valve for application by inspection of identification tag.
- .4 Mount actuator on to valve prior to installation.
- .5 Handle valve with care so as to prevent damage to disc and seat faces.
- .6 Valves in horizontal pipe lines should be installed with stem in horizontal position to minimize liner and seal wear.

|                                        |    |                                                                                                                                                                                                                                                              |
|----------------------------------------|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3.2 INSTALLATION OF VALVES<br>(Cont'd) | .7 | Ensure that valves are centered between bolts before bolts are tightened and then opened and closed to ensure unobstructed disc movement. If interference occurs due, for example to pipe wall thickness, taper bore adjacent piping to remove interference. |
|----------------------------------------|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

PART 1 - GENERAL

1.1 REFERENCES

- .1 ASTM International
  - .1 ASTM A125-96(2007), Standard Specification for Steel Springs, Helical, Heat-Treated.
  - .2 ASTM A307-10, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
  - .3 ASTM A563-07a, Standard Specification for Carbon and Alloy Steel Nuts.
- .2 Factory Mutual (FM)
- .3 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
  - .1 MSS SP 58-2009, Pipe Hangers and Supports - Materials, Design and Manufacture.
  - .2 MSS SP 69-2003, Pipe Hangers and Supports - Selection and Application.
  - .3 MSS SP 89-2003, Pipe Hangers and Supports - Fabrication and Installation Practices.
- .4 Underwriter's Laboratories of Canada (ULC)
  - .1 CAN/ULC-

1.2 ACTION AND  
INFORMATIONAL  
SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00.
  - .2 Product Data:
    - .1 Provide manufacturer's printed product literature and data sheets for hangers and supports and include product characteristics, performance criteria, physical size, finish and limitations.
  - .3 Shop Drawings:
    - .1 Submit shop drawings for:
      - .1 Bases, hangers and supports.
      - .2 Connections to equipment and structure.
      - .3 Structural assemblies.
  - .4 Manufacturers' Instructions:
    - .1 Provide manufacturer's installation instructions.
      - .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.
-

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|                            |    |                                                                                       |
|----------------------------|----|---------------------------------------------------------------------------------------|
| 1.3 CLOSEOUT<br>SUBMITTALS | .1 | Provide maintenance data for incorporation into manual specified in Section 01 78 00. |
|----------------------------|----|---------------------------------------------------------------------------------------|

|                                          |    |                                                                                                                                                  |
|------------------------------------------|----|--------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.4 DELIVERY,<br>STORAGE AND<br>HANDLING | .1 | Deliver, store and handle materials in accordance with Section 01 61 00 and with manufacturer's written instructions.                            |
|                                          | .2 | Delivery and Acceptance Requirements:<br>.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address. |

## PART 2 - PRODUCTS

|                           |    |                                                                                                                                                                                                                                                                                                                                                                                           |
|---------------------------|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2.1 SYSTEM<br>DESCRIPTION | .1 | Design Requirements:<br>.1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.<br>.2 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS SP 58.<br>.3 Ensure that supports, guides, anchors do not transmit excessive quantities of heat to building structure. |
|---------------------------|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

|             |    |                                                                                               |
|-------------|----|-----------------------------------------------------------------------------------------------|
| 2.2 GENERAL | .1 | Fabricate hangers, supports and sway braces in accordance with MSS SP 58 and ASME B31.1.      |
|             | .2 | Use components for intended design purpose only. Do not use for rigging or erection purposes. |

|                  |    |                                                                                                                                                                                                                                                                             |
|------------------|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2.3 PIPE HANGERS | .1 | Finishes:<br>.1 Pipe hangers and supports: galvanized painted with zinc-rich paint after manufacture.<br>.2 Use electro-plating galvanizing processhot dipped galvanizing process.<br>.3 Ensure steel hangers in contact with copper piping are copper plated epoxy coated. |
|                  | .2 | Upper attachment structural: suspension from lower flange of I-Beam:                                                                                                                                                                                                        |

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2.3 PIPE HANGERS  
(Cont'd)

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- .2 (Cont'd)
    - .1 Cold piping NPS 2 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.
      - .1 Rod: 9 mm UL listed 13 mm FM approved.
    - .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, UL listed FM approved to MSS-SP 58 and MSS-SP 69.
  - .3 Upper attachment structural: suspension from upper flange of I-Beam:
    - .1 Cold piping NPS 2 maximum: ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, UL listed FM approved to MSS SP 69.
    - .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut UL listed FM approved.
  - .4 Upper attachment to concrete:
    - .1 Ceiling: carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.
    - .2 Concrete inserts: wedge shaped body with knockout protector plate UL listed FM approved to MSS SP 69.
  - .5 Shop and field-fabricated assemblies:
    - .1 Trapeze hanger assemblies:.
    - .2 Steel brackets:.
    - .3 Sway braces for seismic restraint systems: to Section.
  - .6 Hanger rods: threaded rod material to MSS SP 58:
    - .1 Ensure that hanger rods are subject to tensile loading only.
    - .2 Provide linkages where lateral or axial movement of pipework is anticipated.
    - .3 Do not use 22 mm or 28 mm rod.
  - .7 Pipe attachments: material to MSS SP 58:
    - .1 Attachments for steel piping: carbon steel black galvanized.
    - .2 Attachments for copper piping: copper plated black steel.
    - .3 Use insulation shields for hot pipework.
-

2.3 PIPE HANGERS  
(Cont'd)

- .7 (Cont'd)
- .4 Oversize pipe hangers and supports.
- .8 Adjustable clevis: material to MSS SP 69 UL listed FM approved, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
  - .1 Ensure "U" has hole in bottom for rivetting to insulation shields.
- .9 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP 69.
- .10 U-bolts: carbon steel to MSS SP 69 with 2 nuts at each end to ASTM A563.
  - .1 Finishes for steel pipework: black galvanized.
  - .2 Finishes for copper, glass, brass or aluminum pipework: black galvanized, with formed portion plastic coated epoxy coated.
- .11 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP 69.
- .12 Provide oversized pipe hangers/supports to accommodate insulation on following services:
  - .1 Chilled water.
  - .2 Domestic cold water.

2.4 RISER CLAMPS

- .1 Steel or cast iron pipe: galvanized black carbon steel to MSS SP 58, type 42, UL listed FM approved.
- .2 Copper pipe: carbon steel copper plated to MSS SP 58, type 42.
- .3 Bolts: to ASTM A307.
- .4 Nuts: to ASTM A563.

2.5 INSULATION  
PROTECTION SHIELDS

- .1 Insulated cold piping:
  - .1 64 kg/m<sup>3</sup> density insulation plus insulation protection shield to: MSS SP 69, galvanized sheet carbon steel. Length designed for maximum 3 m span.
- .2 Insulated hot piping:

2.5 INSULATION  
PROTECTION SHIELDS  
(Cont'd)

- .2 (Cont'd)
- .1 Curved plate 300 mm long, with edges turned up, welded-in centre plate for pipe sizes NPS 12 and over, carbon steel to comply with MSS SP 69.

2.6 CONSTANT  
SUPPORT SPRING  
HANGERS

- .1 Springs: alloy steel to ASTM A125, shot peened, magnetic particle inspected, with +/-5% spring rate tolerance, tested for free height, spring rate, loaded height and provided with Certified Mill Test Report (CMTR).
- .2 Load adjustability: 10% minimum adjustability each side of calibrated load. Adjustment without special tools. Adjustments not to affect travel capabilities.
- .3 Provide upper and lower factory set travel stops.
- .4 Provide load adjustment scale for field adjustments.
- .5 Total travel to be actual travel + 20%. Difference between total travel and actual travel 25 mm minimum.
- .6 Individually calibrated scales on each side of support calibrated prior to shipment, complete with calibration record.

2.7 VARIABLE  
SUPPORT SPRING  
HANGERS

- .1 Vertical movement: 13 mm minimum, 50 mm maximum, use single spring pre-compressed variable spring hangers.
- .2 Vertical movement greater than 50 mm: use double spring pre-compressed variable spring hanger with 2 springs in series in single casing.
- .3 Variable spring hanger complete with factory calibrated travel stops. Provide certificate of calibration for each hanger.
- .4 Steel alloy springs: to ASTM A125, shot peened, magnetic particle inspected, with +/-5 % spring rate tolerance, tested for free height, spring rate, loaded height and provided with CMTR.



|                                   |    |                                                                                                                                          |
|-----------------------------------|----|------------------------------------------------------------------------------------------------------------------------------------------|
| <u>2.8 EQUIPMENT<br/>SUPPORTS</u> | .1 | Fabricate equipment supports not provided by equipment manufacturer from structural grade steel. Submit calculations with shop drawings. |
|-----------------------------------|----|------------------------------------------------------------------------------------------------------------------------------------------|

|                                                         |    |                                                                |
|---------------------------------------------------------|----|----------------------------------------------------------------|
| <u>2.9 EQUIPMENT<br/>ANCHOR BOLTS AND<br/>TEMPLATES</u> | .1 | Provide templates to ensure accurate location of anchor bolts. |
|---------------------------------------------------------|----|----------------------------------------------------------------|

|                                    |    |                                                                               |
|------------------------------------|----|-------------------------------------------------------------------------------|
| <u>2.10 HOUSE-KEEPING<br/>PADS</u> | .1 | Extend, reconfigure and extend existing concrete pad to suit new air handler. |
|------------------------------------|----|-------------------------------------------------------------------------------|

### PART 3 - EXECUTION

|                                            |    |                                                                                                                                                                                          |
|--------------------------------------------|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>3.1 MANUFACTURER'S<br/>INSTRUCTIONS</u> | .1 | Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet. |
|--------------------------------------------|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

|                         |    |                                                                                                                                                                                                                                                                                                                      |
|-------------------------|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>3.2 INSTALLATION</u> | .1 | Install in accordance with:<br>.1 Manufacturer's instructions and recommendations.                                                                                                                                                                                                                                   |
|                         | .2 | Clamps on riser piping:<br>.1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.<br>.2 Bolt-tightening torques to industry standards.<br>.3 Steel pipes: install below coupling or shear lugs welded to pipe.<br>.4 Cast iron pipes: install below joint. |
|                         | .3 | Clevis plates:<br>.1 Attach to concrete with 4 minimum concrete inserts, one at each corner.                                                                                                                                                                                                                         |
|                         | .4 | Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.                                                                                                                                                                            |

|                           |    |                                                                                           |
|---------------------------|----|-------------------------------------------------------------------------------------------|
| <u>3.3 HANGER SPACING</u> | .1 | Plumbing piping: to Canadian Plumbing Code Provincial Code authority having jurisdiction. |
|---------------------------|----|-------------------------------------------------------------------------------------------|

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3.3 HANGER SPACING  
(Cont'd)

- .2 Fire protection: to applicable fire code.
- .3 Copper piping: up to NPS 1/2: every 1.5 m.
- .4 Flexible joint roll groove pipe: in accordance with table below for steel, but not less than one hanger at joints. Table listings for straight runs without concentrated loads and where full linear movement is not required.
- .5 Within 300 mm of each elbow.

| Maximum Pipe<br>Size : NPS | Maximum<br>Spacing Steel | Maximum<br>Spacing Copper |
|----------------------------|--------------------------|---------------------------|
| up to 1-1/4                | 2.4 m                    | 1.8 m                     |
| 1-1/2                      | 3.0 m                    | 2.4 m                     |
| 2                          | 3.0 m                    | 2.4 m                     |
| 2-1/2                      | 3.7 m                    | 3.0 m                     |
| 3                          | 3.7 m                    | 3.0 m                     |
| 3-1/2                      | 3.7 m                    | 3.3 m                     |
| 4                          | 3.7 m                    | 3.6 m                     |
| 5                          | 4.3 m                    |                           |
| 6                          | 4.3 m                    |                           |
| 8                          | 4.3 m                    |                           |
| 10                         | 4.3 m                    |                           |

3.4 HANGER  
INSTALLATION

- .1 Install hanger so that rod is vertical under operating conditions.
- .2 Adjust hangers to equalize load.
- .3 Support from structural members. Where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members.

3.5 HORIZONTAL  
MOVEMENT

- .1 Angularity of rod hanger resulting from horizontal movement of pipework from cold to hot position not to exceed 4 degrees from vertical.
- .2 Where horizontal pipe movement is less than 13 mm, offset pipe hanger and support so that rod hanger is vertical in the hot position.

3.6 FINAL  
ADJUSTMENT

- .1 Adjust hangers and supports:
  - .1 Ensure that rod is vertical under operating conditions.
  - .2 Equalize loads.
- .2 Adjustable clevis:
  - .1 Tighten hanger load nut securely to ensure proper hanger performance.
  - .2 Tighten upper nut after adjustment.
- .3 C-clamps:
  - .1 Follow manufacturer's recommended written instructions and torque values when tightening C-clamps to bottom flange of beam.
- .4 Beam clamps:
  - .1 Hammer jaw firmly against underside of beam.

3.7 FIELD QUALITY  
CONTROL

- .1 Site Tests: conduct following tests in accordance with Section 01 45 00 and submit report as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
- .2 Manufacturer's Field Services:
  - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
  - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
  - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

PART 1 - GENERAL

- |                                                  |    |                                                                                                                          |
|--------------------------------------------------|----|--------------------------------------------------------------------------------------------------------------------------|
| <u>1.1 RELATED<br/>SECTIONS</u>                  | .1 | Section 23 05 93 - Testing, Adjusting and Balancing of HVAC.                                                             |
| <u>1.2 REFERENCES</u>                            | .1 | National Fire Protection Association (NFPA)<br>.1 NFPA 13-2009, Installation of Sprinkler Systems.                       |
|                                                  | .2 | National Building Code of Canada (NBC) 2010.                                                                             |
| <u>1.3 SHOP DRAWINGS</u>                         | .1 | Submit shop drawings in accordance with Section 01 33 00.                                                                |
|                                                  | .2 | Provide separate shop drawings for each isolated system system shop drawings complete with performance and product data. |
| <u>1.4 WASTE<br/>MANAGEMENT AND<br/>DISPOSAL</u> | .1 | Refer to Section 01 74 20.                                                                                               |

PART 2 - PRODUCTS

- |                                 |    |                                                                                                                                                                                                        |
|---------------------------------|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>2.1 GENERAL</u>              | .1 | Size and shape of bases type and performance of vibration isolation to be as indicated.                                                                                                                |
| <u>2.2 ELASTOMERIC<br/>PADS</u> | .1 | Type EP1 - neoprene waffle or ribbed; 9mm minimum thick; 50 durometer; maximum loading 350 kPa.                                                                                                        |
|                                 | .2 | Type EP2 - rubber waffle or ribbed; 9 mm minimum thick; 30 durometer natural rubber; maximum loading 415 kPa.                                                                                          |
|                                 | .3 | Type EP3 - neoprene-steel-neoprene; 9 mm minimum thick neoprene bonded to 1.71 mm steel plate; 50 durometer neoprene, waffle or ribbed; holes sleeved with isolation washers; maximum loading 350 kPa. |

- |                                            |    |                                                                                                                                                                                                                                                 |
|--------------------------------------------|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2.2 ELASTOMERIC<br>PADS<br><u>(Cont'd)</u> | .4 | Type EP4 - rubber-steel-rubber; 9 mm minimum thick rubber bonded to 1.71 mm steel plate; 30 durometer natural rubber, waffle or ribbed; holes sleeved with isolation washers; maximum loading 415 kPa.                                          |
| 2.3 ELASTOMERIC<br>MOUNTS<br><u></u>       | .1 | Type M1 - colour coded; neoprene in shear; maximum durometer of 60; threaded insert and two bolt-down holes; ribbed top and bottom surfaces.                                                                                                    |
| 2.4 SPRINGS<br><u></u>                     | .1 | Design stable springs so that ratio of lateral to axial stiffness is equal to or greater than 1.2 times the ratio of static deflection to working height. Select for 50% travel beyond rated load. Units to be complete with levelling devices. |
|                                            | .2 | Ratio of height when loaded to diameter of spring to be between 0.8 to 1.0.                                                                                                                                                                     |
|                                            | .3 | Cadmium plate for outdoor 100% relative humidity all installations.                                                                                                                                                                             |
|                                            | .4 | Colour code springs.                                                                                                                                                                                                                            |
| 2.5 SPRING MOUNT<br><u></u>                | .1 | Zinc or cadmium plated hardware; housings coated with rust resistant paint.                                                                                                                                                                     |
|                                            | .2 | Type M2 - stable open spring: support on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad.                                                                                                                         |
|                                            | .3 | Type M3 - stable open spring: 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad, bonded under isolator and on isolator top plate; levelling bolt for rigidly mounting to equipment.                                        |
|                                            | .4 | Type M4 - restrained stable open spring: supported on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad; built-in resilient limit stops, removable spacer plates.                                                   |
|                                            | .5 | Type M5 - enclosed spring mounts with snubbers for isolation up to 950 kg maximum.                                                                                                                                                              |
-

2.5 SPRING MOUNT  
(Cont'd)

- .6 Performance: as indicated.

2.6 HANGERS

- .1 Colour coded springs, rust resistant, painted box type hangers. Arrange to permit hanger box or rod to move through a 30° arc without metal to metal contact.
- .2 Type H1 - neoprene - in-shear, moulded with rod isolation bushing which passes through hanger box.
- .3 Type H2 - stable spring, elastomeric washer, cup with moulded isolation bushing which passes through hanger box.
- .4 Type H3 - stable spring, elastomeric element, cup with moulded isolation bushing which passes through hanger box.
- .5 Type H4 - stable spring, elastomeric element with precompression washer and nut with deflection indicator.
- .6 Performance: as indicated.

2.7 STRUCTURAL  
BASES

- .1 Type B1 - Prefabricated steel base: integrally welded on sizes up to 2400 mm on smallest dimension, split for field welding on sizes over 2400 mm on smallest dimension and reinforced for alignment of drive and driven equipment; without supplementary hold down devices; complete with isolation element attached to base brackets arranged to minimize height; pre-drilled holes to receive equipment anchor bolts; and complete with adjustable built-in motor slide rail where indicated.
- .2 Type B2 - Steel rail base: structural steel, positioned for alignment of drive and driven equipment; without supplementary hold down devices; complete with isolation element attached to base brackets arranged to minimize height; and pre-drilled holes to receive equipment anchor bolts.
- .3 Bases to clear housekeeping pads by 25 mm minimum.

- 2.8 INERTIA BASE
- .1 Type B3 - Full depth perimeter structural or formed channels, frames: welded in place reinforcing rods running in both directions; spring mounted, carried by gussetted height-saving brackets welded to frame; and clear housekeeping pads by 50 mm minimum.
  - .2 Pump bases: "T" shaped, where applicable, to provide support for elbows.

PART 3 - EXECUTION

- 3.1 INSTALLATION
- .1 Install vibration isolation equipment in accordance with manufacturers instructions and adjust mountings to level equipment.
  - .2 Ensure piping, ducting and electrical connections to isolated equipment do not reduce system flexibility and that piping, conduit and ducting passage through walls and floors do not transmit vibrations.
  - .3 Unless indicated otherwise, support piping connected to isolated equipment with spring mounts or spring hangers with 25 mm minimum static deflection as follows:
    - .1 Up to NPS4: first 3 points of support.
    - NPS5 to NPS8: first 4 points of support. NPS10 and Over: first 6 points of support.
    - .2 First point of support shall have a static deflection of twice deflection of isolated equipment, but not more than 50 mm.
  - .4 Where isolation is bolted to floor use vibration isolation rubber washers.
  - .5 Block and shim level bases so that ductwork and piping connections can be made to a rigid system at the operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.

PART 1 - GENERAL

1.1 REFERENCES

- .1 Canadian Standards Association (CSA)
  - .1 CAN/CSA-B149.1-10, Natural Gas and Propane Installation Code.
- .2 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-1.60-97, Interior Alkyd Gloss Enamel.
  - .2 CAN/CGSB-24.3-92, Identification of Piping Systems.
- .3 National Fire Protection Association (NFPA)
  - .1 NFPA 13-2013, Standard for the Installation of Sprinkler Systems.
  - .2 NFPA 14-2013, Standard for the Installation of Standpipe and Hose Systems.

1.2 SUBMITTALS

- .1 Product Data: submit product data for each item specified.
- .2 Submittals: in accordance with Section 01 33 00.
- .3 Product data to include paint colour chips, other products specified in this section.
- .4 Samples:
  - .1 Submit samples in accordance with Section 01 33 00.
  - .2 Samples to include nameplates, labels, tags, lists of proposed legends.

1.3 QUALITY ASSURANCE

- .1 Quality assurance submittals: submit following in accordance with Section 01 33 00.

1.4 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with Section 01 61 00.
  - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.



PART 2 - PRODUCTS

2.1 MANUFACTURER'S  
EQUIPMENT  
NAMEPLATES

- .1 Metal or plastic laminate nameplate mechanically fastened to each piece of equipment by manufacturer.
- .2 Lettering and numbers raised or recessed.
- .3 Information to include, as appropriate:
  - .1 Equipment: manufacturer's name, model, size, serial number, capacity.
  - .2 Motor: voltage, Hz, phase, power factor, duty, frame size.

2.2 SYSTEM  
NAMEPLATES

- .1 Colours:
  - .1 Elsewhere: black letters, white background (except where required otherwise by applicable codes).
- .2 Construction:
  - .1 3 mm thick laminated plastic or white anodized aluminum, matte finish, with square corners, letters accurately aligned and machine engraved into core.
- .3 Sizes:
  - .1 Conform to following table:

| Size # | mm | Sizes (mm) | No. of Lines | Height of Letters (mm) |
|--------|----|------------|--------------|------------------------|
| 1      |    | 10 x 50    | 1            | 3                      |
| 2      |    | 13 x 75    | 1            | 5                      |
| 3      |    | 13 x 75    | 2            | 3                      |
| 4      |    | 20 x 100   | 1            | 8                      |
| 5      |    | 20 x 100   | 2            | 5                      |
| 6      |    | 20 x 200   | 1            | 8                      |
| 7      |    | 25 x 125   | 1            | 12                     |
| 8      |    | 25 x 125   | 2            | 8                      |
| 9      |    | 35 x 200   | 1            | 20                     |

- .2 Use maximum of 25 letters/numbers per line.
- .4 Locations:
  - .1 Terminal cabinets, control panels: use size #5.
  - .2 Equipment in Mechanical Rooms: use size #9.

2.2 SYSTEM  
NAMEPLATES  
(Cont'd)

- .5 Identification for PWGSC Preventive Maintenance Support System (PMSS):
  - .1 Use arrangement of Main identifier, Source identifier, Destination identifier.
  - .2 Equipment in Mechanical Room:
    - .1 Main identifier: size #9.
    - .2 Source and Destination identifiers: size #6.
    - .3 Terminal cabinets, control panels: size #5.
  - .3 Equipment elsewhere: sizes as appropriate.

2.3 EXISTING  
IDENTIFICATION  
SYSTEMS

- .1 Apply existing identification system to new work.
- .2 Where existing identification system does not cover for new work, use identification system specified this section.
- .3 Before starting work, obtain written approval of identification system from Departmental Representative.

2.4 PIPING SYSTEMS

- .1 Identification:
  - .1 Natural gas to CAN/CSA-B149.1
  - .2 Sprinklers: to NFPA 13.

2.5 IDENTIFICATION  
OF PIPING SYSTEMS

- .1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB-24.3 except where specified otherwise.
- .2 Pictograms:
  - .1 Where required: Workplace Hazardous Materials Information System (WHMIS) regulations.
- .3 Legend:
  - .1 Block capitals to sizes and colours listed in CAN/CGSB-24.3.
- .4 Arrows showing direction of flow:
  - .1 Outside diameter of pipe or insulation less than 75 mm: 100 mm long x 50 mm high.
  - .2 Outside diameter of pipe or insulation 75 mm and greater: 150 mm long x 50 mm high.

2.5 IDENTIFICATION  
OF PIPING SYSTEMS  
(Cont'd)

- .4 (Cont'd)  
.3 Use double-headed arrows where flow is reversible.
- .5 Extent of background colour marking:  
.1 To full circumference of pipe or insulation.  
.2 Length to accommodate pictogram, full length of legend and arrows.
- .6 Materials for background colour marking, legend, arrows:  
.1 Pipes and tubing 20 mm and smaller: waterproof and heat-resistant pressure sensitive plastic marker tags.  
.2 Other pipes: pressure sensitive plastic-coated cloth vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150 degrees C and intermittent temperature of 200 degrees C.
- .7 Colours and Legends:  
.1 Where not listed, obtain direction from Departmental Representative.  
.2 Colours for legends, arrows: to following table:

| Background colour: | Legend, arrows: |
|--------------------|-----------------|
| Yellow             | BLACK           |
| Green              | WHITE           |
| Red                | WHITE           |

.3 Background colour marking and legends for piping systems:

| Contents                   | Background colour marking | Legend          |
|----------------------------|---------------------------|-----------------|
| City water                 | Green                     | CITY WATER      |
| Treated water              | Green                     | TREATED WATER   |
| Chilled water supply       | Green                     | CH. WTR. SUPPLY |
| Chilled water return       | Green                     | CH. WTR. RETURN |
| Hot water heating supply   | Yellow                    | HEATING SUPPLY  |
| Hot water heating return   | Yellow                    | HEATING RETURN  |
| Make-up water              | Yellow                    | MAKE-UP WTR     |
| Domestic hot water supply  | Green                     | DOM. HW SUPPLY  |
| Domestic HWS recirculation | Green                     | DOM. HW CIRC    |
| Domestic cold water supply | Green                     | DOM. CWS        |
| Storm Water                | Green                     | STORM           |
| Sanitary                   | Green                     | SAN             |

2.5 IDENTIFICATION .7 (Cont'd)  
OF PIPING SYSTEMS  
(Cont'd)

|                       |          |                |
|-----------------------|----------|----------------|
| Plumbing vent         | Green    | SAN. VENT      |
| Refrigeration suction | Yellow   | REF. SUCTION   |
| Refrigeration liquid  | Yellow   | REF. LIQUID    |
| Refrigeration hot gas | Yellow   | REF. HOT GAS   |
| Natural Gas           | to Codes |                |
| Fire protection water | Red      | FIRE PROT. WTR |
| Sprinklers            | Red      | SPRINKLERS     |

2.6 IDENTIFICATION .1 50 mm high stencilled letters and directional  
DUCTWORK SYSTEMS arrows 150 mm long x 50 mm high.

- .2 Colours: back, or co-ordinated with base colour to ensure strong contrast.

2.7 VALVES,  
CONTROLLERS

- .1 Brass tags with 12 mm stamped identification data filled with black paint.

- .2 Include flow diagrams for each system, of approved size, showing charts and schedules with identification of each tagged item, valve type, service, function, normal position, location of tagged item.

2.8 CONTROLS  
COMPONENTS  
IDENTIFICATION

- .1 Identify all systems, equipment, components, controls, sensors with system nameplates specified in this section.
- .2 Inscriptions to include function and (where appropriate) fail-safe position.

2.9 LANGUAGE

- .1 Identification in English and French.
- .2 Use one nameplate and label for each language both languages.

PART 3 - EXECUTION

- |                                                                      |    |                                                                                                                                                                                                                                                                |
|----------------------------------------------------------------------|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>3.1 MANUFACTURER'S INSTRUCTIONS</u>                               | .1 | Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.                                                                       |
|                                                                      |    |                                                                                                                                                                                                                                                                |
| <u>3.2 TIMING</u>                                                    | .1 | Provide identification only after painting has been completed.                                                                                                                                                                                                 |
|                                                                      |    |                                                                                                                                                                                                                                                                |
| <u>3.3 INSTALLATION</u>                                              | .1 | Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.                                                                                                                                                                                   |
|                                                                      | .2 | Provide ULC and or CSA registration plates as required by respective agency.                                                                                                                                                                                   |
|                                                                      | .3 | Identify systems, equipment to conform to PWGSC PMSS.                                                                                                                                                                                                          |
|                                                                      |    |                                                                                                                                                                                                                                                                |
| <u>3.4 NAMEPLATES</u>                                                | .1 | Locations:<br>.1 In conspicuous location to facilitate easy reading and identification from operating floor.                                                                                                                                                   |
|                                                                      | .2 | Standoffs:<br>.1 Provide for nameplates on hot and/or insulated surfaces.                                                                                                                                                                                      |
|                                                                      | .3 | Protection:<br>.1 Do not paint, insulate or cover.                                                                                                                                                                                                             |
|                                                                      |    |                                                                                                                                                                                                                                                                |
| <u>3.5 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS</u> | .1 | On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels: at not more than 17 m intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles. |
|                                                                      | .2 | Adjacent to each change in direction.                                                                                                                                                                                                                          |
|                                                                      | .3 | At least once in each small room through which piping or ductwork passes.                                                                                                                                                                                      |
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3.5 LOCATION OF  
IDENTIFICATION ON  
PIPING AND DUCTWORK  
SYSTEMS  
(Cont'd)

- .4 On both sides of visual obstruction or where run is difficult to follow.
- .5 On both sides of separations such as walls, floors, partitions.
- .6 Where system is installed in pipe chases, ceiling spaces, galleries, confined spaces, at entry and exit points, and at access openings.
- .7 At beginning and end points of each run and at each piece of equipment in run.
- .8 At point immediately upstream of major manually operated or automatically controlled valves, and dampers. Where this is not possible, place identification as close as possible, preferably on upstream side.
- .9 Identification easily and accurately readable from usual operating areas and from access points.
  - .1 Position of identification approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

3.6 VALVES,  
CONTROLLERS

- .1 Valves and operating controllers, except at plumbing fixtures, radiation, or where in plain sight of equipment they serve: Secure tags with non-ferrous chains or closed "S" hooks.
- .2 Install one copy of flow diagrams, valve schedules mounted in frame behind non-glare glass where directed by Departmental Representative. Provide one copy (reduced in size if required) in each operating and maintenance manual.
- .3 Number valves in each system consecutively.

PART 1 - GENERAL

1.1 GENERAL

- .1 TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do other work as specified in this section.

1.2 QUALIFICATIONS  
OF TAB PERSONNEL

- .1 Names of personnel it is proposed to perform TAB to be submitted to and approved by Departmental Representative Consultant within 90 days of award of contract.
- .2 Provide documentation confirming qualifications, successful experience.

1.3 PURPOSE OF TAB

- .1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads
- .2 Adjust and regulate equipment and systems so as to meet specified performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions.
- .3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.

1.4 EXCEPTIONS

- .1 TAB of systems and equipment regulated by codes, standards to be to satisfaction of authority having jurisdiction.

1.5 CO-ORDINATION

- .1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule so as to ensure completion before acceptance of project.
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|------------------------------------------------|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>1.5 CO-ORDINATION<br/>(Cont'd)</u>          | .2 | Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.                                                                                                                  |
| <br>                                           |    |                                                                                                                                                                                                                                            |
| <u>1.6 PRE-TAB REVIEW</u>                      | .1 | Review contract documents before project construction is started and confirm in writing to Departmental Representative Consultant adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB. |
|                                                | .2 | Review specified standards and report to Departmental Representative Consultant in writing all proposed procedures which vary from standard.                                                                                               |
|                                                | .3 | During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.                                                                                                         |
| <br>                                           |    |                                                                                                                                                                                                                                            |
| <u>1.7 START-UP</u>                            | .1 | Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.                                                                                                                                            |
|                                                | .2 | Follow special start-up procedures specified elsewhere in Mechanical Division.                                                                                                                                                             |
| <br>                                           |    |                                                                                                                                                                                                                                            |
| <u>1.8 OPERATION OF<br/>SYSTEMS DURING TAB</u> | .1 | Operate systems for length of time required for TAB and as required by Departmental Representative Consultant for verification of TAB reports.                                                                                             |
| <br>                                           |    |                                                                                                                                                                                                                                            |
| <u>1.9 START OF TAB</u>                        | .1 | Notify Departmental Representative Consultant 7 days prior to start of TAB.                                                                                                                                                                |
|                                                | .2 | Start TAB when building is essentially completed, including:                                                                                                                                                                               |
|                                                | .3 | Installation of ceilings, doors, windows, other construction affecting TAB.                                                                                                                                                                |
|                                                | .4 | Application of weatherstripping, sealing, caulking.                                                                                                                                                                                        |
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|----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>1.9 START OF TAB<br/>(Cont'd)</u>   | <ul style="list-style-type: none"><li>.5 All pressure, leakage, other tests specified elsewhere in Division 23.</li><li>.6 All provisions for TAB installed and operational.</li><li>.7 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:<ul style="list-style-type: none"><li>.1 Proper thermal overload protection in place for electrical equipment.</li><li>.2 Air systems:<ul style="list-style-type: none"><li>.1 Filters in place, clean.</li><li>.2 Duct systems clean.</li><li>.3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.</li><li>.4 Correct fan rotation.</li><li>.5 Fire, smoke, volume control dampers installed and open.</li><li>.6 Coil fins combed, clean.</li><li>.7 Access doors, installed, closed.</li><li>.8 Outlets installed, volume control dampers open.</li></ul></li><li>.3 Liquid systems:<ul style="list-style-type: none"><li>.1 Flushed, filled, vented.</li><li>.2 Correct pump rotation.</li><li>.3 Strainers in place, baskets clean.</li><li>.4 Isolating and balancing valves installed, open.</li><li>.5 Calibrated balancing valves installed, at factory settings.</li><li>.6 Chemical treatment systems complete, operational.</li></ul></li></ul></li></ul> |
| <u>1.10 APPLICATION<br/>TOLERANCES</u> | <ul style="list-style-type: none"><li>.1 Do TAB to following tolerances of design values:<ul style="list-style-type: none"><li>.1 Other HVAC systems: plus 5%, minus 5 %.</li><li>.2 Hydronic systems: plus or minus 10%.</li></ul></li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <u>1.11 ACCURACY<br/>TOLERANCES</u>    | <ul style="list-style-type: none"><li>.1 Measured values to be accurate to within plus or minus 2% of actual values.</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <u>1.12 INSTRUMENTS</u>                | <ul style="list-style-type: none"><li>.1 Prior to TAB, submit to Departmental Representative Consultant list of instruments to be used together with serial numbers.</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
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|----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>1.12 INSTRUMENTS<br/>(Cont'd)</u>   | <ul style="list-style-type: none"><li>.2 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.</li><li>.3 Calibrate within 3 months of TAB. Provide certificate of calibration to Departmental Representative Consultant.</li></ul>                                                                                                                                                                               |
| <br>                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <u>1.13 SUBMITTALS</u>                 | <ul style="list-style-type: none"><li>.1 Submit, prior to commencement of TAB:</li><li>.2 Proposed methodology and procedures for performing TAB if different from referenced standard.</li><li>.3.</li></ul>                                                                                                                                                                                                                                                                               |
| <br>                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <u>1.14 PRELIMINARY<br/>TAB REPORT</u> | <ul style="list-style-type: none"><li>.1 Submit for checking and approval of Departmental Representative Consultant, prior to submission of formal TAB report, sample of rough TAB sheets. Include:<ul style="list-style-type: none"><li>.1 Details of instruments used.</li><li>.2 Details of TAB procedures employed.</li><li>.3 Calculations procedures.</li><li>.4 Summaries.</li></ul></li></ul>                                                                                       |
| <br>                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <u>1.15 TAB REPORT</u>                 | <ul style="list-style-type: none"><li>.1 Format to be in accordance with referenced standard.</li><li>.2 TAB report to show results in SI units and to include:<ul style="list-style-type: none"><li>.1 Project record drawings.</li><li>.2 System schematics.</li></ul></li><li>.3 Submit 6 copies of TAB Report to Departmental Representative Consultant for verification and approval, in English French both official languages in D-ring binders, complete with index tabs.</li></ul> |
| <br>                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <u>1.16 VERIFICATION</u>               | <ul style="list-style-type: none"><li>.1 Reported results subject to verification by Departmental Representative Consultant.</li><li>.2 Provide manpower and instrumentation to verify up to 30% of reported results.</li></ul>                                                                                                                                                                                                                                                             |
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|---------------------------------------|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>1.16 VERIFICATION<br/>(Cont'd)</u> | .3 | Number and location of verified results to be at discretion of Departmental Representative Consultant.                                                                                                                                                                                                                                                                                                                                          |
|                                       | .4 | Bear costs to repeat TAB as required to satisfaction of Departmental Representative Consultant.                                                                                                                                                                                                                                                                                                                                                 |
| <br>                                  |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <u>1.17 SETTINGS</u>                  | .1 | After TAB is completed to satisfaction of Departmental Representative Consultant, replace drive guards, close access doors, lock devices in set positions, ensure sensors are at required settings.                                                                                                                                                                                                                                             |
|                                       | .2 | Permanently mark settings to allow restoration at any time during life of facility. Markings not to be eradicated or covered in any way.                                                                                                                                                                                                                                                                                                        |
| <br>                                  |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <u>1.18 COMPLETION OF<br/>TAB</u>     | .1 | TAB to be considered complete when final TAB Report received and approved by Departmental Representative.                                                                                                                                                                                                                                                                                                                                       |
| <br>                                  |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <u>1.19 AIR SYSTEMS</u>               | .1 | Standard: TAB to be to most stringent of this section or TAB standards of AABC NEBB SMACNA ASHRAE.                                                                                                                                                                                                                                                                                                                                              |
|                                       | .2 | Do TAB of systems, equipment, components, controls specified Division 21 22 23 following systems, equipment, components, controls:<br>.1 Helicopter hanger AH-1 and associated system.<br>.2 Helicopter hanger exhaust fans EF-16, EF-17, EF-18, E-25 and associated system.<br>.3 Guard House FCU-04, RF-1 and associated system.<br>.4 Central stores FCU-01 and associated system.<br>.5 Boiler room supply fan SF-24 and associated system. |
|                                       | .3 | Qualifications: personnel performing TAB to be current member in good standing of AABC or NEBB qualified to standards of AABC or NEBB.                                                                                                                                                                                                                                                                                                          |
|                                       | .4 | Quality assurance: Perform TAB under direction of supervisor qualified by to standards of AABC or NEBB.                                                                                                                                                                                                                                                                                                                                         |
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1.19 AIR SYSTEMS  
(Cont'd)

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- .5 Measurements: to include, but not limited to, following as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.
- .6 Locations of equipment measurements: To include, but not be limited to, following as appropriate:
  - .1 Inlet and outlet of dampers, filter, coil, humidifier, fan, other equipment causing changes in conditions.
  - .2 At controllers, controlled device.
- .7 Locations of systems measurements to include, but not be limited to, following as appropriate: Main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

1.20 HYDRONIC  
SYSTEMS

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- .1 Definitions: for purposes of this section, to include low pressure hot water heating, chilled water, condenser water, glycol systems.
  - .2 Standard: TAB to be to most stringent of this section or TAB standards of AABC NEBB SMACNA ASHRAE.
  - .3 Do TAB of systems, equipment, components, controls specified Division 25 following systems, equipment, components, controls:
    - .1 New boiler plant.
    - .2 New circulators P-4, p-5, p-6, p-7.
    - .3 Chilled water plant.
  - .4 Qualifications: personnel performing TAB to be current member in good standing of AABC or NEBB qualified to standards of AABC or NEBB.
  - .5 Quality assurance: perform TAB under direction of supervisor qualified by to standards of AABC or NEBB.
  - .6 Measurements: to include, but not limited to, following as appropriate for systems, equipment, components, controls: Flow rate, static pressure, pressure drop (or loss), temperature, specific gravity, density, RPM, electrical power, voltage, noise, vibration.
-

1.20 HYDRONIC  
SYSTEMS  
(Cont'd)

- .7 Locations of equipment measurement: To include, but not be limited to, following as appropriate:
- .1 Inlet and outlet of coil, humidifier, pump, control valve, other equipment causing changes in conditions.
  - .2 At controllers, controlled device.

1.21 OTHER TAB  
REQUIREMENTS

- .1 General requirements applicable to work specified this paragraph:
- .1 Qualifications of TAB personnel: as for air systems specified this section.
  - .2 Quality assurance: as for air systems specified this section.

PART 2 - PRODUCTS

2.1 NOT USED

- .1 Not used.

PART 3 - EXECUTION

3.1 NOT USED

- .1 Not used.

PART 1 - GENERAL

1.1 REFERENCES

- .1 Definitions:
  - .1 For purposes of this section:
    - .1 "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.
    - .2 "EXPOSED" - means "not concealed" as previously defined.
    - .3 Insulation systems - insulation material, fasteners, jackets, and other accessories.
  - .2 TIAC Codes:
    - .1 CRD: Code Round Ductwork,
    - .2 CRF: Code Rectangular Finish.
- .2 Reference Standards:
  - .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
    - .1 ANSI/ASHRAE/IES 90.1-2013, SI; Energy Standard for Buildings Except Low-Rise Residential Buildings.
  - .2 ASTM International Inc.
    - .1 ASTM B209M-14, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
    - .2 ASTM C335-10e1, Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation.
    - .3 ASTM C411-11, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
    - .4 ASTM C449-07, Standard Specification for Mineral Fiber-Hydraulic- Setting Thermal Insulating and Finishing Cement.
    - .5 ASTM C547-15, Standard Specification for Mineral Fiber Pipe Insulation.
    - .6 ASTM C553-13, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
    - .7 ASTM C612-14, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
    - .8 ASTM C921-15, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
  - .3 Canadian General Standards Board (CGSB)

1.1 REFERENCES  
(Cont'd)

- .2 (Cont'd)
- .3 (Cont'd)
  - .1 CGSB 51-GP-52Ma-09, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
  - .4 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (2015).
  - .5 Underwriters Laboratories of Canada (ULC)
    - .1 CAN/ULC-S102-10, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
    - .2 CAN/ULC-S701-11, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

1.2 ACTION AND  
INFORMATIONAL  
SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature and datasheets for duct insulation, and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Manufacturers' Instructions:
  - .1 Provide manufacture's written duct insulation jointing recommendations. and special handling criteria, installation sequence, cleaning procedures.

1.3 QUALITY  
ASSURANCE

- .1 Qualifications:
  - .1 Installer: specialist in performing work of this section, and have at least 3 years successful experience in this size and type of project, qualified to standards member of TIAC.

1.4 DELIVERY,  
STORAGE AND  
HANDLING

- .1 Deliver, store and handle in accordance with Section 01 61 00.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address and ULC markings.

## PART 2 - PRODUCTS

### 2.1 FIRE AND SMOKE RATING

- .1 To CAN/ULC-S102:
  - .1 Maximum flame spread rating: 25.
  - .2 Maximum smoke developed rating: 50.

### 2.2 INSULATION

- .1 Mineral fibre: as specified includes glass fibre, rock wool, slag wool.
  - .1 Recycled content: % (Post-Consumer + ½ Post-Industrial) in accordance with Section 01 35 21.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24°C mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code C-1: Rigid mineral fibre board to ASTM C612, with without factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this Section).
- .4 TIAC Code C-2: Mineral fibre blanket to ASTM C553 faced with without factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this section).
  - .1 Mineral fibre: to ASTM C553.
  - .2 Jacket: to CGSB 51-GP-52Ma.
  - .3 Maximum "k" factor: to ASTM C553.

### 2.3 JACKETS

- .1 Canvas:
  - .1 220 gm/m<sup>2</sup> cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
- .2 Lagging adhesive: compatible with insulation.

### 2.4 ACCESSORIES

- .1 Vapour retarder lap adhesive:
  - .1 Water based, fire retardant type, compatible with insulation.
- .2 Indoor Vapour Retarder Finish:
  - .1 Vinyl emulsion type acrylic, compatible with insulation.



2.4 ACCESSORIES  
(Cont'd)

- .3 Insulating Cement: hydraulic setting on mineral wool, to ASTM C449.
- .4 ULC Listed Canvas Jacket:
  - .1 220 gm/m<sup>2</sup> cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921 untreated.
- .5 Tape: self-adhesive, aluminum reinforced, 50 mm wide minimum.
- .6 Contact adhesive: quick-setting
  - .1 Maximum VOC limit 250 g/L to SCAQMD Rule 1168 GSES GS-36.
- .7 Canvas adhesive: washable.
  - .1 Maximum VOC limit 250 g/L to SCAQMD Rule 1168 GSES GS-36.
- .8 Tie wire: 1.5 mm stainless steel.
- .9 Banding: 19 mm wide, 0.5 mm thick stainless steel.
- .10 Facing: 25 mm stainless steel hexagonal wire mesh stitched on both faces of insulation.
- .11 Fasteners: 4 mm diameter pins with 35 mm diameter or clips, length to suit thickness of insulation.

PART 3 - EXECUTION

3.1 APPLICATION

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

3.2  
PRE-INSTALLATION  
REQUIREMENTS

- .1 Pressure test ductwork systems complete, witness and certify.
- .2 Ensure surfaces are clean, dry, free from foreign material.

3.3 INSTALLATION

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturers instructions and as indicated.
- .3 Use 2 layers with staggered joints when required nominal thickness exceeds 75 mm.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
  - .1 Ensure hangers, and supports are outside vapour retarder jacket.
- .5 Hangers and supports in accordance with Section 23 05 29.
  - .1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.
- .6 Fasteners: install at 300 mm on centre in horizontal and vertical directions, minimum 2 rows each side.

3.4 DUCTWORK  
INSULATION SCHEDULE

- .1 Insulation types and thicknesses: conform to following table:

|                                                                | TIAC Code | Vapour Retarder | Thickness (mm) |
|----------------------------------------------------------------|-----------|-----------------|----------------|
| Rectangular cold and dual temperature supply air ducts         | C-1       | yes             | 50             |
| Round cold and dual temperature supply air ducts               | C-2       | yes             | 50             |
| Supply, return and exhaust ducts exposed in space being served |           |                 | none           |
| Outside air ducts to mixing plenum                             | C-1       | yes             | 50             |
| Mixing plenums                                                 | C-1       | yes             | 50             |
| Exhaust duct                                                   | C-1       | no              | 25             |

3.4 DUCTWORK  
INSULATION SCHEDULE  
(Cont'd)

between dampers  
and louvres

|                              |     |         |    |
|------------------------------|-----|---------|----|
| Rectangular<br>ducts outside | C-1 | special | 50 |
|------------------------------|-----|---------|----|

|                             |      |
|-----------------------------|------|
| Acoustically<br>lined ducts | none |
|-----------------------------|------|

- .2 Exposed round ducts 600 mm and larger, smaller sizes where subject to abuse:  
.1 Use TIAC code C-1 insulation, scored to suit diameter of duct.  
.1 Finishes: conform to following table:

| TIAC Code                              |             |       |
|----------------------------------------|-------------|-------|
| Indoor, concealed                      | Rectangular | Round |
|                                        | none        | none  |
| Indoor, exposed within mechanical room | CRF/1       | CRD/2 |
| Indoor, exposed elsewhere              | CRF/2       | CRD/3 |

3.5 JACKETS .1 All exposed ductwork shall be provided with canvas jacket and lagging.

3.6 CLEANING .1 Clean in accordance with Section 01 74 11.  
.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

PART 1 - GENERAL

1.1 SUMMARY

- .1 Section Includes:
  - .1 Thermal insulation for piping and piping accessories in commercial type applications.

1.2 REFERENCES

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
    - .1 ASHRAE Standard 90.1-2013, Energy Standard for Buildings Except Low-Rise Residential Buildings (ANSI approved; IESNA co-sponsored).
  - .2 American Society for Testing and Materials International (ASTM)
    - .1 ASTM B209M-10, Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate (Metric).
    - .2 ASTM C335/C335M-10e1, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
    - .3 ASTM C411-11, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
    - .4 ASTM C449-07, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
    - .5 ASTM C533-07, Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
    - .6 ASTM C547-07e1, Standard Specification for Mineral Fiber Pipe Insulation.
    - .7 ASTM C795-08, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
    - .8 ASTM C921-10, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
  - .3 Canadian General Standards Board (CGSB)
    - .1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
    - .2 CAN/CGSB-51.53-95, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts.
  - .4 Department of Justice Canada (Jus)
    - .1 Canadian Environmental Assessment Act (CEAA), 1992, c. 37.
-

1.2 REFERENCES  
(Cont'd)

- .4 (Cont'd)
  - .2 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
  - .3 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.
- .5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).
- .6 Manufacturer's Trade Associations
  - .1 Thermal Insulation Association of Canada (TIAC): Mechanical Insulation Best Practice Guide(Revised 2005).
- .7 Underwriters' Laboratories of Canada (ULC)
  - .1 CAN/ULC-S102-10, Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies.
  - .2 CAN/ULC-S701-11, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.
  - .3 CAN/ULC-S702-09, Thermal Insulation, Mineral Fibre, for Buildings
  - .4 ULC-S702.2-10, Standard for Thermal Insulation, Mineral Fibre, for Buildings, Part 2: Application Guidelines.

1.3 DEFINITIONS

- .1 For purposes of this section:
  - .1 "CONCEALED" - insulated mechanical services in suspended ceilings and non-accessible chases and furred-in spaces.
  - .2 "EXPOSED" - will mean "not concealed" as specified.
- .2 TIAC ss:
  - .1 CRF: Code Rectangular Finish.
  - .2 CPF: Code Piping Finish.

1.4 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00.
- .2 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00. Include product characteristics, performance criteria, and limitations.

1.4 SUBMITTALS  
(Cont'd)

- .2 (Cont'd)
  - .1 (Cont'd)
    - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS).
  - .3 Shop Drawings:
    - .1 Submit shop drawings in accordance with Section 01 33 00.
      - .1 Shop drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.

1.5 QUALITY  
ASSURANCE

- .1 Qualifications:
  - .1 Installer: specialist in performing work of this Section, and have at least 3 years successful experience in this size and type of project, qualified to standards member of TIAC.
- .2 Health and Safety:
  - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06.

1.6 DELIVERY,  
STORAGE AND  
HANDLING

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00.
  - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
  - .3 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .2 Storage and Protection:
  - .1 Protect from weather, construction traffic.
  - .2 Protect against damage.
  - .3 Store at temperatures and conditions required by manufacturer.

PART 2 - PRODUCTS

2.1 FIRE AND SMOKE  
RATING

- .1 In accordance with CAN/ULC-S102.
  - .1 Maximum flame spread rating: 25.
  - .2 Maximum smoke developed rating: 50.

2.2 INSULATION

- .1 Mineral fibre specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24°C mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.
  - .1 Mineral fibre: to CAN/ULC-S702 ASTM C547.
  - .2 Maximum "k" factor: to CAN/ULC-S702.
- .4 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.
  - .1 Mineral fibre: to CAN/ULC-S702 ASTM C547.
  - .2 Jacket: to CGSB 51-GP-52Ma.
  - .3 Maximum "k" factor: to CAN/ULC-S702 ASTM C547.
- .5 TIAC Code C-2: mineral fibre blanket faced with without factory applied vapour retarder jacket (as scheduled in PART 3 of this section).
  - .1 Mineral fibre: to CAN/ULC-S702 ASTM C547.
  - .2 Jacket: to CGSB 51-GP-52Ma.
  - .3 Maximum "k" factor: to CAN/ULC-S702 ASTM C547.
- .6 TIAC Code A-6: flexible unicellular tubular elastomer.
- .7 Insulation: with vapour retarder jacket
  - .1 Jacket: to CGSB 51-GP-52Ma.
  - .2 Maximum "k" factor:.
  - .3 Certified by manufacturer: free of potential stress corrosion cracking corrodants.

2.3 INSULATION  
SECUREMENT

- .1 Tape: self-adhesive, aluminum, plain reinforced, 50 mm wide minimum.
- .2 Contact adhesive: quick setting.

|                                          |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|------------------------------------------|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2.3 INSULATION<br>SECUREMENT<br>(Cont'd) | .3 | Canvas adhesive: washable.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|                                          | .4 | Tie wire: 1.5 mm diameter stainless steel.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|                                          | .5 | Bands: stainless steel, 19 mm wide, 0.5 mm thick.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 2.4 CEMENT                               | .1 | Thermal insulating and finishing cement:<br>.1 Hydraulic setting or Air drying on mineral wool, to ASTM C449.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 2.5 VAPOUR RETARDER<br>LAP ADHESIVE      | .1 | Water based, fire retardant type, compatible with insulation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 2.6 INDOOR VAPOUR<br>RETARDER FINISH     | .1 | Vinyl emulsion type acrylic, compatible with insulation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 2.7 OUTDOOR VAPOUR<br>RETARDER FINISH    | .1 | Vinyl emulsion type acrylic, compatible with insulation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|                                          | .2 | Reinforcing fabric: fibrous glass, untreated 305 g/m <sup>2</sup> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 2.8 JACKETS                              | .1 | Polyvinyl Chloride (PVC):<br>.1 One-piece moulded type and sheet to CAN/CGSB-51.53 with pre-formed shapes as required.<br>.2 Colours: to match adjacent finish paint by Departmental Representative.<br>.3 Minimum service temperatures: -20 degrees C.<br>.4 Maximum service temperature: 65 degrees C.<br>.5 Moisture vapour transmission: 0.02 perm.<br>.6 Thickness: mm.<br>.7 Fastenings:<br>.1 Use solvent weld adhesive compatible with insulation to seal laps and joints.<br>.2 Tacks.<br>.3 Pressure sensitive vinyl tape of matching colour.<br>.8 Special requirements:<br>.1 Indoor:. |



- 2.8 JACKETS  
(Cont'd)
- .1 (Cont'd)
  - .8 (Cont'd)
    - .2 Outdoor: UV rated material at least 0.5 mm thick.
  - .2 Canvas:
    - .1 220 gm/m<sup>2</sup> cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
    - .2 Lagging adhesive: compatible with insulation.
  - .3 Aluminum:
    - .1 To ASTM B209M.
    - .2 Thickness: .50 mm sheet.
    - .3 Finish: smooth, stucco embossed, corrugated.
    - .4 Joining: longitudinal and circumferential slip joints with 50 mm laps.
    - .5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.
    - .6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5 mm thick at 300 mm spacing.

PART 3 - EXECUTION

- 3.1 MANUFACTURER'S INSTRUCTIONS
- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.
- 3.2 PRE-INSTALLATION REQUIREMENT
- .1 Pressure testing of piping systems and adjacent equipment to be complete, witnessed and certified.
  - .2 Surfaces clean, dry, free from foreign material.
- 3.3 INSTALLATION
- .1 Install in accordance with TIAC National Standards.
  - .2 Apply materials in accordance with manufacturers instructions and this specification.

- |                                                                   |    |                                                                                                                                                   |
|-------------------------------------------------------------------|----|---------------------------------------------------------------------------------------------------------------------------------------------------|
| 3.3 INSTALLATION<br>(Cont'd)                                      | .3 | Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.                                                          |
|                                                                   | .4 | Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.                                                           |
|                                                                   | .1 | Install hangers, supports outside vapour retarder jacket.                                                                                         |
|                                                                   | .5 | Supports, Hangers:                                                                                                                                |
|                                                                   | .1 | Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided. |
| 3.4 REMOVABLE,<br>PRE-FABRICATED,<br>INSULATION AND<br>ENCLOSURES | .1 | Application: valves, primary flow measuring elements flanges and unions at equipment.                                                             |
|                                                                   | .2 | Design: to permit periodic removal and replacement without damage to adjacent insulation.                                                         |
|                                                                   | .3 | Insulation:                                                                                                                                       |
|                                                                   | .1 | Insulation, fastenings and finishes: same as system.                                                                                              |
|                                                                   | .2 | Jacket: PVC, ABS high temperature fabric.                                                                                                         |
| 3.5 INSTALLATION OF<br>ELASTOMERIC<br>INSULATION                  | .1 | Insulation to remain dry. Overlaps to manufacturers instructions. Ensure tight joints.                                                            |
|                                                                   | .2 | Provide vapour retarder as recommended by manufacturer.                                                                                           |
| 3.6 PIPING<br>INSULATION<br>SCHEDULES                             | .1 | Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.                                                       |
|                                                                   | .2 | TIAC Code: A-1.                                                                                                                                   |
|                                                                   | .1 | Securements: SS wire bands at 300 mm on centre.                                                                                                   |
|                                                                   | .2 | Seals: lap seal adhesive, lagging adhesive.                                                                                                       |
|                                                                   | .3 | Installation: TIAC Code 1501-H.                                                                                                                   |
|                                                                   | .3 | TIAC Code: A-3.                                                                                                                                   |
|                                                                   | .1 | Securements: SS wire bands at 300 mm on centre.                                                                                                   |
-

- 3.6 PIPING INSULATION SCHEDULES (Cont'd)
- .3 (Cont'd)
    - .2 Seals: VR lap seal adhesive, VR lagging adhesive.
    - .3 Installation: TIAC Code: 1501-C.
  - .4 TIAC Code: A-6.
    - .1 Insulation securements.
    - .2 Seals: lap seal adhesive, lagging adhesive.
    - .3 Installation: TIAC Code.
  - .5 TIAC Code: C-2 with without vapour retarder jacket.
    - .1 Insulation securements:.
    - .2 Seals: lap seal adhesive, lagging adhesive.
    - .3 Installation: TIAC Code: 1501-C.
  - .6 Thickness of insulation as listed in following table.
    - .1 Run-outs to individual units and equipment not exceeding 4000 mm long.
    - .2 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.

| Applic<br>ation | Temp<br>degree<br>s C | TIAC<br>code | Pipe sizes (NPS) and insulation thickness<br>(mm) |               |      |  |
|-----------------|-----------------------|--------------|---------------------------------------------------|---------------|------|--|
|                 | Run<br>out            | to 1         | 1 1/4<br>to 2                                     | 2 1/2<br>to 4 | over |  |

|       |              |      |    |    |    |    |
|-------|--------------|------|----|----|----|----|
| Steam | up to<br>175 | A- 1 | 50 | 50 | 65 | 75 |
|-------|--------------|------|----|----|----|----|

|                            |            |      |    |    |    |    |
|----------------------------|------------|------|----|----|----|----|
| Condense<br>sate<br>Return | 60 -<br>94 | A- 1 | 25 | 38 | 38 | 38 |
|----------------------------|------------|------|----|----|----|----|

|                             |            |      |    |    |    |    |
|-----------------------------|------------|------|----|----|----|----|
| Hot<br>Water<br>Heatin<br>g | 60 -<br>94 | A- 1 | 25 | 38 | 38 | 38 |
|-----------------------------|------------|------|----|----|----|----|

|                             |             |      |    |    |    |    |
|-----------------------------|-------------|------|----|----|----|----|
| Hot<br>Water<br>Heatin<br>g | up to<br>59 | A- 1 | 25 | 25 | 25 | 25 |
|-----------------------------|-------------|------|----|----|----|----|

|                  |  |      |    |    |    |    |
|------------------|--|------|----|----|----|----|
| Domest<br>ic HWS |  | A- 1 | 25 | 25 | 25 | 38 |
|------------------|--|------|----|----|----|----|

3.6 PIPING  
INSULATION  
SCHEDULES  
(Cont'd)

|                                            |      |    |    |    |    |
|--------------------------------------------|------|----|----|----|----|
| Chilled<br>Water                           | A- 3 | 25 | 38 | 38 | 25 |
| Chilled<br>Water<br>Pump<br>Casing         | A- 3 | 25 | 25 | 25 | 25 |
| Domestic CWS<br>with<br>vapour<br>retarder | C- 2 | 25 | 25 | 25 | 25 |
| Cooling Coil<br>cond.<br>drain             | C- 2 | 25 | 25 | 25 | 25 |

.7 Finishes:

- .1 Exposed indoors: hot water, PVC jacket.
- .2 Exposed in mechanical rooms: canvas for steam PVC jacket for hot and chilled water.
- .3 Concealed, indoors: canvas on valves, fittings. No further finish.
- .4 Use vapour retarder jacket on TIAC code A-3 insulation compatible with insulation.
- .5 Outdoors: water-proof, aluminum jacket.
- .6 Finish attachments: SS screws, bands, at 150 mm on centre. Seals: wing closed.
- .7 Installation: to appropriate TIAC code CRF/1 through CPF/5.

3.7 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

PART 1 - GENERAL

- |                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|---------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>1.1 RELATED SECTIONS</u>                                   | <ul style="list-style-type: none"><li>.1 Section 01 91 00 - Commissioning: General Requirements, supplemented as specified herein.</li><li>.2 Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.</li><li>.3 Section 22 42 01 - Plumbing Specialities and Accessories.</li><li>.4 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <u>1.2 REFERENCES</u>                                         | <ul style="list-style-type: none"><li>.1 ASTM E202-09, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <u>1.3 CLEANING AND START-UP OF MECHANICAL PIPING SYSTEMS</u> | <ul style="list-style-type: none"><li>.1 In accordance with Section 23 08 02.</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <u>1.4 HYDRONIC SYSTEMS - PERFORMANCE VERIFICATION (PV)</u>   | <ul style="list-style-type: none"><li>.1 Timing:<ul style="list-style-type: none"><li>.1 After cleaning is completed and system is in full operation.</li></ul></li><li>.2 When systems are operational, perform following tests:<ul style="list-style-type: none"><li>.1 Conduct full scale tests at maximum design flow rates, temperatures and pressures for continuous consecutive period of 48 hours to demonstrate compliance with design criteria.</li><li>.2 Verify performance of hydronic system circulating pumps as specified in relevant technical sections, recording system pressures, temperatures, fluctuations by simulating maximum design conditions and varying.<ul style="list-style-type: none"><li>.1 Pump operation.</li><li>.2 Boiler and/or chiller operation.</li><li>.3 Pressure bypass open/closed.</li><li>.4 Control pressure failure.</li><li>.5 Maximum heating demand.</li><li>.6 Maximum cooling demand.</li><li>.7 Boiler and/or chiller failure.</li></ul></li></ul></li></ul> |
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- |                                                                                  |    |                                                                                                                    |
|----------------------------------------------------------------------------------|----|--------------------------------------------------------------------------------------------------------------------|
| 1.4 HYDRONIC<br>SYSTEMS -<br>PERFORMANCE<br>VERIFICATION (PV)<br><u>(Cont'd)</u> | .2 | (Cont'd)                                                                                                           |
|                                                                                  | .2 | (Cont'd)                                                                                                           |
|                                                                                  | .8 | Cooling tower and/or industrial fluid cooler fan failure.                                                          |
|                                                                                  | .9 | Outdoor reset. Re-check heat exchanger output supply temperature at 100% and 50% reset, maximum water temperature. |
- 
- |                                                                     |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|---------------------------------------------------------------------|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.5 HYDRONIC SYSTEM<br>CAPACITY TEST<br><u>                    </u> | .1 | Timing: After:<br>.1 TAB has been completed<br>.2 Verification of operating, limit, safety controls.<br>.3 Verification of primary and secondary pump flow rates.<br>.4 Verification of accuracy of temperature and pressure sensors and gauges.                                                                                                                                                                                                                          |
|                                                                     | .2 | Calculate system capacity at test conditions.                                                                                                                                                                                                                                                                                                                                                                                                                             |
|                                                                     | .3 | Using manufacturer's published data and calculated capacity at test conditions, extrapolate system capacity at design conditions.                                                                                                                                                                                                                                                                                                                                         |
|                                                                     | .4 | When capacity test is completed, return controls and equipment status to normal operating conditions.                                                                                                                                                                                                                                                                                                                                                                     |
|                                                                     | .5 | Submit sample of system water to approved testing agency to determine if chemical treatment is correct. Include cost.                                                                                                                                                                                                                                                                                                                                                     |
|                                                                     | .6 | Heating system capacity test:<br>.1 Perform capacity test when ambient temperature is within 10% of design conditions. Simulate design conditions by:<br>.1 Increasing OA flow rates through heating coils (in this case, monitor heating coil discharge temperatures at all times to ensure that coils are not subjected to freezing conditions) or<br>.2 Reducing space temperature by turning of heating system for sufficient period of time before starting testing. |
|                                                                     | .2 | Test procedures:<br>.1 Open fully heat exchanger, heating coil and radiation control valves.                                                                                                                                                                                                                                                                                                                                                                              |
-

1.5 HYDRONIC SYSTEM .6  
CAPACITY TEST  
(Cont'd)

(Cont'd)

.2 (Cont'd)

.2 With boilers on full firing and hot water heating supply temperature stabilized, record flow rates and supply and return temperatures simultaneously.

.3 Conduct flue gas analysis test on boilers at full load and at low fire conditions.

.7 Chilled water system capacity test:

.1 Perform capacity test when ambient temperature is within 10% of design conditions. Simulate design conditions by:

.1 Adding heat from building heating system or

.2 Raising space temperature by turning off cooling and air systems for sufficient period of time before starting testing and pre-heating building to summer design space temperature (occupied) or above. Set OAD and RAD for minimum outside air if OAT is near outside design temperature or to maximum recirculation if RAT is greater than OAT. RAT to be at least 23°C.

.2 Test procedures:

.1 Open fully cooling coil control valves.

.2 Set thermostats on associated AHU's for maximum cooling.

.3 Set AHU's for design maximum air flow rates.

.4 Set load or demand limiters on chillers to 100%.

.5 After system has stabilized, record chilled water, condenser water, etc., flow rates and supply and return temperatures simultaneously.

1.6 POTABLE WATER .1  
SYSTEMS

When cleaning is completed and system filled:

.1 Verify performance of equipment and systems as specified elsewhere in Mechanical Division.

.2 Check for proper operation of water hammer arrestors. Run one outlet for 10 seconds, then shut off water immediately. If water hammer occurs, replace water hammer arrestor or recharge air chambers. Repeat for each outlet and flush valve.

- |                                                                                      |    |                                                                                                                                                      |
|--------------------------------------------------------------------------------------|----|------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>1.6 POTABLE WATER<br/>SYSTEMS<br/>(Cont'd)</u>                                    | .1 | (Cont'd)<br>.3 Confirm water quality consistent with supply standards, verifying that no residuals remain as a result of flushing and/or cleaning.   |
| <u>1.7 WET AND DRY<br/>PIPE SPRINKLER<br/>SYSTEM, STANDPIPE<br/>AND HOSE SYSTEMS</u> | .1 | Cleaning, testing, start-up, performance verification of equipment, systems, components, and devices is specified elsewhere in Mechanical Divisions. |
|                                                                                      | .2 | Verification of controls, detection devices, alarm devices is specified in Electrical Divisions.                                                     |
|                                                                                      | .3 | Demonstrate that fire hose will reach to most remote location regardless of partitions, obstructions, etc.                                           |
|                                                                                      | .4 | Verify operation of interlocks between HVAC systems and fire alarm systems.                                                                          |
| <u>1.8 SANITARY AND<br/>STORM DRAINAGE<br/>SYSTEMS</u>                               | .1 | Buried systems: Perform tests prior to back-filling. Perform hydraulic tests to verify grades and freedom from obstructions.                         |
|                                                                                      | .2 | Ensure that traps are fully and permanently primed.                                                                                                  |
|                                                                                      | .3 | Ensure that fixtures are properly anchored, connected to system.                                                                                     |
|                                                                                      | .4 | Operate flush valves, tank and operate each fixture to verify drainage and no leakage.                                                               |
|                                                                                      | .5 | Cleanouts: Refer to Section 22 42 01.                                                                                                                |
|                                                                                      | .6 | Roof drains:<br>.1 Refer to Section 22 42 01.<br>.2 Remove caps as required.                                                                         |
| <u>1.9 REPORTS</u>                                                                   | .1 | In accordance with Section 01 91 00: Reports, supplemented as specified herein.                                                                      |



## PART 1 - GENERAL

- |                                                  |    |                                                                                                                                                    |
|--------------------------------------------------|----|----------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>1.1 RELATED<br/>SECTIONS</u>                  | .1 | Section 01 74 21 - Construction/Demolition<br>Waste Management And Disposal.                                                                       |
|                                                  | .2 | Section 23 25 00 - HVAC Water Treatment<br>Systems.                                                                                                |
|                                                  | .3 | Section 23 05 93 - Testing Adjusting and<br>Balancing for HVAC.                                                                                    |
| <u>1.2 REFERENCES</u>                            | .1 | American Society for Testing and Materials<br>.1 ASTM E202-10, Standard Test Methods for<br>Analysis of Ethylene Glycols and Propylene<br>Glycols. |
| <u>1.3 WASTE<br/>MANAGEMENT AND<br/>DISPOSAL</u> | .1 | Refer to Section 01 74 20.                                                                                                                         |

## PART 2 - PRODUCTS

- |                                   |    |                                                              |
|-----------------------------------|----|--------------------------------------------------------------|
| <u>2.1 CLEANING<br/>SOLUTIONS</u> | .1 | Tri-sodium phosphate: 0.40 kg per 100 L water<br>in system.  |
|                                   | .2 | Sodium carbonate: 0.40 kg per 100 L water in<br>system.      |
|                                   | .3 | Low-foaming detergent: 0.01 kg per 100 L water<br>in system. |

## PART 3 - EXECUTION

- |                                                        |    |                                                                                                                                          |
|--------------------------------------------------------|----|------------------------------------------------------------------------------------------------------------------------------------------|
| <u>3.1 CLEANING<br/>HYDRONIC AND STEAM<br/>SYSTEMS</u> | .1 | Timing<br>.1 Systems to be operational, hydrostatically<br>tested and with safety devices functional,<br>before cleaning is carried out. |
|                                                        | .2 | Cleaning Agency:<br>.1 Retain qualified water treatment<br>specialist to perform system cleaning.                                        |
-

3.1 CLEANING  
HYDRONIC AND STEAM  
SYSTEMS  
(Cont'd)

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- .3 Cleaning procedures:
    - .1 Provide detailed report outlining proposed cleaning procedures at least 4 weeks prior to proposed starting date. Report to include:
      - .1 Cleaning procedures, flow rates, elapsed time.
      - .2 Chemicals and concentrations to be used.
      - .3 Inhibitors and concentrations.
      - .4 Specific requirements for completion of work.
      - .5 Special precautions for protecting piping system materials and components.
      - .6 Complete analysis of water to be used to ensure water will not damage systems or equipment.
  - .4 Conditions at time of cleaning of systems
    - .1 Systems to be free from construction debris, dirt and other foreign material.
    - .2 Control valves to be operational, fully open to ensure that terminal units can be cleaned properly.
    - .3 Strainers to be clean prior to initial fill.
    - .4 Install temporary filters on pumps not equipped with permanent filters.
    - .5 Install pressure gauges on strainers to detect plugging.
  - .5 Report on Completion of Cleaning
    - .1 When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.
  - .6 Hydronic Systems:
    - .1 Fill system with water, ensure air is vented from system.
    - .2 Add chemicals under direct supervision of chemical treatment supplier.
    - .3 Closed loop systems: circulate system cleaner at 60° C for at least 36 h. Drain as quickly as possible. Refill with water and inhibitors. Test concentrations and adjust to recommended levels.
    - .4 Flush velocity in system mains and branches so as to ensure removal of debris. System pumps may be used for circulating cleaning solution provided that velocities are adequate.
    - .5 Add chemical solution to system.
-

3.1 CLEANING  
HYDRONIC AND STEAM  
SYSTEMS  
(Cont'd)

- .6 (Cont'd)
- .6 Establish circulation, raise temperature slowly to maximum design 82° C minimum. Circulate for 12 h, ensuring flow in all circuits. Remove heat, continue to circulate until temperature is below 38° C. Drain as quickly as possible. Refill with clean water. Circulate for 6 h at design temperature. Drain and repeat procedures specified above. Flush through low point drains in system. Refill with clean water adding to sodium sulphite (test for residual sulphite).

3.2 START-UP OF  
HYDRONIC SYSTEMS

- .1 After cleaning is completed and system is filled:
- .1 Establish circulation and expansion tank level, set pressure controls.
- .2 Ensure air is removed.
- .3 Check pumps to be free from air, debris, possibility of cavitation when system is at design temperature.
- .4 Dismantle system pumps used for cleaning, inspect, replace worn parts, install new gaskets and new set of seals.
- .5 Clean out strainers repeatedly until system is clean.
- .6 Commission water treatment systems as specified in Section 23 25 00.
- .7 Check water level in expansion tank with cold water with circulating pumps OFF and again with pumps ON.
- .8 Repeat with water at design temperature.
- .9 Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation. Eliminate water hammer and other noises.
- .10 Bring system up to design temperature and pressure slowly over a 48 hour period.
- .11 Perform TAB as specified in Section 23 05 93.
- .12 Adjust pipe supports, hangers, springs as necessary.
- .13 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.
- .14 If sliding type expansion joints bind or if bellows type expansion joints flex incorrectly, shut down system, re-align, repeat start-up procedures.

3.2 START-UP OF  
HYDRONIC SYSTEMS  
(Cont'd)

- .1 (Cont'd)
- .15 Re-tighten bolts, etc. using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.
  - .16 Check operation of drain valves.
  - .17 Adjust valve stem packings as systems settle down.
  - .18 Fully open all balancing valves (except those that are factory-set).
  - .19 Check operation of over-temperature protection devices on circulating pumps.
  - .20 Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.

## PART 1 - GENERAL

### 1.1 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 20 - Construction/Demolition Waste Management And Disposal.
- .3 Section 01 78 00 - Closeout Submittals.
- .4 Section 23 08 02 - Cleaning and Start-Up of Mechanical Piping Systems.
- .5 Section 23 05 01 - Installation of Pipework.

### 1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
  - .1 ANSI/ASME B16.5-2009, Pipe Flanges and Flanged Fittings.
  - .2 ANSI/ASME B16.18-2012, Cast Copper Alloy Solder Joint Pressure Fittings.
  - .3 ANSI/ASME B16.22-2001(R2010), Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
  - .4 ANSI/ASME B18.2.1-2010, Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws.
- .2 ASTM International
  - .1 ASTM A47/A47M-99(R2009), Specification for Ferritic Malleable Iron Castings.
  - .2 ASTM A53/A53M-10, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
  - .3 ASTM B32-08, Specification for Solder Metal.
  - .4 ASTM B75M-99(R2011), Specification for Seamless Copper Tube Metric.
- .3 Canadian Standards Association (CSA)
  - .1 CSA W47.1-09, Certification of Companies for Fusion Welding of Steel Structures.
  - .2 CAN/CSA-B149.1-10, Natural Gas Installation Code.

### 1.3 PRODUCT DATA

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

1.4 CLOSEOUT SUBMITTALS .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00.

1.5 WASTE MANAGEMENT AND DISPOSAL .1 Separate and recycle waste materials in accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 PIPE .1 Steel pipe: to ASTM A53/A53M, Schedule 40, seamless as follows:  
.1 NPS 1/2 to 2, screwed.  
.2 NPS 2 1/2 and over, plain end.  
.2 Copper tube: to ASTM B75M.

2.2 JOINTING MATERIAL .1 Screwed fittings: pulverized lead paste.  
.2 Welded fittings: to CSA W47.1.  
.3 Flange gaskets: nonmetallic flat.  
.4 Soldered: to ASTM B32-08, tin antimony 5/5 50/50.

2.3 FITTINGS .1 Steel pipe fittings, screwed, flanged or welded:  
.1 Malleable iron: screwed, banded, Class 150.  
.2 Steel pipe flanges and flanged fittings: to ANSI/ASME B16.5.  
.3 Welding: butt-welding fittings.  
.4 Unions: malleable iron, brass to iron, ground seat, to ASTM A47/A47M.  
.5 Bolts and nuts: to ANSI/ASME B18.2.1.  
.6 Nipples: schedule 40, to ASTM A53/A53M.  
.2 Copper pipe fittings, screwed, flanged or soldered:  
.1 Cast copper fittings: to ANSI/ASME B16.18.  
.2 Wrought copper fittings: to ANSI/ASME B16.22.

- |                   |                                                                                                                                                                                          |
|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>2.4 VALVES</u> | <ul style="list-style-type: none"><li>.1 Valves 2" (50 mm) and smaller shall be ball valves.</li><li>.2 Valves 2-1/2" (65 mm) and larger shall be lubricated plug gate valves.</li></ul> |
|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

PART 3 - EXECUTION

- |                   |                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>3.1 PIPING</u> | <ul style="list-style-type: none"><li>.1 Install in accordance with Section 23 05 01, supplemented as specified herein.</li><li>.2 Install in accordance with applicable Provincial/Territorial Codes.</li><li>.3 Install in accordance with CAN/CSA B149.1.</li><li>.4 Install drip points:<ul style="list-style-type: none"><li>.1 At low points in piping system.</li><li>.2 At connections to equipment.</li></ul></li></ul> |
|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

- |                   |                                                                                                                                                                                                                                             |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>3.2 VALVES</u> | <ul style="list-style-type: none"><li>.1 Install valves with stems upright or horizontal unless otherwise approved by Consultant.</li><li>.2 Install valves at branch take-offs to isolate pieces of equipment, and as indicated.</li></ul> |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

- |                                  |                                                                                                                                                       |
|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>3.3 FIELD QUALITY CONTROL</u> | <ul style="list-style-type: none"><li>.1 Test system in accordance with CAN/CSA B149.1 and requirements of authorities having jurisdiction.</li></ul> |
|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|

- |                    |                                                                                                                 |
|--------------------|-----------------------------------------------------------------------------------------------------------------|
| <u>3.4 PURGING</u> | <ul style="list-style-type: none"><li>.1 Purge after pressure test in accordance with CAN/CSA B149.1.</li></ul> |
|--------------------|-----------------------------------------------------------------------------------------------------------------|

- |                                     |                                                                                                                                                                                                                                                                                     |
|-------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>3.5 PRE-START-UP INSPECTIONS</u> | <ul style="list-style-type: none"><li>.1 Check vents from regulators, control valves, terminate outside building in approved location, protected against blockage, damage.</li><li>.2 Check gas trains, entire installation is approved by authority having jurisdiction.</li></ul> |
|-------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
-

|                                      |    |                                                                           |
|--------------------------------------|----|---------------------------------------------------------------------------|
| <u>3.6 CLEANING AND<br/>START-UP</u> | .1 | In accordance with Section 23 08 02,<br>supplemented as specified herein. |
|--------------------------------------|----|---------------------------------------------------------------------------|

|  |    |                                                       |
|--|----|-------------------------------------------------------|
|  | .2 | In accordance with requirements of<br>CAN/CSA B149.1. |
|--|----|-------------------------------------------------------|

|                                                |    |                            |
|------------------------------------------------|----|----------------------------|
| <u>3.7 PERFORMANCE<br/>VERIFICATION (P.V.)</u> | .1 | Refer to Section 23 08 01. |
|------------------------------------------------|----|----------------------------|



PART 1 - GENERAL

1.1 SUMMARY

- .1 Section Includes:
  - .1 Copper piping valves and fittings for hydronic systems.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/American Welding Society (AWS)
  - .1 ANSI/AWS A5.8/A5.8M-2011, Specification Filler Metals for Brazing and Bronze Welding.
- .2 American Society of Mechanical Engineers (ASME)
  - .1 ANSI/ASME B16.4-2006, Gray Iron Threaded Fittings.
  - .2 ANSI/ASME B16.15-2006, Cast Bronze Threaded Fittings.
  - .3 ANSI B16.18-2001(R2005), Cast Copper Alloy, Solder Joint Pressure Fittings.
  - .4 ANSI/ASME B16.22-2001(R2005), Wrought Copper and Copper-Alloy Solder Joint Pressure Fittings.
- .3 American Society for Testing and Materials International (ASTM)
  - .1 ASTM B32-08, Standard Specification for Solder Metal.
  - .2 ASTM B61-08, Standard Specification for Steam or Valve Bronze Castings.
  - .3 ASTM B62-09, Standard Specification for Composition Bronze or Ounce Metal Castings.
  - .4 ASTM B88M-05, Standard Specification for Seamless Copper Water Tube Metric.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).
- .5 Manufacturers Standardization Society (MSS)
  - .1 MSS SP-67-2002a, Butterfly Valves.
  - .2 MSS SP-70-2006, Gray Iron Gate Valves, Flanged and Threaded Ends.
  - .3 MSS SP-71-2005, Gray Iron Swing Check Valves, Flanged and Threaded Ends.
  - .4 MSS SP-80-2008, Bronze Gate, Globe, Angle and Check Valves.
  - .5 MSS SP-85-2002, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.3 SUBMITTALS

- .1 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00. Include product characteristics, performance criteria, and limitations.
- .2 Shop Drawings:
  - .1 Submit shop drawings in accordance with Section 01 33 00.
    - .1 Shop drawings: submit drawings
  - .2 Indicate on manufacturers catalogue literature the following: VALVES.
- .3 Quality assurance submittals: submit following in accordance with Section 01 33 00.
- .4 Closeout Submittals:
  - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00.

1.4 QUALITY  
ASSURANCE

- .1 Regulatory Requirements: ensure Work is performed in compliance with CEPA, CEAA, TDGA, and applicable Provincial /Territorial regulations.
- .2 Health and Safety:
  - .1 Do construction occupational health and safety in accordance with Section 01 35 29.

1.5 DELIVERY,  
STORAGE, AND  
HANDLING

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00.

PART 2 - PRODUCTS

2.1 PIPE

- .1 Type L copper tubing: to ASTM B88M, minimum 64% recycled content.
- .2 Type "L" hard drawn copper tubing conforming to ASTM B88. Type "L" soft annealed copper tubing may be used within convactor/fan coil enclosures.

- 
- 2.1 PIPE  
(Cont'd)
- .3 Type "K" soft annealed copper tubing conforming to ASTM B88 with no joints permitted below the floor for below grade applications. Use approved tube bender for tube bending.
- 2.2 FITTINGS
- .1 Cast bronze threaded fittings: to ANSI/ASME B16.15.
- .2 Wrought copper and copper alloy solder joint pressure fittings: to ANSI/ASME B16.22, minimum 64% recycled content.
- .3 Cast iron threaded fittings: to ANSI/ASME B16.4, minimum 25% recycled content.
- .4 Cast copper alloy solder joint pressure fittings: to ANSI B16.18, minimum 64% recycled content.
- 2.3 FLANGES
- .1 Brass or bronze: threaded.
- .2 Cast iron: threaded.
- 2.4 JOINTS
- .1 Solder, tin-antimony, 95:5: to ASTM B32.
- .2 Silver solder BCUP: to ANSI/AWS A5.8.
- .3 Brazing: as indicated.
- 2.5 VALVES
- .1 Connections:
- .1 NPS 2 and smaller: ends for soldering.
- .2 NPS 2 1/2 and larger: flanged or grooved ends.
- .2 Gate Valves Application: isolating equipment, control valves, pipelines:
- .1 NPS 2 and under:
- .1 Mechanical Rooms: Class 125, rising stem split wedge disc, as specified Section 23 05 23.01.
- .2 Elsewhere: Class 125, non- rising stem, solid wedge disc, as specified Section 23 05 23.01.
- .2 NPS 2 1/2 and over:
-

2.5 VALVES  
(Cont'd)

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- .2 (Cont'd)
  - .2 (Cont'd)
    - .1 Mechanical Rooms: rising stem, split wedge disc, bronze trim, as specified Section 23 05 23.02.
- .3 Butterfly valves: application: isolating each cell or section of multiple component equipment (eg. multi-section coils):
  - .1 NPS 2 1/2 and over: lug type grooved ends: as specified Section 23 05 17.
- .4 Globe valves: application: throttling, flow control, emergency bypass:
  - .1 NPS 2 and under:
    - .1 Mechanical Rooms: with PTFE disc, as specified Section 23 05 23.01.
    - .2 Elsewhere: globe, with composition disc, as specified Section 23 05 23.01.
  - .2 NPS 2 1/2 and over:
    - .1 With composition bronze disc, bronze trim, as specified Section 23 05 23.02.
- .5 Balancing, for TAB:
  - .1 Sizes: calibrated balancing valves, as specified.
  - .2 NPS 2 and under:
    - .1 Mechanical Rooms: globe, with plug disc as specified Section 23 05 23.01.
    - .2 Elsewhere: globe, with plug disc as specified Section 23 05 23.01.
- .6 Drain valves: gate, Class 125, non-rising stem, solid wedge disc, as specified Section 23 05 23.01.
- .7 Bypass valves on gate globe valves NPS 8 and larger: NPS 3/4, globe, with PTFE disc as specified Section 23 05 23.01.
- .8 Swing check valves:
  - .1 NPS 2 and under:
    - .1 Class 125, swing, with composition disc, as specified Section 23 05 23.01.
    - .2 NPS 2 1/2 and over:
      - .1 Flanged Grooved ends: as specified Section 23 05 23.02.
- .9 Silent check valves:
  - .1 NPS 2 and under:
    - .1 As specified Section 23 05 23.01.
  - .2 NPS 2 1/2 and over:

- |                                      |                                                                                                                                                                                                      |
|--------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>2.5 VALVES</u><br><u>(Cont'd)</u> | <p>.9 (Cont'd)</p> <p>.2 (Cont'd)</p> <p>.1 Flanged Grooved ends: as specified<br/>Section 23 05 23.02.</p> <p>.10 Ball valves:</p> <p>.1 NPS 2 and under: as specified<br/>Section 23 05 23.01.</p> |
|--------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

PART 3 - EXECUTION

- |                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|--------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>3.1 MANUFACTURER'S</u><br><u>INSTRUCTIONS</u> | <p>.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <u>3.2 PIPING</u><br><u>INSTALLATION</u>         | <p>.1 Connect to equipment in accordance with manufacturer's instruction unless otherwise indicated.</p> <p>.2 Install concealed pipes close to building structure to keep furring space to minimum. Install to conserve headroom and space. Run exposed piping parallel to walls. Group piping where ever practical.</p> <p>.3 Slope piping in direction of drainage and for positive venting.</p> <p>.4 Use eccentric reducers at pipe size change installed to provide positive drainage or positive venting.</p> <p>.5 Provide clearance for installation of insulation and access for maintenance of equipment, valves and fittings.</p> <p>.6 Assemble piping using fittings manufactured to ANSI standards.</p> |
| <u>3.3 VALVE</u><br><u>INSTALLATION</u>          | <p>.1 Install rising stem valves in upright position with stem above horizontal.</p> <p>.2 Install butterfly valves on chilled water only.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

3.3 VALVE  
INSTALLATION  
(Cont'd)

- .3 Install ball or butterfly valves at branch take-offs and to isolate each piece of equipment, and as indicated.
- .4 Install globe valves for balancing and in by-pass around control valves as indicated.
- .5 Install silent check valves on discharge of pumps and in vertical pipes with downward flow and as indicated.
- .6 Install swing check valves in horizontal lines on discharge of pumps and as indicated.
- .7 Install chain operators on valves NPS 2 1/2 and over where installed more than 2400 mm above floor in Mechanical Equipment Rooms.
- .8 Install plug cocks or ball valves for glycol service.

3.4 CIRCUIT  
BALANCING VALVES

- .1 Install flow measuring stations and flow balancing valves as indicated.
- .2 Remove handwheel after installation and TAB is complete.
- .3 Tape joints in prefabricated insulation on valves installed in chilled water mains.

3.5 FLUSHING AND  
CLEANING

- .1 Flush and clean in presence of Departmental Representative.
- .2 Flush after pressure test for a minimum of 4h.
- .3 Fill with solution of water and non-foaming, phosphate-free detergent 3% solution by weight. Circulate for minimum of 8h.
- .4 Refill system with clean water. Circulate for at least 4h. Clean out strainer screens/baskets regularly. Then drain.
- .5 Refill system with clean water. Circulate for at least 2h. Clean out strainer screens/baskets regularly. Then drain.
- .6 Drainage to include drain valves, dirt pockets, strainers, low points in system.

3.5 FLUSHING AND  
CLEANING  
(Cont'd)

- .7 Re-install strainer screens/baskets only after obtaining Departmental Representative's approval.

3.6 FILLING OF  
SYSTEM  
                    

- .1 Refill system with clean water adding water treatment.

3.7 FIELD QUALITY  
CONTROL  
                    

- .1 Testing:  
.1 Test system in accordance with Section 21 05 01.
- .2 Balancing:  
.1 Balance water systems to within plus or minus 5 % of design output.  
.2 Refer to Section for applicable procedures.

PART 1 - GENERAL

1.1 REFERENCES

- .1 American National Standards Institute/American Water Works Association (ANSI/AWWA)
    - .1 ANSI/AWWA C111/A21.11-12, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
  - .2 American Society of Mechanical Engineers (ASME)
    - .1 ASME B16.1-10, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
    - .2 ASME B16.3-11, Malleable Iron Threaded Fittings: Classes 150 and 300.
    - .3 ASME B16.5-09, Pipe Flanges and Flanged Fittings: NPS ½ through NPS 24 Metric/Inch Standard.
    - .4 ASME B16.9-07, Factory-Made Wrought Buttwelding Fittings.
    - .5 ASME B18.2.1-10, Square Hex, Heavy Hex and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Loded Head and Lag Screws (Inch Series).
    - .6 ASME B18.2.2-10, Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series).
  - .3 ASTM International
    - .1 ASTM A47/A47M-99(2009), Standard Specification for Ferritic Malleable Iron Castings.
    - .2 ASTM A53/A53M-10, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
    - .3 ASTM A536-84(2009), Standard Specification for Ductile Iron Castings.
    - .4 ASTM B61-08, Standard Specification for Steam or Valve Bronze Castings.
    - .5 ASTM B62-09, Standard Specification for Composition Bronze or Ounce Metal Castings.
  - .4 CSA International
    - .1 CSA B242-05(R2011), Groove and Shoulder Type Mechanical Pipe Couplings.
    - .2 CSA W48-06, Filler Metals and Allied Materials for Metal Arc Welding.
  - .5 Manufacturer's Standardization of the Valve and Fittings Industry (MSS)
    - .1 MSS-SP-67-2002a, Butterfly Valves.
    - .2 MSS-SP-70-06, Gray Iron Gate Valves, Flanged and Threaded Ends.
-



1.1 REFERENCES  
(Cont'd)

- .5 (Cont'd)
- .3 MSS-SP-71-05, Gray Iron Swing Check Valves Flanged and Threaded Ends.
- .4 MSS-SP-80-08, Bronze Gate, Globe, Angle and Check Valves.
- .5 MSS-SP-85-02, Gray Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.2 ACTION AND  
INFORMATIONAL  
SUBMITTALS

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

1.3 CLOSEOUT  
SUBMITTALS

- .1 Submit in accordance with Section 01 78 00.

1.4 DELIVERY,  
STORAGE AND  
HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 and with manufacturer's written instructions.
- .2 Refer to Section 01 74 20.

PART 2 - PRODUCTS

2.1 PIPE

- .1 Steel pipe: to ASTM A53/A53M, Grade B, as follows:
  - .1 To NPS 6: Schedule 40.

2.2 PIPE JOINTS

- .1 NPS 2 and under: screwed fittings with PTFE tape or lead-free pipe dope.
- .2 NPS 2-1/2 and over: welding fittings and flanges to CSA W48.

2.2 PIPE JOINTS  
(Cont'd)

- .3 Roll grooved: standard rigid coupling to CSA B242.
- .4 Flanges: plain or raised face, slip-on weld neck to ANSI/AWWA C111/A21.11.
- .5 Flange gaskets: to ANSI/AWWA C111/A21.11.
- .6 Pipe thread: taper.
- .7 Bolts and nuts: to ASME B18.2.1 and ASME B18.2.2.
- .8 Roll grooved coupling gaskets: type EPDM.

2.3 FITTINGS

- .1 Screwed fittings: malleable iron, to ASME B16.3, Class 150.
- .2 Pipe flanges and flanged fittings:
  - .1 Cast iron: to ASME B16.1, Class 125.
  - .2 Steel: to ASME B16.5.
- .3 Butt-welding fittings: steel, to ASME B16.9.
- .4 Unions: malleable iron, to ASTM A47/A47M and ASME B16.3.
- .5 Fittings for roll grooved piping: malleable iron to ASTM A47/A47M ductile iron to ASTM A536.

2.4 VALVES

- .1 Connections:
  - .1 NPS 2 and smaller: screwed ends.
  - .2 NPS 2-1/2 and larger: flanged or grooved ends.
- .2 Gate valves: to MSS-SP-70 to MSS-SP-80 application: isolating equipment, control valves, pipelines:
  - .1 NPS 2 and under:
    - .1 Mechanical Rooms: Class 125, rising stem, split wedge disc, as specified Section 23 05 23.01.
    - .2 Elsewhere: Class 125, non- rising stem, solid wedge disc, as specified Section 23 05 23.01.
  - .2 NPS 2-1/2 and over:
    - .1 Mechanical Rooms: rising stem, split wedge disc, lead free bronze trim, as specified Section 23 05 23.02.

2.4 VALVES  
(Cont'd)

---

- .2 (Cont'd)
  - .2 (Cont'd)
    - .1 Operators: chain manual gear.
    - .2 Elsewhere: non- rising stem, solid wedge disc, lead free bronze trim, as specified Section 23 05 23.02.
- .3 Butterfly valves: to MSS-SP-67 application: isolating cells or section of multiple component equipment (i.e. multi-section coils, multi-cell cooling towers):
  - .1 NPS 2-1/2 and over: lug type grooved ends: as specified Section 23 05 17.
- .4 Globe valves: to MSS-SP- 80 85 application: throttling, flow control, emergency bypass:
  - .1 NPS 2 and under:
    - .1 Mechanical Rooms: with PTFE disc, as specified Section 23 05 23.01.
    - .2 Elsewhere: globe, with composition disc, as specified in Section 23 05 23.01
  - .2 NPS 2-1/2 and over:
    - .1 With composition lead free bronze disc, lead free bronze trim, as specified Section 23 05 23.02.
- .5 Balancing, for TAB:
  - .1 Sizes: calibrated balancing valves, as specified this section.
  - .2 NPS 2 and under:
    - .1 Mechanical Rooms: globe, with plug disc as specified Section 23 05 23.01.
    - .2 Elsewhere: globe, with plug disc as specified Section 23 05 23.01.
- .6 Drain valves: Gate, Class 125, non-rising stem, solid wedge disc, as specified Section 23 05 23.01.
- .7 Bypass valves on gate globe valves NPS 8 and larger: NPS 3/4, Globe, with PTFE disc as specified Section 23 05 23.01.
- .8 Swing check valves: to MSS-SP-71.
  - .1 NPS 2 and under:
    - .1 Class 125, swing, with composition disc, as specified Section 23 05 23.01.
  - .2 NPS 2-1/2 and over:
    - .1 Flanged Grooved ends: as specified Section 23 05 23.02.
- .9 Silent check valves:
  - .1 NPS 2 and under:

- 2.4 VALVES  
(Cont'd)
- .9 (Cont'd)
- .1 (Cont'd)
- .1 As specified Section 23 05 23.01.
- .2 NPS 2-1/2 and over:
- .1 Flanged Grooved ends: as specified  
Section 23 05 23.02.
- .10 Ball valves:
- .1 NPS 2 and under: as specified  
Section 23 05 23.01.

PART 3 - EXECUTION

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

- 3.2 PIPING  
INSTALLATION
- .1 Install pipework in accordance with  
Section 23 05 05.

- 3.3 CIRCUIT  
BALANCING VALVES
- .1 Install flow measuring stations and flow  
balancing valves as indicated.
- .2 Remove handwheel after installation and when TAB  
is complete.
- .3 Tape joints in prefabricated insulation on  
valves installed in chilled water mains.

- 3.4 CLEANING,  
FLUSHING AND  
START-UP
- .1 In accordance with Section 23 08 02.

3.5 TESTING .1 Test system in accordance with Section 21 05 01.

3.6 BALANCING .1 Balance water systems to within plus or minus 5%  
of design output.  
.2 In accordance with Section 23 05 93 for  
applicable procedures.

3.7 PERFORMANCE  
VERIFICATION .1 In accordance with Section 23 08 01.

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

3.9 PROTECTION .1 Protect installed products and components from  
damage during construction.  
.2 Repair damage to adjacent materials caused by  
hydronic systems installation.

PART 1 - GENERAL

1.1 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
  - .1 ASME-04(2007), Boiler and Pressure Vessel Code.
- .2 ASTM International Inc.
  - .1 ASTM A47/A47M-99(2009), Standard Specification for Ferritic Malleable Iron Castings.
  - .2 ASTM A278/A278M-01(2006), Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 650 degrees F (350 degrees C).
  - .3 ASTM A516/A516M-06, Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate - and Lower - Temperature Service.
  - .4 ASTM A536-84(2009), Standard Specification for Ductile Iron Castings.
  - .5 ASTM B62-09, Standard Specification for Composition Bronze or Ounce Metal Castings.
- .3 Canadian Standards Association (CSA International)
  - .1 CSA B51-09, Boiler, Pressure Vessel, and Pressure Piping Code.
  - .2 CSA B51-09, Boiler, Pressure Vessel, and Pressure Piping Code, Supplement #1.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature and datasheets for expansion tanks, air vents, separators, valves, and strainers, and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Provide drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit maintenance and operation data in accordance with Section 01 23 00.

1.4 DELIVERY,  
STORAGE AND  
HANDLING

- .1 Deliver, store and handle in accordance with Section 01 61 00.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

PART 2 - PRODUCTS

2.1 SUSTAINABLE  
REQUIREMENTS

- .1 Materials and products in accordance with Section 01 47 15.

2.2 DIAPHRAGM TYPE  
EXPANSION TANK

- .1 Horizontal steel pressurized diaphragm type expansion tank.
- .2 Capacity: As indicated in schedule.
- .3 Size: As indicated in schedule.
- .4 Diaphragm sealed in EPDM suitable for 115 degrees C operating temperature.
- .5 Working pressure: 860 kPa with ASME stamp and certification 520 kPa.
- .6 Air precharged to (initial fill pressure of system).
- .7 Saddles for horizontal installation Base mount for vertical installation.
- .8 Supports: provide supports with hold down bolts and installation templates.
- .9 Renewable diaphragm.

2.3 AUTOMATIC AIR  
VENT

- .1 Standard float vent: brass body and NPS 1/8 connection and rated at 310 620 690 kPa working pressure.
- .2 Industrial float vent: cast iron body and NPS 1/2 connection and rated at 860 kPa working pressure.
- .3 Float: solid material suitable for 115 degrees C working temperature.

- |                                        |    |                                                                                                           |
|----------------------------------------|----|-----------------------------------------------------------------------------------------------------------|
| <u>2.4 AIR SEPARATOR -<br/>IN-LINE</u> | .1 | Working pressure: 860 kPa.                                                                                |
|                                        | .2 | Size: as indicated.                                                                                       |
|                                        |    |                                                                                                           |
| <u>2.5 PIPE LINE<br/>STRAINER</u>      | .1 | NPS 1/2 to 2: bronze body to ASTM B62, solder end screwed connections, Y pattern.                         |
|                                        | .2 | NPS 2 1/2 to 12: cast iron body to ASTM A278/A278M, Class 30 flanged connections.                         |
|                                        | .3 | NPS 2 to 12: T type with ductile iron body to ASTM A536 grooved ends.                                     |
|                                        | .4 | Blowdown connection: NPS 1.                                                                               |
|                                        | .5 | Screen: brass with 1.19 mm perforations.                                                                  |
|                                        | .6 | Working pressure: 860 kPa.                                                                                |
|                                        |    |                                                                                                           |
| <u>2.6 SUCTION<br/>DIFFUSER</u>        | .1 | Body: cast iron with flanged connections.                                                                 |
|                                        | .2 | Strainer: with built-in, disposable 1.19 mm mesh, low pressure drop screen and NPS 1 blowdown connection. |
|                                        | .3 | Permanent magnet particle trap.                                                                           |
|                                        | .4 | Full length straightening vanes.                                                                          |
|                                        | .5 | Pressure gauge tappings.                                                                                  |
|                                        | .6 | Adjustable support leg.                                                                                   |

### PART 3 - EXECUTION

- |                        |    |                                                                                                                                                                                          |
|------------------------|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>3.1 APPLICATION</u> | .1 | Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets. |
|                        |    |                                                                                                                                                                                          |
| <u>3.2 GENERAL</u>     | .1 | Run drain lines and blow off connections to terminate above nearest drain.                                                                                                               |
-



3.2 GENERAL  
(Cont'd)

- .2 Maintain adequate clearance to permit service and maintenance.
- .3 Should deviations beyond allowable clearances arise, request and follow Departmental Representative's directive.
- .4 Check shop drawings for conformance of tappings for ancillaries and for equipment operating weights.

3.3 STRAINERS

- .1 Install in horizontal or down flow lines.
- .2 Ensure clearance for removal of basket.
- .3 Install ahead of each pump.
- .4 Install ahead of each automatic control valve larger than NPS 1 and radiation except at radiation and as indicated.

3.4 SUCTION  
DIFFUSERS

- .1 Install on inlet to pumps having suction size greater than 50.

PART 1 - GENERAL

1.1 REFERENCES

- .1 American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE)
  - .1 Standard 90.1-2010, Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 Electrical Equipment Manufacturers Advisory Council (EEMAC)
- .3 Canadian Standards Association (CSA International)
  - .1 CSA-B214-07, Installation Code for Hydronic Heating Systems.
- .4 National Electrical Manufacturers' Association (NEMA)
  - .1 NEMA MG 1-2006, Motors and Generators.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature and datasheets for pump, circulator, and equipment, and include product characteristics, performance criteria, physical size, finish and limitations indicate point of operation, and final location in field assembly.

1.3 CLOSEOUT SUBMITTALS

- .1 Provide maintenance and operation data for incorporation into manual specified in Section 01 78 00.

1.4 MAINTENANCE

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

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 61 00.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

1.5 DELIVERY,  
STORAGE AND  
HANDLING  
(Cont'd)

.3 Refer to Section 01 74 20.

PART 2 - PRODUCTS

2.1 IN-LINE  
CIRCULATORS

- .1 Volute: cast iron radially split, with screwed or flanged design suction and discharge connections.
- .2 Impeller: cast bronze.
- .3 Shaft: alloy steel with bronze sleeve bearing, integral thrust collar.
- .4 Seal assembly: mechanical for service to 135 °C.
- .5 Coupling: flexible self-aligning.
- .6 Motor: to NEMA MG 1 resilient mounted, drip proof, sleeve bearing, efficiency.
- .6 Premium as per Section 23 05 14.
- .7 Capacity: as indicated.
- .8 Design pressure: 860 kPa.
- .9 Standard of Acceptance: Armstrong, ITT, Bell and Gossett, Talo.

2.2 VERTICAL  
IN-LINE CIRCULATORS

- .1 Volute: cast iron radially split, with tapped openings for venting, draining and gauge connections, with screwed or flanged suction and discharge connections.
- .2 Impeller: brass or bronze.
- .3 Shaft: alloy steel with bronze sleeve bearing, integral thrust collar.
- .4 Seal assembly: mechanical for service to 135 °C.
- .5 Coupling: flexible rigid self-aligning.
- .6 Motor: to NEMA MG 1 resilient mounted, drip proof, sleeve bearing.

2.2 VERTICAL  
IN-LINE CIRCULATORS  
(Cont'd)

- .7 Capacity: as indicated.
- .8 Design pressure: 1200 kPa.
- .9 Standard of Acceptance: Armstrong Series: 4300/4380, ITT: Series 80, Taco.

2.3 SINGLE SUCTION  
CENTRIFUGAL PUMP

- .1 General: bronze fitted all iron pump complete with motor.
- .2 Base: common cast iron with drip rim and tapping for drain connection.
- .3 Volute: cast iron radially split, end suction, flanged suction and discharge, with drain plug and vent cock, suction and discharge pressure gauge tapings.
- .4 Impeller: bronze enclosed type, keyed drive with locking nut or screw.
- .5 Shaft: stainless steel with two point support, sleeve bearings.
- .6 Seal assembly: on mechanical seal, grease lubricated.
- .7 Coupling: flexible self-aligning.
- .8 Motor: As per section.
- .9 Capacity: as indicated.
- .10 Design pressure: 1200 kPa.

PART 3 - EXECUTION

3.1 APPLICATION

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

3.2 INSTALLATION

- .1 Install hydronic pumps to: CSA-B214.

3.2 INSTALLATION  
(Cont'd)

- .2 In line circulators: install as indicated by flow arrows.
  - .1 Support at inlet and outlet flanges or unions.
  - .2 Install with bearing lubrication points accessible.
- .3 Base mounted type: supply templates for anchor bolt placement.
  - .1 Include anchor bolts with sleeves. Place level, shim unit and grout.
  - .2 Align coupling in accordance with manufacturer's recommended tolerance.
  - .3 Check oil level and lubricate.
- .4 Ensure that pump body does not support piping or equipment.
  - .1 Provide stanchions or hangers for this purpose.
  - .2 Refer to manufacturer's installation instructions for details.
- .5 Pipe drain tapping to floor drain.
- .6 Install volute venting pet cock in accessible location.
- .7 Check rotation prior to start-up.
- .8 Install pressure gauge test cocks.

3.3 START-UP

- .1 General:
  - .1 In accordance with Section 01 91 13: General Requirements; supplementd as specified herein.
  - .2 In accordance with manufacturer's recommendations.
- .2 Procedures:
  - .1 Before starting pump, check that cooling water system over-temperature and other protective devices are installed and operative.
  - .2 After starting pump, check for proper, safe operation.
  - .3 Check installation, operation of mechanical seals, packing gland type seals. Adjust as necessary.
  - .4 Check base for free-floating, no obstructions under base.
  - .5 Run-in pumps for 12 continuous hours minimum.

3.3 START-UP

(Cont'd)

- .2 (Cont'd)
  - .6 Verify operation of over-temperature and other protective devices under low- and no-flow condition.
  - .7 Eliminate air from scroll casing.
  - .8 Adjust water flow rate through water-cooled bearings.
  - .9 Adjust flow rate from pump shaft stuffing boxes to manufacturer's recommendation.
  - .10 Adjust alignment of piping and conduit to ensure true flexibility.
  - .11 Eliminate cavitation, flashing and air entrainment.
  - .12 Adjust pump shaft seals, stuffing boxes, glands.
  - .13 Measure pressure drop across strainer when clean and with flow rates as finally set.
  - .14 Replace seals if pump used to degrease system or if pump used for temporary heat.
  - .15 Verify lubricating oil levels.

3.4 PERFORMANCE  
VERIFICATION (PV)

- .1 General:
  - .1 Verify performance in accordance with Section 01 91 13: General Requirements, supplemented as specified herein.
  - .2 Verify that manufacturer's performance curves are accurate.
- .2 Ensure valves on pump suction and discharge provide tight shut-off.
- .3 Mark points of design and actual performance at design conditions as finally set upon completion of TAB.
- .4 Commissioning Reports: in accordance with Section 01 91 00 reports

3.5 CLEANING

- .1 Clean in accordance with Section 01 74 11.
  - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.

## PART 1 - GENERAL

|                             |    |                                              |
|-----------------------------|----|----------------------------------------------|
| <u>1.1 RELATED SECTIONS</u> | .1 | Section 23 05 01 - Installation of Pipework. |
|-----------------------------|----|----------------------------------------------|

|                       |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-----------------------|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>1.2 REFERENCES</u> | .1 | American National Standards Institute (ANSI)/<br>American Society of Mechanical Engineers (ASME)<br>.1 ANSI/ASME B16.22-2001(R2010), Wrought<br>Copper and Copper Alloy Solder - Joint Pressure<br>Fittings.<br>.2 ANSI/ASME B16.24-2011, Cast Copper Pipe<br>Flanges and Flanged Fittings: Class 150, 300,<br>400, 600, 900, 1500 and 2500.<br>.3 ANSI/ASME B16.26-2011, Cast Copper Alloy<br>Fittings for Flared Copper Tubes.<br>.4 ANSI/ASME B31.5-2010, Refrigeration Piping<br>and Heat Transfer Components. |
|                       | .2 | ASTM International<br>.1 ASTM A307-10, Specification for Carbon<br>Steel Bolts and Studs, 60,000 PSI Tensile<br>Strength.<br>.2 ASTM B280-08, Specification for Seamless<br>Copper Tube for Air Conditioning and<br>Refrigeration Field Service.                                                                                                                                                                                                                                                                   |
|                       | .3 | Canadian Standards Association (CSA)<br>.1 CSA B52-05(R2009), Mechanical<br>Refrigeration Code.                                                                                                                                                                                                                                                                                                                                                                                                                    |
|                       | .4 | Environment Canada (EC)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                       | .5 | EPS 1/RA/1-96, Environmental Code of Practice<br>for the Reduction of Fluorocarbon Emissions<br>from Refrigeration and Air Conditioning<br>Systems.                                                                                                                                                                                                                                                                                                                                                                |

|                                          |    |                                                                              |
|------------------------------------------|----|------------------------------------------------------------------------------|
| <u>1.3 WASTE MANAGEMENT AND DISPOSAL</u> | .1 | Separate and recycle waste materials in<br>accordance with Section 01 74 20. |
|------------------------------------------|----|------------------------------------------------------------------------------|

## PART 2 - PRODUCTS

- |                         |    |                                                                                                                                                                                                                  |
|-------------------------|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>2.1 TUBING</u>       | .1 | Processed for refrigeration installations, deoxidized, dehydrated and sealed.<br>.1 Hard copper: to ASTM B88.<br>.2 Annealed copper: to ASTM B280, with minimum wall thickness as per CSA B52 and ASME B31.5.    |
| <u>2.2 FITTINGS</u>     | .1 | Service: design pressure 2070 kPa and temperature 121°C.                                                                                                                                                         |
|                         | .2 | Brazed:<br>.1 Fittings: wrought copper to ASME B16.22.<br>.2 Joints: silver solder, 45% Ag-15% Cu or copper-phosphorous, 95% Cu-5%P and non-corrosive flux.                                                      |
|                         | .3 | Flanged:<br>.1 Bronze or brass, to ASME B16.24, Class 150 and Class 300.<br>.2 Gaskets: suitable for service.<br>.3 Bolts, nuts and washers: to ASTM A307, heavy series.                                         |
|                         | .4 | Flared:<br>.1 Bronze or brass, for refrigeration, to ASME B16.26.                                                                                                                                                |
| <u>2.3 PIPE SLEEVES</u> | .1 | Hard copper or steel, sized to provide 6 mm clearance around between sleeve and uninsulated pipe or between sleeve and insulation.                                                                               |
| <u>2.4 VALVES</u>       | .1 | 22 mm and under: Class 500, 3.5 Mpa, globe or angle non-directional type, diaphragm, packless type, with forged brass body and bonnet, moistureproof seal for below freezing applications, brazed connections.   |
|                         | .2 | Over 22 mm: Class 375, 2.5 Mpa, globe or angle type, diaphragm, packless type, back-seating, cap seal, with cast bronze body and bonnet, moistureproof seal for below freezing applications, brazed connections. |



### PART 3 - EXECUTION

#### 3.1 GENERAL

- .1 In accordance with Section 23 05 01, supplemented as specified herein
- .2 Install in accordance with CSA B52, EPS1/RA/1 and ASME B31.5.

#### 3.2 BRAZING PROCEDURES

- .1 Bleed inert gas into pipe during brazing.
- .2 Remove valve internal parts, solenoid valve coils, sight glass.
- .3 Do not apply heat near expansion valve and bulb.

#### 3.3 PIPING INSTALLATION

- .1 General:
  - .1 Soft annealed copper tubing: bend without crimping or constriction Hard drawn copper tubing: do not bend. Minimize use of fittings.
- .2 Hot gas lines:
  - .1 Pitch at least 1:240 down in direction of flow to prevent oil return to compressor during operation.
  - .2 Provide trap at base of risers greater than 2400 mm high and at each 7600 mm thereafter.
  - .3 Provide inverted deep trap at top of risers.
  - .4 Provide double risers for compressors having capacity modulation.
    - .1 Large riser: install traps as specified above.
    - .2 Small riser: size for 5.1 m/s at minimum load. Connect upstream of traps on large riser.

#### 3.4 PRESSURE AND LEAK TESTING

- .1 Close valves on factory charged equipment and other equipment not designed for test pressures.
- .2 Leak test to CSA B52 before evacuation to 2MPa and 1MPa on high and low sides respectively.

3.4 PRESSURE AND  
LEAK TESTING  
(Cont'd)

- .3 Test Procedure: Build pressure up to 35 kPa with refrigerant gas on high and low sides. Supplement with nitrogen to required test pressure. Test for leaks with electronic or halide detector. Repair leaks and repeat tests.

3.5 DEHYDRATION AND  
CHARGING

- .1 Close service valves on factory charged equipment.
- .2 Ambient temperatures to be at least 13°C for at least 12 hours before and during dehydration.
- .3 Use copper lines of largest practical size to reduce evacuation time.
- .4 Use two-stage vacuum pump with gas ballast on 2nd stage capable of pulling 5Pa absolute and filled with dehydrated oil.
- .5 Measure system pressure with vacuum gauge. Take readings with valve between vacuum pump and system closed.
- .6 Triple evacuate system components containing gases other than correct refrigerant or having lost holding charge as follows:
  - .1 Twice to 14Pa absolute and hold for 4 h.
  - .2 Break vacuum with refrigerant to 14kPa.
  - .3 Final to 5Pa absolute and hold for at least 12 h.
  - .4 Isolate pump from system, record vacuum and time readings until stabilization of vacuum.
  - .5 Submit test results to Departmental Representative.
- .7 Charging:
  - .1 Charge system through filter-drier and charging valve on high side. Low side charging not permitted.
  - .2 With compressors off, charge only amount necessary for proper operation of system. If system pressures equalize before system is fully charged, close charging valve and start up. With unit operating, add remainder of charge to system.
  - .3 Re-purge charging line if refrigerant container is changed during charging process.
- .8 Checks:

- |                                                 |    |                                                                                                                                                                                |
|-------------------------------------------------|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3.5 DEHYDRATION AND CHARGING<br><u>(Cont'd)</u> | .8 | (Cont'd)<br>.1 Make checks and measurements as per manufacturer's operation and maintenance instructions.<br>.2 Record and report measurements to Departmental Representative. |
| <u>3.6 INSTRUCTIONS</u>                         | .1 | Post instructions in frame with glass cover in accordance with Section 01 78 00 and CSA B52.                                                                                   |

PART 1 - GENERAL

- |                                                  |                                                                                                                                                                                           |
|--------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>1.1 REFERENCES</u>                            | .1 American Society of Mechanical Engineers (ASME)<br>.1 ASME Boiler and Pressure Vessel Code,<br>Section VII-2010.                                                                       |
| <u>1.2 SHOP DRAWINGS</u>                         | .1 Submit shop drawings in accordance with<br>Section 01 33 00.                                                                                                                           |
| <u>1.3 CLOSEOUT<br/>SUBMITTALS</u>               | .1 Submit operation and maintenance data for<br>incorporation into manual specified in<br>Section 01 78 00.<br><br>.2 Include following:<br>.1 Log sheets as recommended by manufacturer. |
| <u>1.4 WASTE<br/>MANAGEMENT AND<br/>DISPOSAL</u> | .1 Refer to Section 01 74 20.                                                                                                                                                             |

PART 2 - PRODUCTS

- |                                     |                                                                                                                                                                                                   |
|-------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>2.1 MANUFACTURER</u>             | .1 Equipment, chemicals, service by one supplier.                                                                                                                                                 |
| <u>2.2 POT FEEDER</u>               | .1 Welded steel, pressure rating: 1200 kPa.<br>Temperature rating: 90 degrees C.                                                                                                                  |
| <u>2.3 CHEMICAL FEED<br/>PIPING</u> | .1 Resistant to chemicals employed. Pressure<br>rating: 1200 kPa.                                                                                                                                 |
| <u>2.4 CHEMICALS</u>                | .1 Re-fill existing systems being replaced.<br>.1 Hot water heating system.<br>.2 Chilled water system (glycol system).<br><br>.2 Chemicals provided shall be compatible with<br>existing system. |
-

- 2.5 WATER TREATMENT FOR HYDRONIC SYSTEMS
- .1 Hot water heating system: Pot feeder, 25 L, operating pressure 860 kPa.
  - .2 Micron filter for each pot feeder:
    - .1 Capacity 2% of pump recirculating rate at operating pressure.
    - .2 Six (6) sets of filter cartridges for each type, size of micron filter.

PART 3 - EXECUTION

- 3.1 INSTALLATION
- .1 Provide additional pump and circulators to carry out flushing and cleaning work carried out in this contract.

- 3.2 CLEANING OF MECHANICAL SYSTEM
- .1 Provide copy of recommended cleaning procedures and chemicals for approval by Departmental Representative.
  - .2 Thoroughly flush mechanical systems installed under this contract.
  - .3 During circulation of cleaning solution, periodically examine and clean filters and screens and monitor changes in pressure drop across equipment.
  - .4 Drain and flush systems until alkalinity of rinse water is equal to make-up water. Refill with clean water treated to prevent scale and corrosion during system operation.
  - .5 Disposal of cleaning solutions to be approved by authority having jurisdiction.
  - .6 Do not connect to existing system without prior approval from Departmental Representative.

- 3.3 WATER TREATMENT SERVICES
- .1 Service to include:
    - .1 Initial water analysis and treatment recommendations.
    - .2 System start-up assistance.

- 3.4 START-UP .1 Start up water treatment systems in accordance with manufacturer's instructions.
- 3.5 COMMISSIONING .1 Commissioning Agency: To be installing water treatment sub-contractor and/or mechanical contractor.
- .2 Timing:  
.1 After start-up deficiencies rectified.  
.2 After start-up and before TAB of connected systems.
- .3 Pre-commissioning Inspections:  
.1 Verify:  
.1 Presence of test equipment, reagents, chemicals, details of specific tests to be performed, operating instructions.  
.2 Suitability of log book.  
.3 Currency and accuracy of raw initial water analysis.  
.4 Required quality of treated water.
- .4 Certificates:  
.1 Upon completion, furnish certificates confirming satisfactory installation and performance.
- .5 Commissioning Reports:  
.1 To include system schematics, test results, test certificates, raw and treated water analyses, design criteria, other data required by Departmental Representative.

PART 1 - GENERAL

1.1 SUMMARY

- .1 Section Includes:
  - .1 Materials and installation of low-pressure metallic ductwork, joints and accessories.

1.2 REFERENCES

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
  - .2 ASTM International.
    - .1 ASTM A635/A635M-09b, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot Rolled.
    - .2 ASTM A653/A653M-11, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
  - .3 Department of Justice Canada (Jus).
    - .1 Canadian Environmental Protection Act (CEPA), 1999, c. 33 .
  - .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
    - .1 Material Safety Data Sheets (MSDS).
  - .5 National Fire Protection Association (NFPA).
    - .1 NFPA 90A-2012, Standard for the Installation of Air-Conditioning and Ventilating Systems.
    - .2 NFPA 90B-2012, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
    - .3 NFPA 96-2011, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
  - .6 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).
    - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition 2005.
    - .2 SMACNA HVAC Air Duct Leakage Test Manual, 1985, 1st Edition.
    - .3 SMACNA IAQ Guidelines for Occupied Buildings Under Construction 2nd edition 2007; ANSI/SMACNA 008-2008.
  - .7 Transport Canada (TC).
-

1.2 REFERENCES (Cont'd) .7 (Cont'd)  
.1 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

1.3 SUBMITTALS .1 Submit shop drawings and product data in accordance with Section 01 33 00.  
.2 Product Data: submit WHMIS MSDS - Material Safety Data Sheets for the following:  
.1 Sealants.  
.2 Tape.  
.3 Proprietary Joints.

1.4 QUALITY ASSURANCE .1 Certification of Ratings:  
.1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.  
.2 Health and Safety:  
.1 Do construction occupational health and safety in accordance with Section 01 35 29.

1.5 DELIVERY, STORAGE AND HANDLING .1 Refer to Section 01 74 20.

## PART 2 - PRODUCTS

2.1 SEAL CLASSIFICATION .1 Classification as follows:

### TABLE PRESSURE CLASSIFICATION

| Ductwork                                  | Operating Pressure | Seal Classification | Remarks |
|-------------------------------------------|--------------------|---------------------|---------|
| Supply Air Ductwork Upstream of VAV Boxes | Up to 500 Pa       | B                   |         |
| Supply Air                                | 250 Pa             | C                   |         |



## 2.1 SEAL CLASSIFICATION (Cont'd)

Downstream of  
VAV Boxes

|                        |               |   |
|------------------------|---------------|---|
| Return Air<br>Ductwork | Up to -250 Pa | C |
|------------------------|---------------|---|

|                                              |                  |   |
|----------------------------------------------|------------------|---|
| Exhaust and<br>Outside Air<br>Intake Plenums | Up to +/- 250 Pa | B |
|----------------------------------------------|------------------|---|

|                                           |                        |   |
|-------------------------------------------|------------------------|---|
| All Other<br>Ductwork Not<br>Listed Above | Up to 0.5" wg (125 Pa) | C |
|-------------------------------------------|------------------------|---|

- .2 Seal classification:
  - .1 Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant and tape.
  - .2 Class B: longitudinal seams, transverse joints and connections made airtight with sealant tape or combination thereof.
  - .3 Class C: transverse joints and connections made air tight with gaskets sealant tape or combination thereof. Longitudinal seams unsealed.
  - .4 Unsealed seams and joints.

|                    |                                                                                                                                  |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------|
| <u>2.2 SEALANT</u> | .1 Sealant: oil resistant, water borne, polymer type flame resistant duct sealant. Temperature range of minus 30°C to plus 93°C. |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------|

|                 |                                                                     |
|-----------------|---------------------------------------------------------------------|
| <u>2.3 TAPE</u> | .1 Tape: polyvinyl treated, open weave fiberglass tape, 50 mm wide. |
|-----------------|---------------------------------------------------------------------|

|                         |                                                                 |
|-------------------------|-----------------------------------------------------------------|
| <u>2.4 DUCT LEAKAGE</u> | .1 In accordance with SMACNA HVAC Air Duct Leakage Test Manual. |
|-------------------------|-----------------------------------------------------------------|

## 2.5 FITTINGS

- .1 Fabrication: to SMACNA.
- .2 Radiused elbows.
  - .1 Rectangular: standard radius short radius with single thickness turning vanes Centreline radius: 1.5 times width of duct.
  - .2 Round: smooth radius five piece. Centreline radius: 1.5 times diameter.
- .3 Mitred elbows, rectangular:
  - .1 To 400 mm: with single double thickness turning vanes.
  - .2 Over 400 mm: with double thickness turning vanes.
- .4 Branches:
  - .1 Rectangular main and branch: with radius on branch 1.5 times width of duct 45 degrees entry on branch.
  - .2 Round main and branch: enter main duct at 45 degrees with conical connection.
  - .3 Provide volume control damper in branch duct near connection to main duct.
  - .4 Main duct branches: with splitter damper.
- .5 Transitions:
  - .1 Diverging: 20 degrees maximum included angle.
  - .2 Converging: 30 degrees maximum included angle.
- .6 Offsets:
  - .1 Full short radiused elbows as indicated.
- .7 Obstruction deflectors: maintain full cross-sectional area.
  - .1 Maximum included angles: as for transitions.

## 2.6 FIRE STOPPING

- .1 Retaining angles around duct, on both sides of fire separation.
- .2 Fire stopping material and installation must not distort duct.

## 2.7 GALVANIZED STEEL

- .1 Lock forming quality: to ASTM A653/A653M, Z90 zinc coating.

2.7 GALVANIZED  
STEEL  
(Cont'd)

- .2 Thickness, fabrication and reinforcement: to SMACNA.
- .3 Joints: to SMACNA proprietary manufactured duct joint. Proprietary manufactured flanged duct joint to be considered to be a class A seal.

2.8 HANGERS AND  
SUPPORTS

- .1 Hangers and Supports: in accordance with Section 23 05 29.
  - .1 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct.
    - .1 Maximum size duct supported by strap hanger: 500.
  - .2 Hanger configuration: to ASHRAE and SMACNA.
  - .3 Hangers: galvanized steel angle with galvanized steel rods to ASHRAE and SMACNA following table:

| Duct Size<br>(mm) | Angle Size<br>(mm) | Rod Size<br>(mm) |
|-------------------|--------------------|------------------|
| up to 750         | 25 x 25 x 3        | 6                |
| 751 to 1050       | 40 x 40 x 3        | 6                |
| 1051 to 1500      | 40 x 40 x 3        | 10               |
| 1501 to 2100      | 50 x 50 x 3        | 10               |
| 2101 to 2400      | 50 x 50 x 5        | 10               |
| 2401 and over     | 50 x 50 x 6        | 10               |

- .4 Upper hanger attachments:
  - .1 For concrete: manufactured concrete inserts.
  - .2 For steel joist: manufactured joist clamp steel plate washer.
  - .3 For steel beams: manufactured beam clamps.

PART 3 - EXECUTION

3.1 GENERAL

- .1 Do work in accordance with NFPA 90A, NFPA 90B ASHRAE, SMACNA as indicated.
- .2 Do not break continuity of insulation vapour barrier with hangers or rods.
  - .1 Insulate strap hangers 100 mm beyond insulated duct Ensure diffuser is fully seated
- .3 Support risers in accordance with ASHRAE SMACNA as indicated.

3.1 GENERAL  
(Cont'd)

- .4 Install breakaway joints in ductwork on sides of fire separation.
- .5 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.
- .6 Manufacture duct in lengths and diameter to accommodate installation of acoustic duct lining.

3.2 HANGERS

- .1 Strap hangers: install in accordance with SMACNA.
- .2 Angle hangers: complete with locking nuts and washers.
- .3 Hanger spacing: in accordance with ASHRAE SMACNA as follows:

| Duct Size     | Spacing |
|---------------|---------|
| (mm)          | (mm)    |
| to 1500       | 3000    |
| 1501 and over | 2500    |

3.3 WATERTIGHT DUCT

- .1 Provide watertight duct for:
  - .1 Fresh air intake.
- .2 Form bottom of horizontal duct without longitudinal seams.
  - .1 Solder weld joints of bottom and side sheets.
  - .2 Seal other joints with duct sealer.
- .3 Slope horizontal branch ductwork down towards fume hoods served.
  - .1 Slope header ducts down toward risers.
- .4 Fit base of riser with 150 mm deep drain sump and 32 mm drain connected, with deep seal trap and valve trap primer and discharging to open funnel drain as indicated.

3.4 SEALING AND TAPING

- .1 Apply sealant to outside of joint to manufacturer's recommendations.

|                                       |    |                                                                                                            |
|---------------------------------------|----|------------------------------------------------------------------------------------------------------------|
| 3.4 SEALING AND<br>TAPING<br>(Cont'd) | .2 | Bed tape in sealant and recoat with minimum of<br>one coat of sealant to manufacturers<br>recommendations. |
|---------------------------------------|----|------------------------------------------------------------------------------------------------------------|

PART 1 - GENERAL

- |                                          |                                                                                                                                                                                                      |
|------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>1.1 REFERENCES</u>                    | .1 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)<br>.1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible, 2005.                                           |
| <u>1.2 PRODUCT DATA</u>                  | .1 Submit product data in accordance with Section 01 33 00.<br><br>.2 Indicate the following:<br>.1 Flexible connections.<br>.2 Duct access doors.<br>.3 Turning vanes.<br>.4 Instrument test ports. |
| <u>1.3 CERTIFICATION OF RATINGS</u>      | .1 Catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.                             |
| <u>1.4 WASTE MANAGEMENT AND DISPOSAL</u> | .1 Refer to Section 01 74 20.                                                                                                                                                                        |

PART 2 - PRODUCTS

- |                                 |                                                                                                                                                                                                                                                                                         |
|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>2.1 GENERAL</u>              | .1 Manufacture in accordance with SMACNA - HVAC Duct Construction Standards.                                                                                                                                                                                                            |
| <u>2.2 FLEXIBLE CONNECTIONS</u> | .1 Frame: galvanized sheet metal frame 0.66 mm thick with fabric clenched by means of double locked seams.<br><br>.2 Material:<br>.1 Fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated at minus 40°C to plus 90°C, density of 1.3 kg/m <sup>2</sup> . |

- 
- 2.3 ACCESS DOORS IN DUCTS
- .1 Non-insulated ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame.
  - .2 Insulated ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame and 25 mm thick rigid glass fibre insulation.
  - .3 Gaskets: neoprene foam rubber.
  - .4 Hardware:
    - .1 Up to 300 x 300 mm: two sash locks complete with safety chain.
    - .2 301 to 450 mm: four sash locks complete with safety chain.
    - .3 451 to 1000 mm: piano hinge and minimum two sash locks.
    - .4 Doors over 1000 mm: piano hinge and two handles operable from both sides.
    - .5 Hold open devices.
    - .6 300 x 300 mm glass viewing panels.
- 2.4 TURNING VANES
- .1 Factory or shop fabricated single thickness double thickness with without trailing edge, to recommendations of SMACNA and as indicated.
- 2.5 INSTRUMENT TEST
- .1 1.6 mm thick steel zinc plated after manufacture.
  - .2 Camlock handles with neoprene expansion plug and handle chain.
  - .3 28 mm minimum inside diameter. Length to suit insulation thickness.
  - .4 Neoprene mounting gasket.
- 2.6 SPIN-IN COLLARS
- .1 Conical galvanized sheet metal spin-in collars with lockable butterfly damper.
  - .2 Sheet metal thickness to co-responding round duct standards.
-

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- .1 Flexible connections:
    - .1 Install in following locations:
      - .1 Inlets and outlets to supply air units and fans.
      - .2 Inlets and outlets of exhaust and return air fans.
      - .3 As indicated.
    - .2 Length of connection: 100 mm.
    - .3 Minimum distance between metal parts when system in operation: 75 mm.
    - .4 Install in accordance with recommendations of SMACNA.
    - .5 When fan is running:
      - .1 Ducting on sides of flexible connection to be in alignment.
      - .2 Ensure slack material in flexible connection.
  - .2 Access doors and viewing panels:
    - .1 Size:
      - .1 x mm for person size entry.
      - .2 x mm for servicing entry.
      - .3 x mm for viewing.
      - .4 As indicated.
    - .2 Locations:
      - .1 Fire dampers.
      - .2 Control dampers.
      - .3 Devices requiring maintenance.
      - .4 Required by code.
      - .5 Reheat coils.
      - .6 Elsewhere as indicated.
  - .3 Instrument test ports.
    - .1 General:
      - .1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
    - .2 Locate to permit easy manipulation of instruments.
    - .3 Install insulation port extensions as required.
    - .4 Locations.
      - .1 For traverse readings:
        - .1 Inlets and outlets of other fan systems.
        - .2 Main and sub-main ducts.
        - .3 And as indicated.
      - .2 For temperature readings:
-



- 3.1 INSTALLATION  
(Cont'd)
- .3 (Cont'd)
- .4 (Cont'd)
- .1 At outside air intakes.
  - .2 In mixed air applications in locations as approved by Departmental Representative Consultant.
  - .3 At inlet and outlet of coils.
  - .4 And as indicated.
- .4 Turning vanes:
- .1 Install in accordance with recommendations of SMACNA and as indicated.

PART 1 - GENERAL

- 1.1 REFERENCES .1 Sheet Metal and Air Conditioning National Association (SMACNA)  
.1 SMACNA HVAC Duct Construction Standards, Metal and Flexible-2005.

- 1.2 SUBMITTALS .1 Shop Drawings and Product Data:  
.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00. Include product characteristics, performance criteria, and limitations.

PART 2 - PRODUCTS

- 2.1 GENERAL .1 Manufacture to SMACNA standards.

- 2.2 SPLITTER DAMPERS .1 Of same material as duct but one sheet metal thickness heavier, with appropriate stiffening.  
.2 Single Double thickness construction.  
.3 Control rod with locking device and position indicator.  
.4 Rod configuration to prevent end from entering duct.  
.5 Pivot: piano hinge.  
.6 Folded leading edge.

- 2.3 SINGLE BLADE DAMPERS .1 Fabricate from same material as duct, but one sheet metal thickness heavier. V-groove stiffened.  
.2 Size and configuration to recommendations of SMACNA, except maximum height 100 mm as indicated.

## 2.3 SINGLE BLADE DAMPERS

(Cont'd)

- .3 Locking quadrant with shaft extension to accommodate insulation thickness.
- .4 Inside and outside nylon bronze end bearings.
- .5 Channel frame of same material as adjacent duct, complete with angle stop.

## 2.4 MULTI-BLADED DAMPERS

- .1 Factory manufactured of material compatible with duct.
- .2 Opposed blade: configuration, metal thickness and construction to recommendations of SMACNA.
- .3 Maximum blade height: 100 mm.
- .4 Bearings: self-lubricating nylon.
- .5 Linkage: shaft extension with locking quadrant.
- .6 Channel frame of same material as adjacent duct, complete with angle stop.
- .7 Maximum leakage: 0.07% at 750 Pa.
- .8 Provide staff extension and standoff for insulated ducts.

PART 3 - EXECUTION

### 3.1 INSTALLATION

- .1 Install where indicated and required to balance system.
- .2 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
- .3 Install balancing dampers in each branch duct, for supply, return and exhaust systems.
- .4 Runouts to registers and diffusers: install single blade damper located as close as possible to main ducts.
- .5 All dampers to be vibration free.
- .6 Ensure damper operators are observable and accessible.

PART 1 - GENERAL

- |                                          |    |                                                                                                                                                                            |
|------------------------------------------|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>1.1 REFERENCES</u>                    | .1 | ASTM International<br>.1 ASTM A653/A653M-11, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process. |
| <u>1.2 PRODUCT DATA</u>                  | .1 | Submit product data in accordance with Section 01 33 00.                                                                                                                   |
|                                          | .2 | Indicate the following:<br>.1 Performance data.                                                                                                                            |
| <u>1.3 CLOSEOUT SUBMITTALS</u>           | .1 | Provide maintenance data for incorporation into manual specified in Section 01 78 00.                                                                                      |
| <u>1.4 CERTIFICATION OF RATINGS</u>      | .1 | Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency.                     |
| <u>1.5 WASTE MANAGEMENT AND DISPOSAL</u> | .1 | Refer to Section 01 74 20.                                                                                                                                                 |

PART 2 - PRODUCTS

- |                               |    |                                                                                                                                                                                                                   |
|-------------------------------|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>2.1 MULTI-LEAF DAMPERS</u> | .1 | Opposed and or Parallel blade type as indicated.                                                                                                                                                                  |
|                               | .2 | Structurally formed steel Extruded aluminum, interlocking blades, complete with extruded vinyl seals, spring stainless steel side seals, structurally formed and welded galvanized steel extruded aluminum frame. |
|                               | .3 | Pressure fit self-lubricated bronze bearings.                                                                                                                                                                     |

2.1 MULTI-LEAF  
DAMPERS  
(Cont'd)

- .4 Linkage: plated steel tie rods, brass pivots and plated steel brackets, complete with plated steel control rod.
- .5 Operator: To be supplied and installed by control sub-contractor.
- .6 Performance:
  - .1 Leakage: in closed position in accordance with Class 1 leakage at 1kPa according to AMCA 511.
  - .2 Standard air leakage data to be certified under the AMCA certified ratings program.
  - .3 Pressure drop: at full open position to be less than 25 Pa differential across damper at 10 m/s.
- .7 Insulated aluminum dampers:
  - .1 Frames: insulated with extruded polystyrene foam with R factor of 5.0.
  - .2 Blades: constructed from aluminum extrusions with internal hollows insulated with polyurethane or polystyrene foam, R factor of 5.0.
  - .3 Provide insulated damper for dampers exposed to outside air.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and manufacturer's instructions.
- .3 Seal multiple damper modules with silicon sealant.
- .4 Ensure dampers are observable and accessible.

## PART 1 - GENERAL

### 1.1 REFERENCES

- .1 National Fire Protection Association (NFPA)
  - .1 NFPA 90A-2012, Installation of Air Conditioning and Ventilating Systems.
- .2 Underwriters Laboratories of Canada (ULC)
  - .1 CAN/ULC-S112-10, Standard Method of Fire Test of Fire Damper Assemblies.
  - .2 CAN/ULC-S112.2-07, Standard Method of Fire Test of Ceiling Firestop Flap Assemblies.
  - .3 ULC-S505-1974, Fusible Links for Fire Protection Service.

### 1.2 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00.
- .2 Indicate the following:
  - .1 Fire dampers.
  - .2 Operators.
  - .3 Fusible links.
  - .4 Design details of break-away joints.

### 1.3 CLOSEOUT SUBMITTALS

- .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00.

### 1.4 CERTIFICATION OF RATINGS

- .1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards.

## PART 2 - PRODUCTS

### 2.1 FIRE DAMPERS

- .1 Fire dampers: arrangement Type B, listed and bear label of ULC, meet requirements of provincial fire authority Fire Commissioner of Canada (FCC) CFFM and NFPA 90A and authorities having jurisdiction. Fire damper assemblies to be fire tested in accordance with CAN/ULC-S112.

2.1 FIRE DAMPERS  
(Cont'd)

- .2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation. Minimum rating shall be 1-1/2 hr.
- .3 Top hinged: single damper, round or square; multi-blade hinged or interlocking type; roll door type; guillotine type; sized to maintain full duct cross section as indicated.
- .4 Fusible link actuated, weighted to close and lock in closed position when released or having negator-spring-closing operator for multi-leaf type or roll door type in horizontal position with vertical air flow.
- .5 40 x 40 x 3 mm retaining angle iron frame, on full perimeter of fire damper, on both sides of fire separation being pierced.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Install in accordance with NFPA 90A and in accordance with conditions of ULC listing.
- .2 Maintain integrity of fire separation.
- .3 After completion and prior to concealment obtain approvals of complete installation from authority having jurisdiction.
- .4 Install access door adjacent to each damper. See Section 23 33 00.
- .5 Coordinate with installer of firestopping.
- .6 Ensure access doors/panels, fusible links, damper operators are easily observed and accessible.
- .7 Install break-away joints of approved design on each side of fire separation.

PART 1 - GENERAL

1.1 REFERENCES

- .1 National Fire Protection Association (NFPA)
  - .1 NFPA 90A-2012, Installation of Air Conditioning and Ventilating Systems.
  - .2 NFPA 90B-2012, Installation of Warm Air Heating and Air Conditioning Systems.
- .2 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
  - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005.
- .3 Underwriter's Laboratories of Canada (ULC)
  - .1 CAN/ULC-S110-07, Fire Tests for Air Ducts.
  - .2 UL 181-2005, Factory Made Air Ducts and Connectors.

1.2 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00.
- .2 Indicate the following:
  - .1 Thermal properties.
  - .2 Friction loss.
  - .3 Acoustical loss.
  - .4 Leakage.
  - .5 Fire rating.

1.3 CERTIFICATION OF RATINGS

- .1 Catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

1.4 WASTE MANAGEMENT AND DISPOSAL

- .1 Refer to Section 01 74 00.

PART 2 - PRODUCTS

2.1 GENERAL

- .1 Factory fabricated to CAN/ULC-S110.



2.1 GENERAL  
(Cont'd)

- .2 Pressure drop coefficients listed below are based on relative sheet metal duct pressure drop coefficient of 1.00.
- .3 Flame spread rating not to exceed 25. Smoke developed rating not to exceed 50.

2.2 METALLIC -  
UNINSULATED

- .1 Type 1: spiral wound flexible aluminum stainless steel.
- .2 Performance:
  - .1 Factory tested to 2.5 kPa without leakage.
  - .2 Maximum relative pressure drop coefficient: 3.

2.2 METALLIC  
ACOUSTIC INSULATED

- .1 Type 5: Spiral wound, flexible perforated aluminum with factory applied 37 mm thick flexible glass fibre thermal insulation and sleeved by aluminum foil and Type M vapour barrier.
- .2 Performance:
  - .1 Factory tested to 3 kPa without leakage.
  - .2 Maximum relative pressure drop coefficient: 3.
  - .3 Acoustical performance: Minimum attenuation (dB/m) to following table:

|               | Frequency (Hz) |     |     |      |      |
|---------------|----------------|-----|-----|------|------|
| Duct<br>Diam: | 125            | 250 | 500 | 1000 | 2000 |
| 100           | 0.6            | 3   | 12  | 27   | 0    |
| 150           | 1.2            | 3   | 12  | 22   | 27   |
| 200           | 2.0            | 5   | 12  | 19   | 20   |
| 300           | 2.4            | 5   | 12  | 16   | 15   |

PART 3 - EXECUTION

3.1 DUCT  
INSTALLATION

- .1 Install in accordance with: CAN/ULC S110, UL 181 NFPA 90A, NFPA 90B and SMACNA.
- .2 Use type 5 throughout.
- .3 Connections:
  - .1 Duct Sizes 300 mm and Under:

3.1 DUCT  
INSTALLATION  
(Cont'd)

- .3 (Cont'd)
  - .1 (Cont'd)
    - .1 Provide a minimum of three (3) #8 sheet metal screws equally spaced to hold the flexible duct.
    - .2 Duct sizes above 300 mm:
      - .1 Provide a minimum of five (5) #8 sheet metal screws equally spaced to hold the flexible duct.
      - .3 Screws shall be located at least 12 mm from the end of the duct.
      - .4 The collar to which the flexible duct is attached shall be a minimum 50 mm in length.
      - .5 Cover entire joint with tape and seal as specified in 23 33 00 Air Duct Accessories.
  - .4 Supports:
    - .1 Support shall be in accordance with SMACNA.
    - .2 The maximum amount of sag for flexible duct shall not exceed 12 mm per foot. Provide additional supports as required.
  - .5 Length:
    - .1 Maximum length of flexible duct: 3000 mm.
    - .2 Minimum length of flexible duct connecting to ceiling diffusers shall be 1800 mm.

PART 1 - GENERAL

1.1 RELATED  
SECTIONS

- .1 Section 23 05 13 - Common Motor Requirements for HVAC Equipment.
- .2 Section 23 05 48 - Vibration for HVAC Piping and Equipment.
- .3 Section 23 33 00 - Air Duct Accessories.

1.2 REFERENCES

- .1 Air Movement and Control Association (AMCA)
  - .1 AMCA 99-10, Standards Handbook.
  - .2 ANSI/AMCA 210-07/ANSI/ASHRAE 51-2007, Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
  - .3 ANSI/AMCA 300-08, Reverberant Room Method for Sound Testing of Fans.
  - .4 ANSI/AMCA 301-06, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- .2 CAN/CGSB-1.181-99, Coating, Zinc Rich, Organic, Ready Mixed.

1.3 SHOP DRAWINGS  
AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00.
- .2 Provide :
  - .1 Fan performance curves showing point of operation, BHP kW and efficiency.
  - .2 Sound rating data at point of operation.
- .3 Indicate: Motors, sheaves, bearings, shaft details
  - .1 Minimum performance achievable with variable speed controllers and variable inlet vanes as appropriate.

1.4 CLOSEOUT  
SUBMITTALS

- .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00.

1.5 EXTRA MATERIALS

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

- 1.5 EXTRA MATERIALS .1 (Cont'd)  
(Cont'd)
- .1 Spare parts to include:  
.1 Matched sets of belts.
- .2 Furnish list of individual manufacturer's recommended spare parts for equipment such as bearings and seals, and addresses of suppliers, together with list of specialized tools necessary for adjusting, repairing or replacing, for placement into operating manual.
- 1.6 MANUFACTURED ITEMS .1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards in force.

PART 2 - PRODUCTS

- 2.1 FANS GENERAL .1 Capacity: flow rate, total static pressure, bhp W, efficiency, revolutions per minute, power, model, size, sound power data and as indicated on schedule.
- .2 Fans: statically and dynamically balanced, constructed in conformity with AMCA 99.
- .3 Sound ratings: comply with ANSI/AMCA 301, tested to ANSI/AMCA 300. Unit shall bear AMCA certified sound rating seal.
- .4 Performance ratings: based on tests performed in accordance with ANSI/AMCA 210/ANSI/ASHRAE 51. Unit shall bear AMCA certified rating seal, except for propeller fans smaller than 300 mm diameter.
- .5 Motors:  
.1 In accordance with Section 23 05 13 supplemented as specified herein.  
.2 For use with variable speed controllers.  
.3 Sizes as indicated specified.

2.1 FANS GENERAL  
(Cont'd)

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- .6 Accessories and hardware: matched sets of V-belt drives, adjustable slide rail motor bases, belt guards, coupling guards fan inlet and or outlet safety screens as indicated and as specified in Section 23 05 13. inlet outlet dampers and vanes and as indicated.
- .7 Factory primed before assembly in colour standard to manufacturer.
- .8 Scroll casing drains: as indicated.
- .9 Finish on fume hood exhaust fans:.
- .10 Bearing lubrication systems plus extension lubrication tubes where bearings are not easily accessible.
- .11 Vibration isolation: to Section 23 05 48.
- .12 Flexible connections: to Section 23 33 00.

2.2 CENTRIFUGAL  
FANS

---

- .1 Fan wheels:
  - .1 Welded steel aluminum construction.
  - .2 Maximum operating speed of centrifugal fans not more than 40% of first critical speed.
  - .3 Air foil forward curved backward inclined blades, as indicated.
- .2 Bearings: heavy duty split pillow-block flange mounted grease lubricated ball or roller self aligning type with oil retaining, dust excluding seals and a certified minimum rated life of 200,000 h.
- .3 Shaft seals on laboratory fume hood and biological safety cabinet exhaust fans:
  - .1 Single disc multi-disc labyrinth water-cooled stuffing box carbon ring with nitrogen air purging seals.
- .4 Housings:
  - .1 Volute with inlet cones: fabricated steel for wheels 300 mm or greater, cast iron, steel, aluminum, for smaller wheels, braced, and with welded supports.
  - .2 For horizontally and vertically split housings provide flanges on each section for bolting together, with gaskets of non-oxidizing non-flammable material.

2.2 CENTRIFUGAL  
FANS  
(Cont'd)

- .4 (Cont'd)
  - .3 Provide bolted latched airtight access doors with handles.
- .5 Variable volume control devices:
  - .1 Mounted by fan manufacturer.
  - .2 Adjustable inlet vanes: operated from a centre mechanism linked to each damper vane. Support each vane at ends in bronze bearings. On DWDI fans interconnect vanes to operate in unison. Provide locking devices for manual operation.
  - .3 Variable Speed Drives.

PART 3 - EXECUTION

3.1 FAN  
INSTALLATION

- .1 Install fans as indicated, complete with resilient mountings specified in Section 23 05 48, flexible electrical leads and flexible connections in accordance with Section 23 33 00.
- .2 Provide sheaves and belts required for final air balance.
- .3 Bearings and extension tubes to be easily accessible.
- .4 Access doors and access panels to be easily accessible.
- .5 Clean and dynamically balance existing return fan. Motor for existing return fan to be replaced. Provide new VFD for existing return fan.

3.2 ANCHOR BOLTS  
AND TEMPLATES

- .1 Size anchor bolts to withstand seismic acceleration and velocity forces as specified.

PART 1 - GENERAL

- |                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|--------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>1.1 REFERENCES</u>                            | <ul style="list-style-type: none"><li>.1 Air Movement and Control Association (AAMC)<ul style="list-style-type: none"><li>.1 AMCA 99-1986(R2003), Standards Handbook.</li><li>.2 AMCA 300-08, Reverberant Room Method for Sound Testing of Fans.</li></ul></li><li>.2 American National Standards Institute (ANSI)<ul style="list-style-type: none"><li>.1 ANSI/ASHRAE 51-2007/AMCA 210-07, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.</li></ul></li></ul> |
| <u>1.2 SHOP DRAWINGS<br/>AND PRODUCT DATA</u>    | <ul style="list-style-type: none"><li>.1 Submit shop drawings and product data in accordance with Section 01 33 00.</li><li>.2 Include :<ul style="list-style-type: none"><li>.1 Fan performance curves showing specified point of operation.</li><li>.2 Sound rating data.</li></ul></li></ul>                                                                                                                                                                                        |
| <u>1.3 CLOSEOUT<br/>SUBMITTALS</u>               | <ul style="list-style-type: none"><li>.1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00.</li></ul>                                                                                                                                                                                                                                                                                                                                 |
| <u>1.4 CERTIFICATIONS</u>                        | <ul style="list-style-type: none"><li>.1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered from independent testing agency signifying adherence to codes and standards in force.</li><li>.2 Provide confirmation of testing.</li></ul>                                                                                                                                                                                   |
| <u>1.5 WASTE<br/>MANAGEMENT AND<br/>DISPOSAL</u> | <ul style="list-style-type: none"><li>.1 Separate and recycle waste materials in accordance with Section 01 74 20.</li></ul>                                                                                                                                                                                                                                                                                                                                                           |
| <u>1.6 EXTRA MATERIALS</u>                       | <ul style="list-style-type: none"><li>.1 Provide maintenance materials in accordance with Section 01 78 00.</li></ul>                                                                                                                                                                                                                                                                                                                                                                  |
-

## PART 2 - PRODUCTS

### 2.1 FANS GENERAL

- .1 Provide as indicated on schedule.
- .2 Statically and dynamically balanced.  
Constructed in conformity with AMCA 99.
- .3 Sound ratings: comply with AMCA 301, tested to AMCA 300. Unit shall bear AMCA certified sound rating seal.
- .4 Performance ratings: based on tests performed in accordance with ANSI/ASHRAE 51/AMCA 210, unit to bear AMCA certified rating seal.
- .5 Bearings: sealed lifetime oilite ball bearings heavy duty grease lubricated ball or roller bearings of self aligning type with oil retaining, dust excluding seals and a certified minimum rated life of 80,000 100,000 h.

### 2.2 ROOF EXHAUSTERS

- .1 Centrifugal V belt or direct driven.
  - .1 Housings: spun aluminum complete with resilient mounted motor and fan.
  - .2 Impeller: aluminum non-overloading.
  - .3 Adjustable motor sheave.
  - .4 12 mm mesh or 2.0 mm dia aluminum birdscreen.
  - .5 Automatic Motorized gasketed aluminum backdraft dampers.
  - .6 Disconnect switch within fan housing.
  - .7 Continuous curb gaskets, cadmium plated securing bolts and screws, and 300 mm high curbs where indicated.
- .2 Acceptable material: Cook, Woods, Twin City, Greenheck.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- .1 Install in accordance with manufacturer's instructions.



PART 1 - GENERAL

1.1 REFERENCES

- .1 American National Standards Institute (ANSI)
  - .1 ANSI/ASHRAE 51-2007/AMCA 210-07, Laboratory Methods of Testing Fans for Rating.
- .2 National Fire Protection Association (NFPA)
  - .1 NFPA 90A-12, Installation of Air Conditioning and Ventilating Systems.
- .3 International Organization of Standardization (ISO)
  - .1 ISO 3741:2010, Acoustics-Determination of Sound Power Levels of Noise Sources Using Sound Pressure - Precision Methods for Reverberation Rooms.
- .4 Underwriter's Laboratories (UL)
- .5 UL 181-2008, Factory-Made Air Ducts and Air Connectors.

1.2 SHOP DRAWINGS  
AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00.
- .2 Indicate the following:
  - .1 Capacity.
  - .2 Pressure drop.
  - .3 Noise rating.
  - .4 Leakage.

1.3 TEST REPORTS

- .1 To ANSI/ASHRAE 51/AMCA 210. Submit published test data on DIN (Direct Internal Noise), in accordance with ISO 3741 made by independent testing agency for 0, 2.5 and 6 m/s branch velocity or inlet velocity. Sound power level with minimum inlet pressure of 0.5 kPa in accordance with ISO 3741 for 2nd through 7th octave band, also made by independent testing agency. Pressure loss through silencer shall not exceed 60% of inlet velocity pressure maximum.

1.4 CLOSEOUT  
SUBMITTALS

- .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00.

1.5 CERTIFICATION .1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from certified ADC (Air Diffusion Council) testing agency signifying adherence to codes and standards.

1.6 WASTE  
MANAGEMENT AND  
DISPOSAL .1 Refer to Section 01 74 20.

1.7 EXTRA MATERIALS .1 Provide maintenance materials in accordance with Section 01 78 00.

## PART 2 - PRODUCTS

2.1 VAV BOXES .1 General

- .1 Units: Pressure independent volume regulator type.
- .2 Low pressure systems of single duct type with variable volume control and housed within
- .3 Casing: 22 gauge (0.89 mm) minimum thickness galvanized steel insulated with minimum of 3/4" (20 mm) thick thermal and acoustic insulation which complies with UL-181 and NFPA 90A. Any cut sections of fiberglass exposed to the air stream shall be coated with NFPA 90A approved sealant.
- .4 The primary air valve damper shall be heavy gauge metal, with peripheral gasket, pivoted in self lubricating bearings. In full closed position, air leakage past the closed damper shall not exceed 2% of the nominal catalog rating at 3" inlet static pressure, as rated by ARI Standard 880. An opposed blade primary air damper and DDC motor operator shall vary primary air in response to a signal. Damper operation shall be demonstrated to be closed to minimum position before heating is activated. No overlap under any circumstances shall be allowed. Damper shall be located inside unit. Damper connection to operating shaft shall be a positive mechanical connection.

2.1 VAV BOXES  
(Cont'd)

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- .1 (Cont'd)
- .5 The air flow sensor shall be of cross configuration located at the inlet of the assembly. The sensor shall have twelve total pressure sensing ports and a centre averaging chamber designed to accurately average the flow across the inlet of the assembly. Sensor shall provide accuracy within 5% with a 90o sheet metal elbow directly at the inlet of the assembly. The air flow sensor shall amplify the sensed air flow signal.
- .6 Factory preset maximum and minimum air volume setting Factory preset maximum and minimum air volume setting being field adjustable, and duct collars. Leakage through casing not to exceed 2% of design volume with 3" (750 kPa) upstream and 0" (0 kPa) downstream of regulator while maintaining flow regulation within 5% of setting as rated by ARI Standard 880.
- .7 At an inlet velocity of 2000 fpm pressure drop for cfm range of box shall not exceed 0.11 in w.g. (27 Pa.).
- .8 Sound rating of air distribution assembly including box and attenuator shall not exceed the following:
- .1 Radiated: 35 NC.
- .2 Discharge: 36 NC. Based on room absorption of 10 db, and an inlet static pressure of 1.5" W.G. (375 Pa.)
- .9 Provide minimum 36" (915mm) attenuator for discharge of every box. Attenuator shall have interior lining as previously specified, of 1" (25 mm) for its entire length.
- .10 Provide terminal units with air volumes of 900 cfm or more with additional 24" (600mm) silencer section.
- .11 In fully closed position, air leakage through damper shall not exceed 2% of catalogued rating at 3 in wg. (750 Pa.).
- .12 Schedule: as indicated on the drawings.
- .13 All digital controls including motor, transducer, controller, etc. to be supplied by Division 25 for factory installation by box manufacturer. The cost of the Installation of the controls shall be carried by the box manufacturer.
- .14 Provide a reheat coil sized in accordance with the schedule where indicated on the drawings. Refer to Section 15770 "Plate Fin Heating Coils".
- .15 Provide an access door upstream of heating coil and dampers.

- |                                             |    |                                                                                                                                                                                                                 |
|---------------------------------------------|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>2.1 VAV BOXES<br/>(Cont'd)</u>           | .2 | Standard of Acceptance: Metalaire, E.H. Price, Titus, Tuttle and Bailey, Nailor.                                                                                                                                |
| <u>2.2 MANUFACTURED<br/>UNITS</u>           | .1 | Terminal units of the same type to be product of one manufacturer.                                                                                                                                              |
| <u>2.3 CONSTANT VOLUME<br/>BYPASS BOXES</u> | .1 | Maintain space conditon by bypassing supply air to return air.                                                                                                                                                  |
|                                             | .2 | Sized, capacities, pressure loss, and discharge sound pressure level: as indicated.                                                                                                                             |
|                                             | .3 | Discharge sound pressure level: to be less than 35 NC.                                                                                                                                                          |
|                                             | .4 | Complete with:<br>.1 Bypass collar for connection to return air duct.<br>.2 Minimum air volume stop.<br>.3 Controller and operator as specified under controls specifications.<br>.4 Reheat coils as indicated. |
|                                             | .5 | Casing: constructed of 22 gauge thick zinc coated steel, internally lined with 12 mm, 0.7 kg density fibrous glass, to UL 181 and NFPA 90A. Mount control components inside protective metal shroud.            |
|                                             | .6 | Sequence of operation as specified under 25 90 01.                                                                                                                                                              |
|                                             | .7 | Standard of Acceptance: E.H. Price, Titus, Tuttle and Bailey, Nailor.                                                                                                                                           |

### PART 3 - EXECUTION

- |                         |    |                                                                                         |
|-------------------------|----|-----------------------------------------------------------------------------------------|
| <u>3.1 INSTALLATION</u> | .1 | Install in accordance with manufacturer's recommendations.                              |
|                         | .2 | Support independently of ductwork.                                                      |
|                         | .3 | Install with minimum of four duct diameters of straight inlet duct, same size as inlet. |

|                              |    |                                                                              |
|------------------------------|----|------------------------------------------------------------------------------|
| 3.1 INSTALLATION<br>(Cont'd) | .4 | Locate so that controls, dampers and access<br>panels are easily accessible. |
|------------------------------|----|------------------------------------------------------------------------------|

PART 1 - GENERAL

1.1 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00.
- .2 Indicate the following:
  - .1 Capacity.
  - .2 Throw and terminal velocity.
  - .3 Noise criteria.
  - .4 Pressure drop.
  - .5 Neck velocity.

1.2 CERTIFICATIONS

- .1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards.

1.3 WASTE  
MANAGEMENT AND  
DISPOSAL

- .1 Refer to Section 01 74 00.

PART 2 - PRODUCTS

2.1 GENERAL

- .1 Provide standard product to meet capacity, throw, noise level, throat and outlet velocity.
  - .2 Where grilles, registers and diffusers penetrate fire walls and fire partitions, provide approved steel sleeve secured to structure in accordance with NFPA 90A 2009 and required fire damper.
  - .3 Frames:
    - .1 Steel: primed cold rolled steel with exposed welded joints and mitred corners.
    - .2 Aluminum: extruded satin finish with mechanical fasteners and mitred corners.
    - .3 Provide plaster frames as plaster stops where set into plaster or gypsum board.
    - .4 Provide concealed fasteners and balancing operators in all finished areas.
-

- |                                                             |    |                                                                                                                                                                                                   |
|-------------------------------------------------------------|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>2.1 GENERAL<br/>(Cont'd)</u>                             | .3 | (Cont'd)                                                                                                                                                                                          |
|                                                             | .5 | Final finish to be selected by Architect from standard manufacturer finishes at shop drawing stage.                                                                                               |
|                                                             | .6 | Style, frame, and installation details as indicated on the schedule.                                                                                                                              |
|                                                             | .4 | Sizes and capacities: as indicated in the schedule.                                                                                                                                               |
|                                                             | .5 | Standard of Acceptance: EH Price, Titus, Tuttle and Bailey, Nailor, Metalaire.                                                                                                                    |
| <u>2.2 SUPPLY GRILLES<br/>AND REGISTERS</u>                 | .1 | 1-1/4" (32 mm) border double deflection with airfoil shape horizontal face and vertical rear bars, opposed blade dampers (OBD) where indicated with concealed manual operator, and gaskets.       |
| <u>2.3 RETURN AND<br/>EXHAUST GRILLES AND<br/>REGISTERS</u> | .1 | 1-1/4" (32 mm) border, single deflection, air foil shape, horizontal bar type 35? max turn up, when shown on the schedule opposed blade damper with concealed operator and rubber sealing strips. |
|                                                             | .2 | Egg crate to be 1/2" x 1/2" x 1" (12 x 12 x 25), type as per schedule.                                                                                                                            |
|                                                             | .3 | Perforated Grilles shall consist of a perforated core with 3/16" (5) holes on 1/4" (6) centres staggered 60 degrees and an extruded aluminum border. Finish in accordance with the schedule.      |
| <u>2.4 DIFFUSERS</u>                                        | .1 | Diffusers shall consist of a precision formed back cone of one piece seamless construction which incorporates a round inlet collar of sufficient length for connecting rigid or flexible duct.    |
|                                                             | .2 | Refer to schedule for finish.                                                                                                                                                                     |
|                                                             | .3 | As indicated on the schedule, Circular, square or perforated type, having adjustable fixed pattern, and volume control dampers with flow straightening devices and blank off quadrants.           |

2.4 DIFFUSERS  
(Cont'd)

- .4 For plaque diffusers an inner plaque assembly shall be incorporated that drops no more than 1/4" below the ceiling plane to assure proper air distribution performance. The inner plaque assembly shall be completely removable from the diffuser face to allow full access to any dampers or other ductwork components located near the diffuser neck.

2.5 LINEAR GRILLES

- .1 Bar core linear grilles with frame as indicated, plaster frame, sealing strip and accessories as indicated.
- .2 All corners shall be mitred
- .3 Floor grilles to be capable of supporting 200 lb (90 kg) point load weight between supports with negligible deflection.
- .4 Provide opposed blade damper in maximum 3'0" (1000 mm) lengths. Do not supply OBD in return air linear grilles.
- .5 Extruded aluminum linear slot diffuser with adjustable vane controls and accessories as indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Install in accordance with manufacturers instructions.
- .2 Install in accordance with manufacturers instructions.
- .3 All diffusers and grilles in finished areas to have concealed mounting. In unfinished areas and where grilles or diffusers are to be installed in ductwork. For linear bar grilles and linear slot diffusers site measure for exact fit.
- .4 Final locations of diffusers and grilles to be in accordance with details of Architectural reflected ceiling plan.



|                              |    |                                                                                                                                                                                       |
|------------------------------|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3.1 INSTALLATION<br>(Cont'd) | .5 | Install and adjust air registers to provide noiseless and draftless distribution. Primary air balance to be done at duct dampers with final adjustment only at diffusers and grilles. |
|------------------------------|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

PART 1 - GENERAL

- |                               |    |                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------------------------------|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>1.1 SUMMARY</u>            | .1 | Section Includes:<br>.1 Mechanical louvers; intakes; vents; and reinforcement and bracing for air vents, intakes and gooseneck hoods.                                                                                                                                                                                                                                                                                                      |
| <u>1.2 REFERENCES</u>         | .1 | ASTM International<br>.1 ASTM E90-09, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.                                                                                                                                                                                                                                                                             |
|                               | .2 | Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)                                                                                                                                                                                                                                                                                                                                                                |
| <u>1.3 SYSTEM DESCRIPTION</u> | .1 | Performance Requirements:<br>.1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.                                                                                                                                                                                      |
| <u>1.4 SUBMITTALS</u>         | .1 | Product Data:<br>.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00. Include product characteristics, performance criteria, and limitations.<br>.2 Indicate following:<br>.1 Pressure drop.<br>.2 Face area.<br>.3 Free area.                                                                                                                                           |
|                               | .2 | Quality assurance submittals: submit following in accordance with Section 01 33 00.<br>.1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.<br>.2 Instructions: submit manufacturer's installation instructions.<br>.1 Departmental Representative will make available 1 copy of systems supplier's installation instructions. |
-

1.4 SUBMITTALS

(Cont'd)

.2 (Cont'd)

.2 (Cont'd)

.3 Test Reports:

.1 Submit certified data from independent laboratory substantiating acoustic and aerodynamic performance to ASTM E90.

1.5 DELIVERY,  
STORAGE, AND  
HANDLING

- .1 Packing, shipping, handling and unloading:
- .1 Deliver, store and handle in accordance with Section 01 61 00.
- .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 GOOSENECK HOODS

- .1 Thickness: to ASHRAE and SMACNA.
- .2 Fabrication: to ASHRAE and SMACNA.
- .3 Joints: to ASHRAE and SMACNA.
- .4 Supports: as indicated.
- .5 Complete with integral birdscreen of 2.7 mm diameter aluminum wire. Use 12 mm mesh on exhaust and 19 mm mesh on intake.

2.2 FIXED LOUVRES -  
ALUMINUM

- .1 Construction: welded with exposed joints ground flush and smooth.
- .2 Material: extruded aluminum alloy AA 6063-T5.
- .3 Blade: stormproof pattern with centre watershed in blade, reinforcing bosses and maximum blade length of 1500 mm.
- .4 Frame, head, sill and jamb: 100 mm deep one piece extruded aluminum, minimum 3 mm thick with approved caulking slot, integral to unit.
- .5 Mullions: at 1500 mm maximum centres.

- 2.2 FIXED LOUVRES - ALUMINUM  
(Cont'd)
- .6 Fastenings: stainless steel SAE-194-8F with SAE-194-SFB nuts and resilient neoprene washers between aluminum and head of bolt, or between nut, ss washer and aluminum body.
  - .7 Screen: 12 mm exhaust and 19 mm intake mesh, 2 mm diameter wire aluminum birdscreen on inside face of louvres in formed U-frame.
  - .8 Finish: anodized. Colour: to Departmental Representative approval.

PART 3 - EXECUTION

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

- 3.2 INSTALLATION
- .1 In accordance with manufacturer's and SMACNA recommendations.
  - .2 Reinforce and brace as indicated.
  - .3 Anchor securely into opening. Seal with caulking to ensure weather tightness.

- 3.3 CLEANING
- .1 Proceed in accordance with Section 01 74 11.
  - .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

PART 1 - GENERAL

1.1 REFERENCES

- .1 National Fire Prevention Association (NFPA)
  - .1 NFPA 96-2011, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
  - .2 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
    - .1 ASHRAE 52.2-2007, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size. WITHDRAWN
  - .3 Canadian General Standards Board (CGSB)
    - .1 CAN/CGSB-115.10-M90, Disposable Air Filters for the Removal of Particulate Matter from Ventilating Systems.
    - .2 CAN/CGSB-115.11-M85, Filters, Air, High Efficiency, Disposable, Bag Type (Reaffirmed April 1985).
    - .3 CAN/CGSB-115.12-M85, Filters, Air, Medium Efficiency, Disposable, Bag Type (Reaffirmed April 1985).
    - .4 CAN/CGSB-115.14-M91, High Efficiency Cartridge Type Supported Air Filters for the Removal of Particulate Matter from Ventilating Systems.
    - .5 CAN/CGSB-115.15-M91, High Efficiency Rigid Type Air Filters for Removal of Particulate Matter from Ventilating Systems.
    - .6 CAN/CGSB-115.18-M85, Filter, Air, Extended Area Panel Type, Medium Efficiency.
  - .4 Underwriters' Laboratories of Canada
    - .1 ULC-S111-07, Standard Method of Fire Tests for Air Filter Units.
    - .2 ULC-S649-06, Grease Filters for Commercial and Institutional Kitchen Exhaust Systems.

1.2 SHOP DRAWINGS  
AND PRODUCT DATA

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

1.3 CLOSEOUT  
SUBMITTALS

- .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00.

|                                                  |    |                                                                                                                  |
|--------------------------------------------------|----|------------------------------------------------------------------------------------------------------------------|
| <u>1.4 WASTE<br/>MANAGEMENT AND<br/>DISPOSAL</u> | .1 | Separate and recycle waste materials in accordance with Section 01 74 20, and with the Waste Reduction Workplan. |
|--------------------------------------------------|----|------------------------------------------------------------------------------------------------------------------|

|                                      |    |                                                                    |
|--------------------------------------|----|--------------------------------------------------------------------|
| <u>1.5 MAINTENANCE<br/>MATERIALS</u> | .1 | Provide maintenance materials in accordance with Section 01 78 00. |
|--------------------------------------|----|--------------------------------------------------------------------|

|                                |    |                                                                                                                                                                                                                                 |
|--------------------------------|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>1.6 EXTRA<br/>MATERIALS</u> | .1 | Spare filters: in addition to filters to be installed immediately prior to acceptance by Departmental Representative, supply 1 complete set of filters for each filter unit or filter bank in accordance with Section 01 78 00. |
|--------------------------------|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

## PART 2 - PRODUCTS

|                    |    |                                                                                                                               |
|--------------------|----|-------------------------------------------------------------------------------------------------------------------------------|
| <u>2.1 GENERAL</u> | .1 | Media: suitable for air at 100% RH and air temperatures between minus 40 and 50°C.                                            |
|                    | .2 | Number of units, size and thickness of panels, overall dimensions of filter bank, configuration and capacities: as indicated. |
|                    | .3 | Pressure drop when clean and dirty, sizes and thickness: as indicated on schedule.                                            |

|                        |    |                                                                                                                                                                                              |
|------------------------|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>2.2 ACCESSORIES</u> | .1 | Holding frames: permanent "T" section or channel section construction of galvanized steel or extruded aluminum same material as casing/hood, 1.6 mm thick, except where specified otherwise. |
|                        | .2 | Seals: to ensure leakproof operation.                                                                                                                                                        |
|                        | .3 | Blank-off plates: as required, to fit all openings and of same material as holding frames.                                                                                                   |
|                        | .4 | Access and servicing: through doors/panels on each side or from upstream or downstream face of filter bank.                                                                                  |

2.3 FILTER  
PERFORMANCE

- .1 Pleated Panel Filters 500 ; MERV 8; UL 900 Class 2) (30 to 35% Dust Spot Efficiency)
- .1 Each filter shall consist of an individual pleated media pack, enclosed in a clay coated board frame, with integral pleat stabilizers and support straps.
- .2 The media shall be a blend of 100% virgin synthetic fibers. Media must also be self-supporting in pleated form, with no metal or plastic material laminated to the media to provide pleat support.
- .3 The pleated media pack must be enclosed in a 1-piece, 28 pt. moisture resistant beverage carrier board frame. In addition to the perimeter frame, the filter must have three pleat stabilizers bonded to the media on the air leaving side and three support straps adhered to the air entering side of the filter. The pleat stabilizers must be made of moisture resistant beverage carrier board, and bonded to the media to maintain the proper pleat spacing throughout the life of the filter. The support straps are to be made from moisture resistant beverage carrier board and must be adhered along the tips of each pleat.
- .4 Filters of the size and air flow capacity shall meet the following rated performance specifications based on the ASHRAE 52.2-1999 test method. Pertinent tolerances specified in Section 7.4 of the Air-Conditioning and Refrigeration Institute (ARI) Standard 850-93 shall apply to the performance ratings. All testing is to be conducted on filters with a nominal 600 x600 (24" x 24") face dimension.

|                                        |                               |
|----------------------------------------|-------------------------------|
| Minimum Efficiency Reporting Value     | 8                             |
| Dust Holding Capacity (grams)          | 105                           |
| Nominal Size (Width x Height x Depth)  | 600 x 600 x 50<br>24 x 24 x 2 |
| Rated Air Flow Capacity (cfm)          | 2000                          |
| Rated Air Flow Rate (feet per minute)  | 500                           |
| Final Resistance (inches w.g.)         | 1.0                           |
| Rated Initial Resistance (inches w.g.) | 0.33                          |

- .5 The filters shall be approved and listed by Underwriters' Laboratories, Inc. as Class 2 when tested according to U. L. Standard 900 and CAN 4-5111.

2.3 FILTER  
PERFORMANCE  
(Cont'd)

---

- .2 Extended Surface Cartridge Filters (300mm );  
MERV 13; UL 900 Class 1.
- .1 Each filter shall consist of a pleated media pack contained in galvanized steel cell sides. The filters shall be capable of operating at temperatures up to 176 deg. The filters must fit without modification to the holding frames.
- .2 The filter cell sides and single (peripheral) header shall be constructed of 30 gauge galvanized steel. The header and cell sides must be of unitized design, where the cell sides are interlocked with the header along the entire perimeter of the filter. This is to provide maximum sealing around the filter, eliminating the potential for air bypass. To further seal the contact between the header and cell sides, tape is applied at each corner of the filter to eliminate any bypass that may occur. The rear flanges of the cell sides should also be crimped to eliminate sharp edges and riveted to eliminate air bypass. One half inch wide bars of 20 gauge steel are riveted to the air leaving side of the filter to add supplemental support to the media pack.
- .3 The media shall be made of micro glass fibers with a water repellent binder. The media shall be a dual density construction, with coarser fibers on the air entering side and finer fibers on the air leaving side.
- .4 The media shall be pleated using corrugated aluminum separators. The edges of the separators shall be rolled over, to prevent any accidental abrasion or cutting of the media.
- .5 During the pleating of the media, a small amount of adhesive is applied to each separator, which bonds the adjacent media to the separator. This provides a rigid media pack that minimizes any shifting or excessive movement of the pack which could damage the media. A layer of lofted, high efficiency media is applied between the media pack and the cell sides at the top and bottom of the filter. This provides a sealant for air bypass, as well as a cushion for the media pack during any shipping or handling. The media is glued along the sides of the filter to prevent air bypass.



2.3 FILTER  
PERFORMANCE  
(Cont'd)

.2 (Cont'd)  
.6 Filters of the size, air flow capacity and nominal efficiency (MERV) shall meet the following rated performance specifications based on the ASHRAE 52.2-1999 test method. Where applicable, performance tolerance specified in Section 7.4 of the Air-Conditioning and Refrigeration Institute (ARI) Standard 850-93 shall apply to the performance ratings. All testing is to be conducted on filters with a nominal 600 x 600 mm (24"x24") header dimension.

|                                        |           |
|----------------------------------------|-----------|
| Minimum Efficiency Reporting Value     | 13        |
| Dust Spot Efficiency                   | 80 to 90% |
| Dust Holding Capacity (grams)          | 130       |
| Nominal Size (Width x Height x Depth)  | 24x24x12  |
| Rated Air Flow Capacity (cfm)          | 2000      |
| Rated Air Flow Rate (feet per minute)  | 500       |
| Final Resistance (inches w.g.)         | 1.2       |
| Rated Initial Resistance (inches w.g.) | 0.56      |

.7 The filters shall be approved and listed by Underwriters' Laboratories, Inc. as Class 1 when tested according to U. L. Standard 900 and CAN 4 5111.

.3 Extended Surface V-Bank Cartridge Filters (300; MERV 13; UL 900 Class 2:

2.3 FILTER  
PERFORMANCE  
(Cont'd)

- .3 (Cont'd)
- .1 Each filter shall consist of 8 pleated media packs assembled into 4 V banks within a totally plastic frame. The filters shall be capable of operating at temperatures up to 176 degrees Fahrenheit. The filters must either fit without modification or be adaptable to the existing holding frames. If adapters are required, they must be included in the total bid price and notation of this requirement made on the bid form.
- .2 The molded end panels are to be made of high impact polystyrene plastic. The center support members shall be made of ABS plastic. No metal components are to be used.
- .3 The media shall be made of micro glass fibers with a water repellent binder. The media shall be a dual density construction, with coarser fibers on the air entering side and finer fibers on the air leaving side.
- .4 The media shall be pleated using separators made of continuous beads of low profile thermoplastic material.
- .5 The media packs shall be bonded to the structural support members at all points of contact, this improves the rigidity as well as eliminates potential air bypass in the filter.
- .6 Filters of the size, air flow capacity and nominal efficiency (MERV) shall meet the following rated performance specifications based on the ASHRAE 52.2-1999 test method. Where applicable, performance tolerance specified in Section 7.4 of the Air-Conditioning and Refrigeration Institute (ARI) Standard 850-93 shall apply to the performance ratings. All testing is to be conducted on filters with a nominal 24"x24" header dimension.

|                                          |                        |
|------------------------------------------|------------------------|
| Minimum Efficiency<br>Reporting Value    | 13                     |
| Dust Spot Efficiency                     | 80 to 90%              |
| Dust Holding Capacity<br>(grams)         | 430                    |
| Nominal Size<br>(Width x Height x Depth) | 600x600x150<br>24x24x6 |
| Rated Air Flow<br>Capacity (cfm)         | 2000                   |

Rated Initial Resistance  
(inches w.g.)

|                   |    |                                                   |
|-------------------|----|---------------------------------------------------|
| 2.4 FILTER GAUGES | .1 | Diaphragm actuated, direct reading.               |
| <u>DIAL TYPE</u>  | .2 | Range: 0 to 2 times initial pressure 0 to 250 Pa. |

### 3.3 FILTER GAUGES

- .1 Install type across each filter bank (pre-filter and final filter) in approved and easy readable location.
- .2 Mark each filter gauge with value of pressure drop for clean condition and manufacturer's recommended replacement (dirty) value.

PART 1 - GENERAL

1.1 GENERAL

- .1 This section of the Specification shall be read in conjunction with and will be governed by the requirements outlined in Section 01 33 00.
- .2 Submit shop drawings in accordance with Section 01 33 00. Do not proceed with fabrication without approved shop drawings.
- .3 Clearly indicate proposed routing, fittings, expansion joints, supports, radiation shield and all other related parts.
- .4 Height of stacks shall be at least 60" (1500 mm) unless noted otherwise. Also refer to mechanical and architectural drawings.
- .5 Breeching and Chimneys shall be a manufactured chimney product. The use of Schedule 40 steel pipe with insulation is not acceptable.

1.2 SUMMARY

- .1 Section Includes:
  - .1 Materials, accessories and installation for breechings, chimneys and stacks.

1.3 REFERENCES

- .1 Sheet Metal and Air Conditioning Contractors National Association (SMACNA).
- .2 Underwriters' Laboratories of Canada (ULC.)
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
  - .1 Material Safety Data Sheets (MSDS).

1.4 SUBMITTALS

- .1 Product Data:
    - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 Submittal Procedures and 01 78 00. Include product characteristics, performance criteria, and limitations.
  - .2 Shop Drawings:
-

1.4 SUBMITTALS  
(Cont'd)

- .2 (Cont'd)
  - .1 Submit shop drawings in accordance with Section 01 33 00 Submittal Procedures and Section 01 78 00.
  - .2 Indicate following:
    - .1 Methods of sealing sections.
    - .2 Methods of expansion.
    - .3 Details of thimbles.
    - .4 Bases/Foundations.
    - .5 Supports.
    - .6 Guy details.
    - .7 Rain caps.
- .3 Quality assurance submittals: submit following in accordance with Section 01 33 00 Submittal Procedures.
  - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .4 Closeout Submittals
  - .1 Submit operation and maintenance data for incorporation into manual specified in Section 01 78 00 Closeout Submittals.

1.5 DELIVERY,  
STORAGE AND  
HANDLING

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with manufacturer's written instructions.

1.6 WASTE  
MANAGEMENT AND  
DISPOSAL

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

PART 2 - PRODUCTS

2.1 BREECHINGS

- .1 Shop fabricated 3.5 mm thick stainless steel welded, with sweep bends from boiler outlet to thimble or chimney as indicated.
- .2 Type A: To CAN/ULC-S604-1994, Factory Built, Type A chimneys.
  - .1 Application: gas and liquid fuel fired appliances.

2.1 BREECHINGS  
(Cont'd)

- .2 (Cont'd)
  - .2 Service Temperature: Maximum flue gas temperature of 540 C.
- .3 Type B: To CAN/ULC-S605-1991, Gas Vents
  - .1 Application: gas fired appliances certified with draft hoods or divertors.
  - .2 Service Temperature: Maximum flue gas temperature of 243 C.

2.2 POSITIVE  
PRESSURE VENT -  
FOR GAS FIRED  
POSITIVE PRESSURE  
BOILERS -  
CONDENSING BOILERS  
AND CONDENSING  
DOMESTIC HOT WATER  
HEATERS

- .1 The vent shall be of double wall, factory-built type for use on condensing appliances or pressurized venting system serving Category II, III, or IV appliances or as specified by the equipment manufacturer.
- .2 Maximum temperature shall not exceed 550 deg F (288 deg C).
- .3 Vent shall be listed for an internal static pressure of 6" w.g. and tested to 15" w.g.
- .4 Vent shall be constructed on an inner and outer wall with a 1" annular insulating air space.
- .5 The inner wall (vent) shall be constructed of AL29-4c superferric stainless steel, 0.015 thickness for 6" to 12" diameters and 0.024 thickness for 14" to 24" diameters.
- .6 The outer wall (casing) shall be type 304 stainless steel, .018 thickness for 6"-12" diameters and .024 thickness for 14" to 24" diameters.
- .7 Inner and outer walls shall be connected by means of spacer clips that maintain the concentricity of the annular space and allow unobstructed differential thermal expansion of the inner and outer walls.
- .8 All sections and accessories shall be joined with mated fittings and couplings, outer and inner seals between sections to suit application.
- .9 Clearance to Combustible: 2" (50 mm) air space, clearance to non combustible: 0.

2.2 POSITIVE  
PRESSURE VENT -  
FOR GAS FIRED  
POSITIVE PRESSURE  
BOILERS -  
CONDENSING BOILERS  
AND CONDENSING  
DOMESTIC HOT WATER  
HEATERS  
(Cont'd)

- .10 All supports, roof or wall penetrations, terminations, appliance connectors and drain fittings, required to install the vent system shall be included.
- .11 Roof penetration pieces shall be UL listed and provided by the vent manufacturer. Roof curbs shall be required on roofs greater than 12:12 pitch.
- .12 All inner vent connections shall be secured by means of profiled connector bands with gear clamp tighteners. Joints shall be sealed with P077 sealant.
- .13 Where exposed to weather, the outer closure band shall be sealed to prevent rainwater from entering the space between inner and outer walls.
- .14 Vent shall terminate in accordance with installation instructions and local codes.
- .15 Accessories:
  - .1 Cleanouts shall be bolted shall be bolted, gasketed type, full size of breeching, and as indicated.
  - .2 Rain caps, radiation shields, supports, flashings, storm collars, appliance adaptors and all components required for installation in accordance with manufactures recommendations and instructions.
  - .3 Hangers and supports shall be constructed in accordance with recommendations of SMACNA and the manufacturer(s) of chimneys and breeching and shall be ULC labeled, Type A, 540 C. rated, all fuels.
- .16 Standard of Acceptance: Metal-Fab Corr/Guard Model CG, Van Packer, Selkirk, Metalbestos, Industrial Chimney Co. ( ICC)

2.3 GAS VENT

- .1 Chimney shall be ULC labeled, Type B, 425? C. rating maximum, gas vent only. Use "B" vents only for venting approved gas appliances in accordance with the "Installation Code for Gas Burning Appliances and Equipment", CSA B149.1, CSA B149.2 , NFPA 211 Standards and Authorities having jurisdiction.

2.3 GAS VENT  
(Cont'd)

- .2 Clearance to combustibles : 1" (25 mm)  
clearance to non combustible : 0.
- .3 Sectional prefabricated double wall with mated fittings and couplings. Outer casing galvalume, and inner liner of aluminum.
- .4 Accessories:
  - .1 Cleanouts shall be bolted, gasketted type and full size of breeching;
  - .2 Support assembly;
  - .3 Firestop spacer;
  - .4 Roof Flashing and Storm Collar;
  - .5 Raincap;
  - .6 Draft Hood Connector ( If applicable);
  - .7 Tee or reduction tee with swivel joint;
  - .8 Barometric dampers shall be complete with double acting, 70% of full size of breeching area as per appliance manufacturers recommendation and as indicated.
- .5 Hangers and supports shall be in accordance with recommendations of SMACNA and the manufacturer.
- .6 Standard of Acceptance:
  - .1 Cleaver Brooks Amerivent, Van Packer, Selkirk, Metalbestos B Vent and Don Park Inc.

2.4 ACCESSORIES

- .1 Cleanouts: bolted, gasketted type, full size of breeching, as indicated.
- .2 Barometric dampers: single or double acting as required, 70% of full size of breeching area.
- .3 Hangers and supports: in accordance with recommendations of Sheet Metal and Air Conditioning Contractors National Association Inc. (SMACNA) and manufacturers recommendations.
- .4 Rain cap.
- .5 Expansion sleeves with heat resistant caulking, held in place as indicated.



PART 3 - EXECUTION

3.1 MANUFACTURER'S  
INSTRUCTIONS

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

3.2 INSTALLATION -  
GENERAL

- .1 Follow manufacturer's and SMACNA installation recommendations for shop fabricated components.
- .2 Support chimneys at bottom, roof and intermediate levels as required. Install thimbles where penetrating roof and floor.
- .3 Install chimneys penetrating roofs as indicated, complete with flashings to suit installation.
- .4 Provide all fuels chimney for all natural gas appliances with chimney under positive pressure.
- .5 Submit detailed shop drawings prior to fabrication.
- .6 For all fuel chimneys, insure the shaft provided is non combustible.
- .7 Do not penetrate the flue gas chamber of vent with screws or mechanical fasteners.
- .8 Install breeching with positive slope upward from appliance.
- .9 Suspend breeching using trapeze hangers at 1500 mm centres.
- .10 Install cleanout at the base of the chimney.
- .11 Provide for expansion and contraction of chimney and breeching.
- .12 Provide barometric dampers when required by system design and indicated on the drawings
- .13 Follow manufacturer's and SMACNA installation recommendations for shop fabricated components.

3.2 INSTALLATION -  
GENERAL  
(Cont'd)

- .14 Install thimbles where penetrating roof, floor and ceiling.
- .15 Install flashings on chimneys penetrating roofs, as indicated.
- .16 Install rain caps and cleanouts, as indicated.

3.3 CLEANING

- .1 Proceed in accordance with Section 01 74 00 - Cleaning and Waste Management.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

PART 1 - GENERAL

1.1 REFERENCES

- .1 American Boiler Manufacturer's Association (ABMA)
- .2 American National Standards Institute (ANSI)
  - .1 ANSI Z21.13-2004/CSA 4.9-2004, Gas-Fired Low-Pressure Steam and Hot Water Boilers.
- .3 American Society of Mechanical Engineers (ASME)
  - .1 ANSI/ASME Boiler and Pressure Vessel Code, Section IV, 2010.
- .4 Canadian Gas Association (CGA)
  - .1 CAN1-3.1-77(R2006), Industrial and Commercial Gas-Fired Package Boilers.
- .5 Canadian Standards Association (CSA)
  - .1 CSA B51-14, Boiler, Pressure Vessel, and Pressure Piping Code.
  - .2 CSA B140.7.2-1967(R2001), Oil-Fired Steam and Hot Water Boilers for Commercial and Industrial Use.
  - .3 CAN/CSA-B149.1-15, Natural Gas and Propane Installation Code.
- .6 Electrical and Electronic Manufacturer's Association of Canada (EEMAC)

1.2 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00.
- .2 Indicate the following:
  - .1 General arrangement showing terminal points, instrumentation test connections.
  - .2 Clearances for operation, maintenance, servicing, tube cleaning, tube replacement.
  - .3 Foundations with loadings, anchor bolt arrangements.
  - .4 Piping hook-ups.
  - .5 Equipment electrical drawings.
  - .6 Burners and controls.
  - .7 All miscellaneous equipment.
  - .8 Flame safety control system.
  - .9 Breeching and stack configuration.
  - .10 Stack emission continuous monitoring system to measure CO, O<sub>2</sub>, NO<sub>x</sub>, SO<sub>2</sub>, stack temperature and smoke density of flue gases.

- |                                                  |    |                                                                                                                                                                                                                                                                                                                                                                   |
|--------------------------------------------------|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>1.2 SHOP DRAWINGS<br/>(Cont'd)</u>            | .3 | Engineering data to include:<br>.1 Boiler efficiency at 25%, 50%, 75%, 100%,<br>and 110% of design capacity.<br>.2 Radiant heat loss at 100% design capacity.                                                                                                                                                                                                     |
| <u>1.3 CLOSEOUT<br/>SUBMITTALS</u>               | .1 | Submit operation and maintenance data for<br>incorporation into manual specified in<br>Section 01 78 00.                                                                                                                                                                                                                                                          |
| <u>1.4 WASTE<br/>MANAGEMENT AND<br/>DISPOSAL</u> | .1 | Separate and recycle waste materials in<br>accordance with Section 01 74 20.                                                                                                                                                                                                                                                                                      |
| <u>1.5 MAINTENANCE</u>                           | .1 | Maintenance materials to include:<br>.1 Special tools for burners, manholes,<br>handholes and Operation and Maintenance.<br>.2 Spare parts for 1 year of operation.<br>.3 Spare gaskets.<br>.4 Spare gauge glass inserts.<br>.5 Probes and sealants for electronic<br>indication.<br>.6 Spare burner tips.<br>.7 Spare burner gun.<br>.8 Safety valve test gauge. |

PART 2 - PRODUCTS

- |                                            |    |                                                                                                                                                                                                                                                                                                                  |
|--------------------------------------------|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>2.1 GENERAL - CAST<br/>IRON BOILERS</u> | .1 | Boiler unit shall be factory assembled and<br>tested. The boilers shall be guaranteed against<br>faulty design, material and workmanship for a<br>period of one year from date of delivery. The<br>guarantee will cover the cost of repair or<br>replacement of warranty assessed material and<br>freight costs. |
|                                            | .2 | Packaged boiler: complete with burner and<br>necessary accessories and controls, fire tested<br>ready for attachment of water supply, return<br>and drain piping, electrical connections, and<br>vent connection, designed and constructed to<br>Section IV, ASME Code.                                          |
|                                            | .3 | Standard of Acceptance: Viessman, Dedietrich,<br>Buderus.                                                                                                                                                                                                                                                        |

2.2 PERFORMANCE

- .1 Capacity as indicated on the schedule.
- .2 Flue gas temperature leaving boiler not to exceed 260 C or to be lower than dew point conditions at minimum firing rate.
- .3 The boiler pressure vessel shall be warranted against damage resulting from thermal stress for a period of 20 years from the date of shipment, provided the boiler is operated and maintained in accordance with the conditions specified in the Owner's Operating and Maintenance Manual.

2.3 BOILER DESIGN

- .1 Building heating boilers shall be near condensing for operation using a natural gas forced draft power burner. Boilers approved to ANSI Z21.13 CSA 4.9-2000 standards meeting Category II with minimum efficiency of 85.2% and sustainable efficiency of up to 88%. Boilers shall have no limit on inlet water temperatures, tempering of return water with supply water is NOT ACCEPTABLE.
- .2 Boilers shall be constructed of eutectic cast iron sections manufactured in accordance with ASME requirements for low-pressure boilers and each section shall be permanently marked with the ASME symbol and the maximum allowable working pressures. The eutectic cast iron shall have a modulus of elasticity of 30% greater than other cast iron. The warranty on boilers shall not be affected if flue gas condensation is allowed within the boiler. Boilers and burners shall be listed as a package, site approval not acceptable. Boiler and burner package must have proven field verified track record for a period of 3 years minimum.
- .3 Boilers shall be of a three pass wetbase, wetbacks design with optimized fins and cast iron turbulators to permit greater heat transfer. The forced draft burner shall be capable of firing the boilers pressurized combustion chamber assuring proper draft and positive ventilation. The burner shall be mounted to swing open either left or right on hinged mounting plate.

2.3 BOILER DESIGN  
(Cont'd)

- .4 Boiler sections shall be surface ground to ensure smooth positive mating surfaces. Boiler sections shall be assembled with precision-machined bi-spherical push nipples pressed into mating machinery nipple port in the section. A gas tight seal with the use of a siliconed thermocord sandwiched between sections prevents leakage of flue gases. The boiler shall be complete with a drain tapping and drain valve. Boilers shall be complete with full-swing doors that give access to all flue ways and combustion areas for easy maintenance and cleaning without burner removal.
- .5 The complete boiler including the bottom shall be insulated with a minimum thickness of 100mm (4") of reinforced fiberglass wool insulation, and shall be encased in a heavy gauge steel boiler jacket. This jacket shall be installed after system piping has been connected to the boiler section assembly. Jacket will have removable panels to allow access to the boiler as required.
- .6 Boiler shall have flame viewports.
- .7 Standard of Acceptance: DeDietrich, Viessman.

2.4 BOILER SUPPLY  
TO SITE

- .1 Boilers are to be supplied to site in separate sections to allow the boiler to be brought into the boiler room through a standard single exterior door.

2.5 BOILER TRIM

- .1 The following items will be installed on the boiler:
  - .1 Low water cut off: A probe type, low water cut off control shall be supplied loose for installation in a straight run on the supply pipe. It shall be wired to the burner control circuit to prevent the burner operation if the boiler water falls below a safe level. The low water cut off shall be mounted and wired at the factory.
  - .2 Water pressure relief valves shall be of a type and size to comply with ASME Code requirements. Relief valves shall be sized to release the entire boiler capacity.
  - .3 Pressure and temperature gauges.

2.5 BOILER TRIM  
(Cont'd)

- .1 (Cont'd)
- .4 Low water cut off high limit operating control.
- .5 High fire control.
- .6 Drain valve.
- .7 Flush valve kit connected to the flush opening.

2.6 BURNER

- .1 The boiler/burner shall be pre-wired to provide the following operation:
  - .1 Local - Remote switch on burner.
  - .2 In Remote position burner shall be capable of being controlled from BAS.
  - .3 In Local position burner shall operate from supplied controls.
- .2 All control circuits shall be 120V, 60 Hz., 1 Ph. With all switches in the ungrounded leg. Fuse protection for the control circuit shall be provided.
- .3 The burner shall be provided with squirrel cage 3,450 rpm motor, and shall be factory tested and incorporated all necessary devices and controls to make a complete fuel burning system and bear a National Recognized Testing Laboratory listing The burner shall be designed for natural gas/oil/dual fuel and be of the forced-draft pressure-atomizing type with no CO present in the products of combustion. The burner shall be furnished with an integral motor-driven blower, stainless steel flame retention type combustion head and observation port, and a primary control which utilizes a UV scanner. No alternate burners acceptable.
- .4 Main gas pressure regulator, (vented to outside atmosphere, in accordance with local codes), approved automatically operated motorized safety gas shutoff valve, with proof of closure interlock switches, second automatically operated gas safety, manually operated gas shutoff valve located downstream of both automatic gas valves (to permit leakage testing of valves), test pressure tappings upstream and downstream of each valve and regulator, air damper with high-low control linkage.

2.6 BURNER  
(Cont'd)

- .5 Furnish and install a natural gas fired UL/ULC approved fuel burning systems in full accordance with the requirements of provincial and local codes, the local gas utility and other applicable regulatory bodies.
- .6 The burner shall be factory fire tested in a pressure vessel to ensure proper operation before shipment. The burner shall be fired, and linkages and pressures set at the rated capacity and under simulated field conditions.

2.7 PILOT GAS TRAIN  
FOR EACH BURNER

- .1 A separate pilot gas cock, gas pressure regulator, pilot safety shut off gas valve, and pilot pressure test port shall be provided for the ignition gas supply.
- .2 The pilot gas train shall be factory mounted and wired.

2.8 GAS TRAIN FOR  
EACH BURNER

- .1 The gas train piping shall include a 6 mm N.P.T. pressure tap, with 6 mm pipe plug upstream and downstream of each valve and regulator in the gas train.
- .2 Provide a pressure gauge to indicate the gas burner manifold pressure.
- .3 Furnish and install one manually operated ball valve upstream of all valves.
- .4 Provide main gas pressure regulator (of tight shut off type) with vent to outside atmosphere in accordance with local codes.
- .5 Provide one automatically operated motorized safety gas valve for each boiler.
- .6 One safety shut off valve shall be proven closed during pre-ignition by proof of valve closure interlock switch on valve.
- .7 A manually operated gas valve shall be located downstream of both automatic gas valves to permit leakage testing of the valves. A leak test gauge and gauge cock shall be provided.



2.8 GAS TRAIN FOR  
EACH BURNER  
(Cont'd)

- .8 Gas pressure monitoring shall be provided by approved pressure switches interlocked to accomplish a non recycling safety shutdown in the event of either high or low gas pressure.

2.9 BURNER CONTROLS

- .1 Boiler controls shall be housed in a factory pre-wired control cabinet. The cabinet shall house combustion Safeguard Control to provide prepurge, postpurge and burner sequencing, complete with flame rod. Panel shall include the following:
- .1 All panel wiring with color-coded wire.
  - .2 Motor starters with overload protection for blower motor.
  - .3 On/off switch.
  - .4 Low/auto switch.
  - .5 Step down transformer for 120-volt output. With circuit fuse if power supply is 3-phase.
  - .6 Individual pilot lights with nameplated to indicate: "Power On", "Main Fuel Valve On", and "Flame Failure".
  - .7 Electronic safety combustion controls shall be supplied to monitor pilot and main flame. Detection will be means of a flame rod. The programming control shall be a Fireye, model MC120 and will provide pre and post purge, trial for ignition, energize main fuel circuit, interrupted tupe pilot and sequence operation.
  - .8 Manual restart of each burner shall be necessary in the event of a shutdown due to flame failure.
- .2 The modulating operation of the burner shall be controlled by water temperature by means of a temperature control. The signal shall be received from a 4-20 mA signal from the Building Automation System.
- .3 Pre and post operation of the burner fan shall be provided per current cUL requirements.
- .4 A manual restart of the burner shall be necessary in the event of shutdown due to flame failure.
- .5 All three phase motors shall be controlled and protected by an automatic starter with thermal overload protection. The starter shall be interlocked to prevent burner operation when over load relays are tripped out.

2.9 BURNER CONTROLS  
(Cont'd)

- .6 Supply a burner mounted diaphragm air flow switch to prevent energizing the main fuel valves in the event of insufficient combustion air.
- .7 A factory wired control cabinet shall be supplied and mounted on the burner. The control cabinet shall house the flame safeguard control, programming timer, burner motor starter, fuses, control switches, alarm bell with automatic reset silencing switch to ring on low water or flame failure, indicating lamps and required relays.
- .8 Full modulation of fuel input shall be provided. A modulating pressure control shall be supplied to modulate a burner mounted damper motor controlling both fuel and air supply by means of direct mechanical linkage.
- .9 The controller shall have a run/test switch. It shall allow interruptions to sequence just after pre purge, during pilot ignition trial and run cycles for adjustments to firing rate motors and pilot flame for minimum turndown tests.

2.10 BOILER  
CONTROLS

- .1 Boiler shall be provided with the following:
  - .1 Boiler run time meter.
  - .2 Flue gas temperature thermometer displayed at boiler control panel.
- .2 A dry contact shall be provided for each boiler to allow the BAS to detect an alarm from the Boiler Control Panel. Boiler manufacturer shall provide a connection for the dry contact on a terminal strip.
- .3 A 4-20 mA signal shall be provided for each boiler control panel to modulate the burner as required. The boiler shall receive the 4-20 mA signal and fire the burner accordingly.
- .4 Lead/Lag control of the boilers shall be performed by the BAS.
- .5 Remote/Local switch to enable BAS to control the boilers in the remote position and the boiler to operate independently in the local position.

2.11 CONDENSING  
BOILER

---

- .1 General Requirements
  - .1 Boiler Factory-packaged unit, complete with jacket, gas manifold, burner and controls mounted and wired, as specified in this Section.
  - .2 The complete boiler shall be factory fire tested by the manufacturer and a copy of the firetest report shall be sent to the Consultant.
  - .3 Heat exchangers shall be constructed in accordance with Section IV of the ASME code, with straight, integral copper-finned tube construction and a gastketless header at top and bottom.
  - .4 The heat exchanger design must allow for individual access and replacement of each tube.
  - .5 The heat exchanger shall encompass the entire burner and be enclosed in stainless steel with a fully water-backed tube sheet.
  - .6 Each boiler shall be contained in a minimum 16-gauge negative pressure steel jacket protected with a powder-coated finish. The unit shall be able to operate with any jacket panels removed during inspection or maintenance periods.
  - .7 Standard of Acceptance: Viessman, Dedietrich, Buderus.
- .2 Fuel Burning System
  - .1 Radiant non-corroding ceramic burner, with no moving parts. Double-meshed screen, fiber-metal mats, aluminized or stainless steel construction of the burner will not be accepted.
  - .2 Burner operation shall be Full Modulation with minimum 3:1 turn down utilizing a VFD and air-fuel ratio valve for dependable, repeatable modulation. Dampers, linkages or a one-speed fan are not acceptable.
  - .3 Interrupted-type mixed fuel/air pilot system with electric spark-to-pilot ignition that utilizes a UV scanner to prove pilot before main gas valves open. Hot surface ignition systems are not acceptable.

2.11 CONDENSING  
BOILER  
(Cont'd)

- .2 (Cont'd)
- .4 The entire firing control sequence shall be monitored by a UL approved, commercial-type microprocessor flame safeguard programmer with first out fault annunciation and diagnostic indicator lights. Furnish pre-purge and post-purge timing. Shut down burner in the event of ignition pilot and/or main flame failure with manual reset. It shall also recognize the Proof of Closure switches on the gas valves (if IRI w/POC).
- .5 Full frontal access port shall be provided for the control area.
- .6 The boiler will be equipped with a non-sparking blower manufactured with a cast aluminum housing.
- .7 Combustion air pressure switch shall be provided.
- .8 The blower shall be equipped with a replaceable combustion air filter, 99% efficient to one micron. The unit will have the capability of sealed, direct, or conventional venting. Air inlet dampers and vacuum relief dampers are not required for proper operation.
- .9 The sound level for a single boiler shall be no more than 60 Db.
- .3 Gas Train
- .1 Gas train shall be UL/FM/CSD-1 compliant.
- .2 The gas train shall be certified to take a maximum of 5 psi Natural Gas.. Additional step-down regulators are not allowed and can cause nuisance shutdowns of the unit.
- .3 Pilot and main gas pressure regulator.
- .4 Automatic main and redundant gas valves.  
.1 Motorized automatic main and redundant gas valves and a normally open vent valve in between.
- .5 Leak test valves downstream of each gas valve.
- .6 High and low gas pressure switches.
- .7 Manual shut off valve upstream of burner and downstream of last gas valve.
- .4 Electrical Input
- .1 Electrical input to each boiler shall be 208v/3ph. The manufacturer will mount the control transformer and fuses inside the unit, as needed, before it leaves the factory. Single-point electrical hook-up on every unit is required; separate power wiring and control wiring is not acceptable.

2.11 CONDENSING  
BOILER

(Cont'd)

- .4 (Cont'd)
  - .2 The boilers must utilize a commercial quality 120v/1ph control system. A residential type 24v control system is not acceptable.
- .5 Water Trim and Controls
  - .1 ASME rated pressure relief valve.
  - .2 Combination water pressure and temperature gage. Furnish graduated pressure gauge scale from 1-1/2 to 3 times of pressure relief valve setting.
  - .3 A water flow switch to prevent burner operation during low water flow conditions.
  - .4 An adjustable high limit temperature controller with manual reset to prevent water temperature from exceeding a safe system temperature.
  - .5 An adjustable operating temperature controller.
- .6 Venting
  - .1 Refer to Section 23 51 00.
  - .2 Barometric dampers are not allowed.
- .7 Air Intake Piping
  - .1 Provide galvanized smoke pipe that is sealed and pressure tight. Pipe must be at least the same size as the connection on the unit.
  - .2 The pipes passing through the exterior wall and exposed outside shall be stainless steel. Provide a stainless steel bird screen on the pipe inlet and provide a whistle cut on the bottom of the pipe.
- .8 Boiler Controls
  - .1 A dry contact shall be provided for each boiler to allow the Building Automation System to accept an alarm from the Boiler Control Panel. Boiler manufacturer shall provide a connection for the dry contact on a terminal strip.
  - .2 A 4-20 mA signal shall be provided for each boiler control panel to modulate the burner as required. The boiler shall receive the 4-20 mA signal and fire the burner accordingly.
  - .3 Lead/Lag control of the boilers shall be performed by the Building Automation System.
  - .4 Remote/Local switch to enable Building Automation System to control the boilers in the remote position and the boiler to operate independently in the local position.

2.12 EMISSION  
CONTROL

- .1 Rate of discharge of air contaminants from boiler not to exceed:
  - .1 For nitrogen oxides expressed as nitrogen dioxide:
    - .1 22 ng/J of heat input when fired with gaseous fuel.

2.13 PERFORMANCE

- .1 The boiler shall have a minimum of 88% thermal efficiency as listed in the Equipment Schedule of the Contract Documents.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Install in accordance with ANSI/ASME Boiler and Pressure Vessels Code Section IV, regulations of Province having jurisdiction, except where specified otherwise, and manufacturers recommendations.
- .2 Make required piping connections to inlets and outlets recommended by boiler manufacturer.
- .3 Maintain clearances as indicated or if not indicated, as recommended by manufacturer for operation, servicing and maintenance without disruption of operation of any other equipment/system.
- .4 Mount unit level using specified vibration isolation in Section 23 05 48.
- .5 Pipe hot water relief valves full size to nearest drain.
- .6 Natural gas fired installations in accordance with CAN/CSA-B149.1.
- .7 LP gas installations in accordance with CAN/CSA-B149.1.

3.2 MOUNTINGS AND  
ACCESSORIES

- .1 Safety valves and relief valves:
  - .1 Run separate discharge from each valve.
  - .2 Terminate discharge pipe as indicated.
  - .3 Run drain pipe from each valve outlet and drip pan elbow to above nearest drain.

3.3 COMMISSIONING

- .1 Manufacturer to:
  - .1 Certify installation.
  - .2 Start up and commission installation.
  - .3 Carry out on-site performance verification tests.
  - .4 Demonstrate operation and maintenance.
- .2 Provide Departmental Representative at least 24 h notice prior to inspections, tests, and demonstrations. Submit written report of inspections and test results.
- .3 Refer to 23 05 03 for commissioning requirements.

## PART 1 - GENERAL

### 1.1 GENERAL

- .1 Conform to the General Provisions For Mechanical Section 23 05 00.

### 1.2 SUBMITTALS

- .1 Submit shop drawings and product data in accordance with Section 01 33 00.
- .2 Indicate the following: complete specifications; wiring diagrams (showing all interconnections); weight; performance details.
- .3 Provide data for inclusion in the Operating and Maintenance manuals in accordance with Section 01 78 00.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- .1 Scroll compressor chiller shall CSA approved and UL listed.
- .2 Unit shall meet the performance detailed in the schedule. Construction and ratings shall be in accordance with latest ARI Standard 550/590, ANSI/ASHRAE 15, CSA-B52 and ASME Code.
- .3 Equipment shall meet efficiency standards of ASHRAE Standard 90.1
- .4 The unit shall be completely factory assembled on a rugged steel base and shall be shipped with a full operating charge of R410A refrigerant.
- .5 Standard of Acceptance: McQuay, York, Trane.

### 2.2 COMPRESSORS

- .1 The compressors shall be sealed hermetic scroll type with crankcase oil heater and suction strainer. The compressor motor shall be refrigerant gas cooled, high torque, hermetic induction type, two-pole, with inherent thermal protection on all three phases and shall be mounted on RIS vibration isolator pads.
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2.3 EVAPORATOR

- .1 Evaporators on units ranging from 30 tons to 130 tons shall be direct expansion type with stainless steel plates brazed together. It shall be insulated with 3/4 inch (19mm) closed cell polyurethane insulation and shall be rated for 653 psi (4500 kPa) water side working pressure.
- .2 Provide a chilled water flow switch to be field mounted in the chilled water line and field wired to terminals in the control panel.

2.4 CONDENSER

- .1 Condenser shall be a steel shell with integral finned copper tubes rolled into steel tube sheets. The chiller shall be equipped with intermediate tube supports.
- .2 It shall be designed for 232 psi (1599 kPa) water side working pressure and 450 psig (3104 kPa) refrigerant side pressure and be provided with ASME, ANSI B9.1 pressure relief valves.

2.5 REFRIGERANT  
CIRCUIT

- .1 Each refrigerant circuit shall be completely independent and shall include a liquid line shutoff valve, replaceable core or sealed filter-drier, sight glass with moisture indicator, liquid line solenoid valve, thermal expansion valve, and insulated suction line.
- .2 Hot gas bypass shall be provided on all circuits.

2.6 CONTROLS

- .1 The control panel shall contain a microprocessor controller providing operating and equipment protection controls, plus motor starting equipment. Controller shall be factory wired, operationally tested, and ready for operation. Standard components shall include a control transformer with primary and secondary fusing, microprocessor transformers with integral fusing, compressor contactors, circuit breakers, single-point wiring arrangement and switches for each circuit pump down and unit control power.

2.6 CONTROLS  
(Cont'd)

- .2 The control system shall stage the compressors based on the leaving water temperature.
- .3 Equipment protection devices include motor protection, high pressure, loss of refrigerant, loss of water flow, freeze protection, and low refrigerant pressure. Controls shall include auto/stop switch, chilled water set point adjustment, anti-recycle timer, and digital display with water temperature and set point, operating temperatures and pressures, and diagnostic messages.
- .4 The keypad/display shall provide access to all vital equipment data. Data shall include full description of current unit status, setpoint parameters, and alarms. Data shall be displayed in clear, precise English text with either English or metric units. Programmable security password protection shall be provided.
- .5 Control system shall monitor all system temperatures, pressures and safeties, and shall automatically shut down a refrigerant circuit or entire unit should a fault occur. All fault conditions shall be automatically time and date stamped, retained in memory and shall be available for display.
- .6 The DDC controller shall be equipped with a timeclock to allow the user to program a yearly schedule for weekday, weekend, and up to 14 separate holidays. The control system shall have auto-restart after power failure and NOT require battery back-up or auxiliary power supply for maintaining program memory. The microprocessor shall have a lithium battery timeclock to automatically ensure correct time of day input after power failure. Once power is restored, the controller shall check for any other faults and if none are present, shall permit normal unit operation.
- .7 Microprocessor shall accept a 4-20 mA DC for resetting chilled water temperature.
- .8 The microprocessor shall incorporate two short cycle time functions: start to start; and stop to start. These shall be specially programmed to provide the least amount of time off line while providing the maximum compressor motor protection.

2.6 CONTROLS  
(Cont'd)

- .9 During part load operation, the controller shall unload alternately between refrigeration circuits to maximize efficiency. On unit start-up, the microprocessor shall limit the rate at which chilled water loop temperature is pulled down. The pulldown rate shall be adjustable.
- .10 Controller shall provide output contact closure for control of chilled water and condenser water pump.
- .11 The chiller shall be factory installed with a microprocessor based DDC controller capable of communications with any Building Automation System supporting BACnet, Modbus and LONMark communications protocol. The information communicated between the BAS and the factory mounted unit controllers shall include the reading and writing of data to allow unit monitoring, control and alarm notification as specified in the unit sequence of operation and the unit points list.

2.7 ELECTRICAL

- .1 Field power connection, control interlock terminals and unit control system shall be centrally located. Panel access door shall key lock to prevent unauthorized access. Dead front panel shall protect service personnel against accidental contact with line voltage components.
- .2 Chiller shall be supplied with factory installed non fused disconnect and a single electrical connection.

2.8 START-UP  
SERVICE AND  
WARRANTY

- .1 Manufacturer shall furnish a factory trained service technician to perform the unit startup. Manufacturer shall provide instruction of the owner's personnel on the operation and maintenance of the unit. The warranty period shall commence at the date of initial startup and shall continue for a period of one (1) year not to exceed eighteen (18) months from shipment. Manufacturer's warranty shall include all parts and labour to install parts.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Install units on a flat surface level within 1/8 inch and of sufficient strength to support concentrated loading.
- .2 Provide components furnished as per manufacturer's literature.
- .3 Provide all water piping so unit and water circuits are serviceable, without having to dismantle excessive lengths of pipe.
- .4 Provide valves in water piping upstream and downstream of the evaporator and condenser water connections for isolating the shells for maintenance and to balance and trim the system.
- .5 Provide strainers ahead of all pumps and automatic modulating valves.
- .6 Provide pressure relief piping from relief valve to outside in accordance with manufacturer's instructions and CSA-B52.
- .7 Provide certified wiring schematics to the electrical division for the chiller, associated equipment and controls.
- .8 Provide all necessary control wiring as recommended by the manufacturer.

3.2 COMMISSIONING

- .1 Refer to 23 05 03 for commissioning requirements.

PART 1 - GENERAL

1.1 GENERAL

- .1 units shall be completely factory assembled piped, wired, tested and shipped in one piece to the job site. Refer to schedules for unit performance.
- .2 Air handling units shall be ETL-Canada safety listed to conform to UL Standard 1995 and CAN/CSA Standard C22.2 No. 236. Air handling unit water heating & cooling coils shall be certified in accordance with the forced circulation air cooling and air heating coils certification program, which is based on ARI Standard 410.

1.2 CASING

- .1 Fabricate unit with 16 gauge nominal channel posts and panels secured with mechanical fasteners. All panels and access doors shall be sealed with bulb-type gasket.
- .2 Panels and access doors shall be constructed as a 2-inch (50-mm) nominal thick, thermal broke double wall assembly, with 3 lb. per cu ft. density density neoprene coated fiberglass glass fiber insulation. The outer casing shall be constructed of 16 gauge G90 galvanized steel.
- .3 The inner liner shall be constructed of 22 gauge G90 galvanized steel. Panel deflection shall not exceed L/240 at 125% of design static pressure, minimum +/- 8". Deflection shall be measured at the midpoint of the panel height.
- .4 Access doors shall be flush mounted to the cabinetry and secured with heavy-duty stainless steel hinges. The door latch handle assembly shall be provided with a full-size grip handle and roller pall for smooth operation. The assembly shall be gasketed and sealed to prevent thermal bridging. All access doors shall open against pressure. Provide inspection window for each access door.
- .5 Construct drain pans from stainless steel with cross break and pitch to drain connection. Provide drain pans under fan section, cooling coil section and humidifier sections.

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- |                               |    |                                                                                     |
|-------------------------------|----|-------------------------------------------------------------------------------------|
| <u>1.2 CASING</u><br>(Cont'd) | .6 | Provide unit with a factory installed 6 inch high full perimeter channel base rail. |
|-------------------------------|----|-------------------------------------------------------------------------------------|
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- |                    |    |                                                                                                                                                                                                                          |
|--------------------|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>1.3 FILTERS</u> | .1 | Provide filter box section with filter guides, hinged and latching access doors on one sides, for side loading of filters. Filter section shall house prefilters and final filters per requirements in section 23 41 00. |
|                    | .2 | Filter media shall be UL 900 listed, Class I or Class II.                                                                                                                                                                |
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|--------------------|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>1.4 FILTERS</u> | .1 | Unit shall be provided with a draw-through filter section.                                                                                                     |
|                    | .2 | Provide angle arrangement filters with 2 inch deep (pleated panel filter) (disposable panel filters). Filters shall be accessible from both sides of the unit. |
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|----------------------------|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>1.5 FANS AND MOTORS</u> | .1 | Fans shall be belt driven, double inlet, forward curved or backward airfoil as indicated in the specification or on the equipment schedules.                                                                                                                                                               |
|                            | .2 | All fans shall be tested in accordance with AMCA Standard 210-70 Test Code for Air Moving Devices. Fans to carry AMCA authorized seal.                                                                                                                                                                     |
|                            | .3 | Fan housing shall be constructed of steel, continuously welded. All housings are equipped with spun intake cones designed for smooth air flow. The housing shall be adequately braced with structural steel for rigidity.                                                                                  |
|                            | .4 | Fan shafts are to be solid, ground and polished, carbon steel, machined to close tolerances, keyed to the fan wheel and designed with its maximum operating speed not to exceed 75% of its first critical speed. Coat the shaft with rust inhibitor after machining. Hollow shafts will not be acceptable. |
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1.5 FANS AND MOTORS  
(Cont'd)

- .5 Fan bearings shall be self aligning pillow block type with split tapered adapter locking sleeves, pre-lubricated with grease, heavy duty ball type, selected for an average life of 200,000 hours at design operating conditions. Bearings are to be mounted on the structural frame of the fan.
- .6 Drive sheaves are to be machined cast iron minimum two groove. An adjustable motor sheave is provided on 7-1/2 HP and less. Sheave selection and belt lengths are to be in accordance with the drive manufacturer and shall be rated for a capacity greater than 125% (150%) of the motor HP. For motors greater than 7 HP provide one drive change for air balancing.
- .7 Provide extended lubrication lines to permit lubrication for offside bearings from the access door side of the air handling unit.
- .8 Motors shall be high efficiency ODP type in accordance with section 23 05 13 for requirements.
- .9 Standard of Acceptance: Twin City, Barry Blower, Chicago, New York Blower.

1.6 VIBRATION  
ISOLATION

- .1 Fan and motor are to be mounted on an all welded, structural steel base, prime coated, internally isolated with springs to provide vibration isolation from the building structure. The fan outlet shall be separated from the unit casing with a factory installed flexible fabric connection. The motor shall be mounted on a slide rail base with dual adjustments for belt tensioning.
- .2 Vibration isolators shall be open type with sound deadening pads and leveling bolts. Isolators shall be sized in accordance with the manufacturers recommendations. Removable shipping restraints are provided to protect the fan, motor and base during shipment.

1.7 VARIABLE  
FREQUENCY DRIVES

- .1 Refer to Section 23 05 14.
- .2 Where units are indicated to be provided with variable speed drives in item 1.5.6 above, the variable speed drives shall be factory mounted on the air handling units. A power connection point shall be provided for each variable speed drive for connection by Electrical Contractor. The wiring from the variable speed drive to the motor shall be factory wired by the unit manufacturer in accordance with Electrical Contractor wiring methods.

1.8 FILTER GAUGE

- .1 Provide magnehelic gauges accurate to +/- 2 percent of full range for each filter bank.
- .2 Sensing probes and shut off valves shall be provided for each gauge.

1.9 DAMPERS

- .1 Refer to Section 23 33 15 for damper requirements.

1.10 COILS

- .1 Coils shall be fully enclosed within casing and mounted on primed and painted angle iron racks manufactured to allow coils to slide out individually.
- .2 Removable coil access panels shall be provided to remove coils through casing wall. Coils shall be individually removable towards the access side as shown on the drawings.
- .3 Drain pans shall be continuously welded galvanized steel. Intermediate drain pans shall be interconnected with 25 mm (1") drain lines.
- .4 Coils shall be designed for glycol and chilled water service.
- .5 Water coils shall be certified in accordance with ARI Standard 410-81.
- .6 Coils shall be hydrostatically tested at 400 Psig, (2758 KPa) and shall be suitable for working pressures and temperatures up to 200 Psig (1379 Kpa) and 220oF (104 C).



1.10 COILS  
(Cont'd)

- .7 Pipe connections shall be on the same end , and shall be threaded.
- .8 Air handling unit manufacturer to extend coil connections, coil drain, and vent connections through the casing wall and properly grommet and seal to ensure leakage specification is met.
- .9 Provide access to coils from connection side of unit for service and cleaning. Enclose coil headers and return bends fully within unit casing. Fabricate coil connections, vents and drains to extend beyond unit casing. Coils shall be removable through side panels without removal and disassembly of entire section.
- .10 Coil performance shall be as per schedule. Coil performance data shall be certified in accordance with ARI Standard 410 where applicable.
- .11 Water and glycol coils shall be circuited drainable with a vent connection at the high point and a drain connection at the low point. Coil headers shall be copper with steel male pipe connections.
- .12 Electrical requirements:
  - .1 All unit power wiring shall enter unit cabinet at factory predrilled locations.
  - .2 Provide marine lights in accordance with item 2.2.16 where indicated in the components list.

1.11 HUMIDIFIERS

- .1 Provide a complete humidification system as per schedules and schematics and as indicated on the drawings.
- .2 Direct Steam Injection Humidifiers
- .3 The humidification steam shall be generated by a DriSteem electric steam generator (or equivalent noted below) and shall be directly into air handling unit for humidification.
- .4 The humidification grid within the air handling unit shall be DriSteem Rapid Sorb (or equivalent noted below) with the following specifications:

1.11 HUMIDIFIERS  
(Cont'd)

- .4 (Cont'd)
- .1 Supply high-efficiency dispersion tubes insulated with plenum approved insulating material for in duct installation. The insulation material shall meet the criteria mandated by UL 723, NFPA 255 and ASTM E48 standards.
- .2 Each dispersion tube shall be fitted with two rows of high temperature tubelets inserted into the tube wall, centered on the diametric line, and spaced 1 ½" (40mm) apart. These tubelets shall be made of thermal resin material designed for high temperature steam temperatures. The two rows of tubelets in each dispersion tube shall discharge steam in diametrically opposite directions.
- .3 Each tubelet shall contain a steam orifice sized for its required steam capacity.
- .4 Each humidifier panel assembly of tubes and headers shall be contained with a stainless steel casing to facilitate the stacking of and/or the end to end mounting of multiple humidifier panels in the air handling unit.
- .5 All tubes and headers shall be 304 stainless steel and joints shall be Heli arc welded.
- .6 High Limit Duct Humidistat: Compatible high limit duct humidistat shall be shipped loose for field installation. Humidistat shall sense humidity level with the duct and provide over-humidification protection.
- .7 Air Flow Proving Switch: diaphragm operated, air flow proving switch shall be provided for field installation. Switch shall have an adjustable control point range of 1.27 mm to 305 mm W.C. and be rated for 1/4 H.P. at 125 VAC.

1.12 EXECUTION

- .1 Install units in accordance with manufacturers' instructions and as indicated.
- .2 Air handling unit may required in sections in order to fit through the louver opening. Mechanical Contractor shall be required to coordinate with the Air Handling unit Manufacturer the required section sizes to fit through this louver opening.
- .3 All air handling units shall be installed on 6" (150 mm) concrete housekeeping pads.

1.12 EXECUTION  
(Cont'd)

- .4 All air handling units shall be installed on 6" (150 mm) concrete housekeeping pads.
- .5 If equipment is stored before use, the field contactor must provide adequate protection to ensure that the unit interior and unit exterior are undamaged. This protection shall remain on the unit until such time as unit start up is performed. The contractor must rotate the fan assemblies on a periodic basis as recommended by the fan manufacturer.
- .6 Rig and set the unit in place. Ensure that spreader bars are used and the unit is protected from lifting cables. All lifting lugs must be used during the rigging process.
- .7 Entire unit shall be leveled.
- .8 Each drain connection shall be provided with a properly sized P trap. Provide union to allow for trap removal.
- .9 Remove all internal hold downs and shipping fasteners, and install any parts which were shipped loose. Level spring isolators.
- .10 Check and realign all access doors and dampers as required to ensure smooth operation through the entire range of travel.
- .11 Upon start up, fan motor is to be checked for rotation and amperage draw for each phase. Amperage readings are to be marked on the manufacturers start up form and returned to the manufacturer.
- .12 All belt drives are to be readjusted for tension and alignment. Refer to the manufacturers O & M manual for detailed servicing requirements.
- .13 Check all fan bearings and sheave set screws to ensure tightness. Refer to manufacturers O & M manual for detailed servicing requirements.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- .1 Units shall be completely factory assembled, piped, wired, tested and shipped in one piece to the job site. Refer to schedules for unit performance.
- .2 Units shall be specifically designed for outdoor rooftop application and include a weatherproof cabinet. Cooling capacity, heating capacity and fan performance shall be ARI certified. Complete unit shall be ETL- Canada listed.
- .3 The unit shall undergo a complete factory run test prior to shipment. The factory test shall include final balancing of the supply and return fan assemblies, a refrigeration circuit run test, a unit control system operations checkout, test and adjustment of the gas furnace, a unit refrigerant leak test and a final unit inspection. Units shall be shipped fully charged with refrigerant R410A.

### 2.2 CASING

- .1 The frame and unit base shall be heavy gauge galvanized steel. Unit base shall overhang the roof curb for water runoff and shall have a formed recess that seats on the roof curb gasketing to provide a positive weather tight seal.
- .2 Exterior panels shall be double-wall construction. Insulation shall be a minimum of 1" thick with an R-value of (4.0 on MPS units size 015 to 050) (6.5 on MPS units size 062 to 075), and shall be neoprene coated glass fiber. All floor panels shall have a solid galvanized steel inner liner on the air stream side of the unit to protect insulation during service and maintenance.
- .3 Exterior surfaces shall be constructed of pre-painted galvanized steel with a high quality, polyester resin topcoat of a neutral beige color. Finished panel surfaces to withstand a minimum 750-hour salt spray test in accordance with ASTM B117 standard for salt spray resistance.

2.2 CASING  
(Cont'd)

- .4 Service doors shall be provided on the fan section, coil section, economizer section and the filter section in order to provide user access to unit components. All service access doors shall be mounted on multiple, stainless steel hinges and shall be secured by a latch system. Removable service panels secured by multiple mechanical fasteners are not acceptable.
- .5 Lifting brackets with lifting holes shall be provided on each unit base.

2.3 FANS

- .1 Supply fan shall be a single width single inlet or double width double inlet airfoil centrifugal fan with performance as scheduled. Forward curved fans will not be accepted. The fan wheel shall be Class II construction with aluminum fan blades welded to the back plate and end rim.
- .2 The fan assembly shall have fixed pitched drives with a minimum of two belts. The drives shall be selected with a minimum diameter of 4 inches and a 1.2 service factor.
- .3 All supply fan assemblies shall be statically and dynamically balanced at the factory, including a final trim balance, prior to shipment. All fan assemblies shall employ solid steel fan shafts. Heavy-duty pillow block type, self-aligning, grease lubricated ball bearings shall be used. Bearings shall be sized to provide a L-50 life at 250,000 hours. The entire fan assembly shall be isolated from the fan bulkhead and mounted on spring isolators. Unit sizes 015 through to 050 shall be provided with 1 inch spring isolators. Larger units shall be supplied with 2 inch isolators.
- .4 Supply fan motors shall be heavy-duty 1800 rpm open drip-proof type with grease lubricated ball bearings. Motors shall be premium efficiency. Motors shall be mounted on an adjustable base that provides for proper alignment and belt tension adjustment. Motors shall be suitable for use with a variable frequency drive.

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|------------------------------------|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>2.3 FANS</u><br><u>(Cont'd)</u> | .5 | Exhaust fans shall be direct drive, axial type. Blades shall be constructed with fabricated steel and shall be securely attached to fan shafts. All exhaust fan assemblies shall be statically and dynamically balanced. Motors shall be permanently lubricated, heavy-duty type, carefully matched to the fan load. Ground and polished steel fan shafts shall be mounted in permanently lubricated and sealed ball bearings. Bearings shall be selected for a minimum (L10) life in excess of 100,000 hours at maximum cataloged operating speeds. |
| <br>                               |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <u>2.4 COOLING COIL</u>            | .1 | Evaporator coils shall be fabricated of seamless high efficiency copper tubing that is mechanically expanded into aluminum plate fins. Coils shall be a multi-row, staggered tube design. All units shall have two independent refrigerant circuits and shall use an interlaced coil circuiting that keeps the full coil face active at all load conditions. Single circuit systems will not be accepted.                                                                                                                                            |
|                                    | .2 | Stainless steel drain pans shall be sloped in two directions and comply with ASHRAE Standard 62.1. The drain pan shall extend beyond the leaving side of the coil.                                                                                                                                                                                                                                                                                                                                                                                   |
| <br>                               |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <u>2.5 FILTERS</u>                 | .1 | Unit shall be provided with a draw-through filter section.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|                                    | .2 | Provide angle arrangement filters with 2 inch deep (pleated panel filter) (disposable panel filters). Filters shall be accessible from both sides of the unit.                                                                                                                                                                                                                                                                                                                                                                                       |
| <br>                               |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <u>2.6 CONDENSING SECTION</u>      | .1 | Condenser coils shall be an all aluminum design. The aluminum tube shall be a micro channel design with high efficiency aluminum fins. Fins shall be brazed to the tubing for a direct bond. Condenser coils shall be protected from incidental contact to coil fins by a coil guard. Coil guard shall be constructed of cross wire welded steel with PVC coating.                                                                                                                                                                                   |
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2.6 CONDENSING  
SECTION  
(Cont'd)

- .2 Condenser fans shall be direct drive, axial type designed for low tip speed and vertical air discharge. Condenser fan rpm shall be 1140 rpm maximum. Fan blades shall be constructed of steel and riveted to a steel center hub. Condenser fan motors shall be heavy-duty, inherently protected, three-phase, non-reversing type with permanently lubricated ball bearing and integral rain shield.
- .3 Each circuit shall have fan cycling on at least one condenser fan to maintain positive head pressure. An ambient thermostat shall prevent the refrigeration system from operating below 20 degrees F.
- .4 Condenser coils shall be protected from hail damage as an integral part of the unit design.
- .5 Each unit shall have multiple, heavy-duty scroll compressors. Each compressor shall be complete with gauge ports, crankcase heater, sight-glass, anti-slug protection, motor overload protection and a time delay to prevent short cycling and simultaneous starting of compressors following a power failure. Compressors shall be isolated with resilient rubber isolators to decrease noise transmission.
- .6 Each unit shall have two independent refrigeration circuits. Each circuit shall be complete with isolation ball valves on the suction and discharge sides of the compressor, a low pressure control, filter-drier, liquid moisture indicator/sight-glass, thermal expansion valve, and a manual reset high pressure safety switch. The thermal expansion valve shall be capable of modulation from 100% to 25% of its rated capacity. Sight-glasses shall be accessible for viewing without disrupting unit operation. Each circuit shall be dehydrated and factory charged with Refrigerant 410A and oil.

2.7 ELECTRIC  
HEATING SECTION

- .1 Heating coils shall be constructed of a low watt density, high nickel chromium alloy resistance wire, mechanically stacked and heli-arc welded to corrosion resistant terminals. A corrosion resistant heavy gauge rack shall support the elements.

2.7 ELECTRIC  
HEATING SECTION  
(Cont'd)

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- .2 Safety controls shall include automatic reset high limit control with manual reset backup line break protection. Heating element branch circuits shall be fused for a maximum of 48 Amps per NEC requirements.
- .3 The electric heat elements shall be controlled by the factory installed DDC control system. Provide a minimum of four stages of heating control on units greater than 25 tons.
- .4 Power supply for the electric heater shall be from the rooftop unit control panel. Rooftop unit shall be designed for a single point power supply connection.

2.8 CONTROLS

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- .1 Provide a unit standalone DDC microprocessor based control system to operate the control of all unit functions including temperature control, scheduling, monitoring, compressor run times, and unit diagnostics. This system shall consist of all required temperature sensors, pressure sensors, controller and keypad/display operator interface. All MCBs and sensors shall be factory mounted, wired and tested.
- .2 The microprocessor shall maintain existing set points and operate as a stand alone device if the unit loses either direct connect or network communications. The microprocessor memory shall be protected from voltage fluctuations as well as any extended power failures. All factory and user set schedules and control points shall be maintained in nonvolatile memory. No settings shall be lost, even during extended power shutdowns.
- .3 The DDC control system shall permit starting and stopping of the unit locally or remotely. The control system shall be capable of providing a remote alarm indication. The unit control system shall provide for outside air damper actuation, emergency shutdown, remote heat enable/disable, remote cool enable/disable, heat indication, cool indication, and fan operation.



2.8 CONTROLS  
(Cont'd)

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- .4 The DDC controller shall have a built-in time schedule. There shall be one start/stop per day and a separate holiday schedule. The controller shall accept up to sixteen holidays each with up to a 5-day duration. Each unit shall also have the ability to accept a time schedule via BAS network communications.
- .5 If the unit is to be programmed with a night setback or setup function, an optional space sensor shall be provided. Sensor options shall include a zone sensor with tenant override switch plus heating and cooling set point adjustment.
- .6 The unit keypad/display character format shall be 4 lines x 20 characters. All control settings shall be password protected against unauthorized changes. For ease of service, the display format shall be English language readout. Coded formats with look-up tables will not be accepted. The user interaction with the display shall provide the following information as a minimum:
  - .1 Return air temperature
  - .2 Discharge air temperature
  - .3 Outdoor air temperature
  - .4 Space air temp
  - .5 Outdoor enthalpy, high/low
  - .6 Dirty filter indication
  - .7 Airflow verification Cooling status
  - .8 Control temperature (Changeover)
  - .9 VAV box output status
  - .10 Cooling status/capacity
  - .11 Unit status
  - .12 All time schedules
  - .13 Active alarms w/time and date
  - .14 Previous alarms with time and date
  - .15 Optimal start
  - .16 System operating hours
  - .17 Fan
  - .18 Exhaust fan
  - .19 Cooling
  - .20 Individual compressor
  - .21 Heating
  - .22 Economizer
  - .23 Tenant override.

2.8 CONTROLS  
(Cont'd)

- .7 To increase the efficiency of the cooling system the DDC controller shall include a discharge air temperature reset program for part load operating conditions. The discharge air temperature shall be controlled between a minimum and a maximum discharge air temperature (DAT) based on one of the following inputs:
  - .1 Airflow
  - .2 Outside air temperature
  - .3 Space Temperature
  - .4 Return air temperature
  - .5 External signal of 1-5 VDC
  - .6 External signal of 0-20 mA
  - .7 Network signal.
- .8 The unit control system shall have the ability to communicate to an independent Building Management System through a direct (BACnet Ethernet) (BACnet MSTP) (LonTalk) communication connection. The independent BMS system shall have access to "read only" variables and "read & write" variables. Communications shall not require field mounting of any additional sensors or devices at the unit.

2.9 ELECTRICAL

- .1 Each unit shall be wired and tested at the factory before shipment. Wiring shall comply with all applicable UL and CSA standards. All wiring shall be number coded per the electrical wiring diagrams. All electrical components shall be labeled according to the electrical diagram and be CSA recognized where applicable.
- .2 Unit shall have a single point power terminal block for main power connection. A terminal board shall be provided for low voltage control wiring. Branch short circuit protection, 115-volt control circuit transformer and fuse, system switches, and a high temperature sensor shall also be provided with the unit.
- .3 Each compressor and condenser fan motor shall be furnished with contactors and inherent thermal overload protection. Supply fan motors shall have contactors and external overload protection. Knockouts shall be provided in the bottom of the main control panels for field wiring entrance.

2.9 ELECTRICAL  
(Cont'd)

- .4 A single non-fused disconnect switch shall be provided for disconnecting electrical power at the unit. Disconnect switches shall be mounted internally to the control panel and operated by an externally mounted handle.
- .5 A GFI receptacle shall be unit mounted. The receptacle shall be powered by a factory installed and wired 120 V, 20 amp power supply. The power supply shall be wired to the line side of the unit's main disconnect, so the receptacle is powered when the main unit disconnect is off. This option shall include a GFI receptacle, transformer, and a branch circuit disconnect.

2.10 ROOF CURB

- .1 Each unit shall be provided with a prefabricated 14-gauge galvanized steel, mounting curb for field assembly on the roof decking prior to unit shipment. The roof curb shall be a full perimeter type with complete perimeter support of the air handling section and condensing section. The curb shall be a minimum of 14" high and include a nominal 2" x 4" wood nailing strip. Gasket shall be provided for field mounting between the unit base and roof curb.

2.11 START-UP  
SERVICE AND WARRANTY

- .1 Manufacturer shall furnish a factory trained service technician to perform the unit startup. Manufacturer shall provide instruction to the owner's personnel on the operation and maintenance of the unit. Factory technician to provide copy of start up log to owner and to demonstrate operation and maintenance to owners' representative. The warranty period shall commence at the date of initial startup and shall continue for a period of one (1) year not to exceed eighteen (18) months from shipment. Manufacturer's warranty shall include all parts and labour to install parts.

PART 3 - EXECUTION

- |                          |    |                                                                                                     |
|--------------------------|----|-----------------------------------------------------------------------------------------------------|
| <u>3.1 INSTALLATION</u>  | .1 | Install unit flat and level on roof curb in accordance with manufacturers' installation literature. |
|                          | .2 | Install and wire all control accessories and power wiring to the unit.                              |
| <u>3.2 COMMISSIONING</u> | .1 | Refer to Section 23 05 03 for commissioning requirements.                                           |

PART 1 - GENERAL

- 1.1 PRODUCT DATA
- .1 Submit product data in accordance with Section 01 33 00.
  - .2 Product data to include:
    - .1 Filters, fan accessibility.
    - .2 Physical size.
    - .3 Thermostat, transformer, controls where integral.
    - .4 Finish.
    - .5 kW rating, voltage, phase.
    - .6 Cabinet material thicknesses.
    - .7 Performance data.

- 1.2 WASTE MANAGEMENT AND DISPOSAL
- .1 Separate and recycle waste materials in accordance with Section 01 74 20.

PART 2 - PRODUCTS

- 2.1 GENERAL
- .1 The unit shall be McQuay, York or Carrier and shall be ARI certified.

- 2.2 CASING
- .1 Unit shall have corrosion resistant casing design consisting of an aluminum frame with 1" thick, double wall panels. Extruded aluminum frame and polymeric corners pieces shall be provided for casing protection and rigidity. Unit panels shall consist of injected polystyrene insulation sandwiched between galvanized steel exterior and interior sheets. Formed "thermal break" panels shall have a plastic molded edge to eliminate inner and outer panels from contacting each other. Panels shall be fastened to frame with perimeter screws that hold panels in place with a neoprene gasket in-between the panel and the frame to prevent thermal bridging from the interior to the exterior of the unit.

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- |                                    |    |                                                                                                                                                                                                                                                                                                                                                             |
|------------------------------------|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>2.2 CASING<br/>(Cont'd)</u>     | .2 | Removable panels on both sides of unit shall provide full access to unit interior. Blower access panels shall include handle to assist in removing panel.                                                                                                                                                                                                   |
| <br>                               |    |                                                                                                                                                                                                                                                                                                                                                             |
| <u>2.3 FANS</u>                    | .1 | Provide forward curved (direct drive SWSI plenum) fans as scheduled. Dynamically balance fans before and after installation in fan cabinet section. Ensure maximum fan RPM is below the first critical speed fan.                                                                                                                                           |
|                                    | .2 | Provide fan and motor assembly mounted on vibration isolators inside cabinet.                                                                                                                                                                                                                                                                               |
|                                    | .3 | Provide open drip proof high efficiency motors.                                                                                                                                                                                                                                                                                                             |
| <br>                               |    |                                                                                                                                                                                                                                                                                                                                                             |
| <u>2.4 BEARINGS AND<br/>DRIVES</u> | .1 | Provide bearings with basic load rating computed in accordance with AFBMA - ANSI Standards L-50 life at 200,000 hours, heavy duty pillow block type, self-aligning, grease-lubricated ball bearings.                                                                                                                                                        |
|                                    | .2 | Provide solid, hot rolled steel, ground and polished shaft, protectively coated with lubricating oil.                                                                                                                                                                                                                                                       |
|                                    | .3 | Provide variable pitch sheaves on all motors 7-1/2 HP and lower. Provide constant pitch sheaves on all motors greater than 7 1/2 HP. Size V-belt drive for a service factor of 1.25. On constant pitch units, allow for one sheave change including belts (parts only, labour by balancing contractor).                                                     |
| <br>                               |    |                                                                                                                                                                                                                                                                                                                                                             |
| <u>2.5 COILS</u>                   | .1 | Provide access to coils from connection side of unit for service and cleaning. Enclose coil headers and return bends fully within unit casing. Fabricate coil connections, vents and drains to extend beyond unit casing including grommets for an airtight unit casing. Coils shall be field interchangeable from right hand to left hand connection side. |
-

2.5 COILS  
(Cont'd)

- .2 Construct drain pans from stainless (anti-microbial coated galvanized) steel with sloping pitch to drain connection to allow for condensate drainage. Drain Pan shall be positioned above 1" thick insulated double wall panel. Condensate drain connections shall be provided on both sides of drain pan.
- .3 Coil performance shall be as per schedule. Coil performance data shall be certified in accordance with ARI Standard 410 where applicable.
- .4 Refrigerant cooling coils shall be designed for use with Refrigerant R410. Sweat type copper suction connections shall be located at the bottom of the suction headers for gravity oil drainage.
- .5 Provide electric heating coils with low watt density, open wire resistant elements. Heaters shall have primary and secondary protection circuits, airflow switch and a 24v control transformer. Provide single stage, multiple stage or SCR control as scheduled. Factory wire between element terminal block and control panel. Provide non-fusible disconnect for electric heat section.

2.6 FILTERS

- .1 Provide filter box section with filter guides, hinged and latching access doors for side loading of filters.
- .2 Filter section shall be a 2" flat type furnished with MERV 7 deep pleated panel filters.
- .3 Filter media shall be UL 900 listed, Class I or Class II.

2.7 UNIT ELECTRICAL

- .1 Provide factory mounted and wired starters for each fan motor.
- .2 Each starter shall have a Hand-OFF-Auto control switch, thermal overload and disconnect switch.
- .3 Provide a factory mounted non-fused disconnect switch.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Install unit flat and level on house keeping pad or from ceiling hangers and in accordance with manufacturer's installation literature.
- .2 Provide piping connections to coils such that individual coils can be isolated, drained and removed. Provide valved pressure gauge connections and thermometer wells on the entering and leaving piping.
- .3 Provide valved drain connections with hose end, cap and chain for all coils.
- .4 Pipe all drain pan connections the nearest floor drain with appropriately sized trap.

3.2 COMMISSIONING

- .1 Refer to Section 23 05 03 for commissioning requirements.



PART 1 - GENERAL

1.1 RELATED  
INSTRUCTIONS

- .1 This section of the specification shall be read in conjunction with and shall be governed by the requirements outlined in Section 23 05 00 of the specification.
- .2 Submit maintenance manuals in accordance Section 01 78 00.
- .3 Comply with the General Requirements of Electrical division.

1.2 GENERAL  
REQUIREMENTS

- .1 Upgrade the existing BAS control and monitoring system for the addition of new air handling equipment, terminal equipment and other specified systems employing distributed processing and direct digital control (DDC). The new components shall consist of the following:
    - .1 Stand Alone DDC Controllers
    - .2 Application Specific Controller.
  - .2 Reuse existing BAS controllers/panels where possible and integrate into upgraded system.
  - .3 The system shall be modular in nature and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, DDC controllers and operator devices.
  - .4 System architectural design shall eliminate dependence upon any single device for alarm reporting or control execution.
  - .5 The system proposed must be in full compliance with the specification as to configuration, function and features. Control subcontractor shall submit a compliance statement with the tender which shall detail areas to noncompliance of the specification.
-

1.2 GENERAL  
REQUIREMENTS  
(Cont'd)

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- .6 The Building Automation System (BAS) manufacturer shall furnish and install a fully integrated building automation system, incorporating direct digital control (DDC) for energy management, equipment monitoring and control, and subsystems with open communications capabilities as herein specified.
- .7 Provide networking to new DDC equipment using communication standards. System shall be capable of BACnet communication according to ASHRAE standard ANSI/ASHRAE 135-2010 for interoperability with smart equipment and for the main IP communication trunk to the BAS Server. The system shall not be limited to only standard protocols, but shall also be able to integrate to a wide variety of third-party devices and applications via drivers and gateways.
- .8 The intent is to either use the Operator Workstation provided under this contract to communicate with control systems provided by other vendors or to allow information about the system provided in this contract to be sent to another workstation. This allows the user to have a single seat from which to perform daily operation.
- .9 The operator interface for the system shall be web based. Each mechanical system, building floor plan, and control device will be depicted by point and click graphics. A web server with a network interface card will gather data from this system and generate web pages that can be accessed through a conventional web browser, and the browser interface shall allow the operator to perform all normal operator functions.
- .10 The installation of the control system shall be performed under the direct supervision of the controls manufacturer with the shop drawings, flow diagrams, bill of materials, component designation, or identification number and sequence of operation all bearing the name of the manufacturer.

1.2 GENERAL  
REQUIREMENTS  
(Cont'd)

- .11 Furnish a complete distributed direct digital control system in accordance with this specification section. This includes all system controllers, logic controllers, and all input/output devices. Items of work included are as follows:
  - .1 Provide a submittal that meets the requirements below for approval.
  - .2 Coordinate installation schedule with the mechanical contractor and general contractor.
  - .3 Provide installation of all panels and devices unless otherwise stated.
  - .4 Provide power for panels and control devices.
  - .5 Provide all low voltage control wiring for the DDC system.
  - .6 Provide miscellaneous control wiring for HVAC and related systems regardless of voltage.
  - .7 Provide engineering and technician labor to program and commission software for each system and operator interface. Submit commissioning reports for approval.
  - .8 Participate in commissioning for all equipment that is integrated into the BAS (Refer to Commissioning sections of the equipment or systems in other parts of this specification.)
  - .9 Provide testing, demonstration and training as specified below.
- .12 All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and not custom designed specially for this project. All systems and components shall have been thoroughly tested and proven in actual use for at least two years.
- .13 BAS manufacturer shall be responsible for all BAS and Temperature Control wiring for a complete and operable system. All wiring shall be done in accordance with all local and national codes.

1.3 REFERENCES

- .1 American National Standards Institute (ANSI)/The Instrumentation, Systems and Automation Society (ISA).
  - .1 ANSI/ISA 5.5 1985, Graphic Symbols for Process Displays.

1.3 REFERENCES  
(Cont'd)

- .2 American National Standards Institute (ANSI)/  
Institute of Electrical and Electronics  
Engineers (IEEE).
  - .1 ANSI/IEEE 260.1 1993, American National  
Standard Letter Symbols Units of Measurement  
(SI Units, Customary Inch Pound Units, and  
Certain Other Units).
- .3 American Society of Heating, Refrigerating and  
Air-Conditioning Engineers, Inc. (ASHRAE).
  - .1 ASHRAE STD 135-2010, BACNET - Data  
Communication Protocol for Building Automation  
and Control Network.
- .4 Canadian Standards Association (CSA  
International).
  - .1 CAN/CSA Z234.1 89 (R1995), Canadian Metric  
Practice Guide.
- .5 Consumer Electronics Association (CEA).
  - .1 CEA-709.1-B-2002, Control Network Protocol  
Specification.
- .6 Department of Justice Canada (Jus).
  - .1 Canadian Environmental Assessment Act  
(CEAA), 1995, c. 37.
  - .2 Canadian Environmental Protection Act  
(CEPA), 1999, c. 33.
- .7 Electrical and Electronic Manufacturers  
Association (EEMAC).
  - .1 EEMAC 2Y 1 1958, Light Gray Colour for  
Indoor Switch Gear.
- .8 Health Canada/Workplace Hazardous Materials  
Information System (WHMIS).
  - .1 Material Safety Data Sheets (MSDS).

1.4 SCOPE OF WORK

- .1 The responsibility of the Mechanical Contractor  
shall be as follows:
  - .1 Cooperating with the Control Contractor to  
assist with the installation of control  
devices.
  - .2 Reviewing all control valve and control  
system shop drawings to ensure that they meet  
Mechanical expectations.
  - .3 Receiving all control valves from the  
Control Contractor and installing them in the  
piping systems in accordance with the  
schematics and details shown on the drawings.

1.4 SCOPE OF WORK  
(Cont'd)

- .1 (Cont'd)
- .4 Providing all of the motorized dampers required to be installed in the ductwork. Damper actuators will be provided by the BAS Contractor.
- .5 Providing all temperature sensor wells, humidity sensor wells, flow switch wells and mounting requirements for all duct mounted devices.
- .6 Provide a copy of all motorized damper and equipment shop drawings to the BAS Contractor.
- .7 Installation of all air flow monitoring stations.
- .8 Installation of all flow meters.

1.5 SPARE PARTS

- .1 The BAS Contractor shall provide a list of Contractor or system supplier to provide:
- .1 Spare parts and the option to buy specialized tools at base cost.
- .2 List of Preventative Maintenance items that owner can implement in their own city wide Preventative Maintenance program.
- .3 List of maintenance materials and part numbers.

1.6 DEFINITIONS

- .1 Point Name: composed of two parts, point identifier and point expansion.
- .1 Point identifier: comprised of three descriptors, "area" descriptor, "system" descriptor and "point" descriptor, for which database to provide 25 character field for each point identifier. "System" is system that point is located on.
- .1 Area descriptor: building or part of building where point is located.
- .2 System descriptor: system that point is located on.
- .3 Point descriptor: physical or logical point description. For point identifier "area", "system" and "point" will be shortforms or acronyms. Database must provide 25 character field for each point identifier.

1.6 DEFINITIONS  
(Cont'd)

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- .1 (Cont'd)
- .2 Point expansion : comprised of three fields, one for each descriptor. Expanded form of shortform or acronym used in "area", "system" and "point" descriptors is placed into appropriate point expansion field. Database must provide 32 character field for each point expansion.
- .2 Point Object Type: points fall into following object types:
  - .1 AI (analog input).
  - .2 AO (analog output).
  - .3 DI (digital input).
  - .4 DO (digital output).
  - .5 Pulse inputs.
- .3 Symbols and engineering unit abbreviations utilized in displays: to ANSI/ISA S5.5.
  - .1 Printouts: to ANSI/IEEE 260.1.
- .4 BACnet: An industry standard data communication protocol for Building Automation and Control Networks. Refer to AHSRAE standard 135-2010.
- .5 BIBB: BACnet Interoperability Building Blocks.
- .6 MS/TP: Master-slave/token-passing. Refer to AHSRAE standard 135-2010.

1.7 SYSTEM  
ARCHITECTURE

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- .1 Performance Standards. The system shall conform to the following minimum standards. Information transmission and display times are based upon network, rather than modem, connections. Systems shall be tested using the manufacturer's recommended hardware and software for the operator workstation. (Server and browser, for web-based systems.)
  - .1 Graphic Display. The system shall display a graphic with 20 dynamic points with all current data within 5 seconds.
  - .2 Graphic Refresh. The system shall update a graphic with 20 dynamic points with all current data within 5 seconds.
  - .3 Configuration and Tuning Screens. Any special screens used for configuring, calibrating, or tuning points, PID loops, and similar control logic shall refresh every 5 seconds.

1.7 SYSTEM  
ARCHITECTURE  
(Cont'd)

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- .1 (Cont'd)
  - .4 Object Command. The maximum time between the command of a binary object by the operator and the reaction by the device shall be less than 2 seconds. Analog objects should start to adjust within 2 seconds.
  - .5 Alarm Response Time. The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed 2 seconds.
  - .6 Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 seconds. The Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.
    - .1 Performance. Programmable controllers shall be able to execute DDC PID control loops at a selectable frequency adjustable down to once per second. The Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.
  - .7 Multiple Alarm Annunciation. All workstations on the network must receive alarms within 5-seconds of each other.
  - .8 Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
    - .1 Water Temperature: Plus or minus 1 deg F.
    - .2 Water Flow: Plus or minus 5 percent of full scale.
    - .3 Water Pressure: Plus or minus 2 percent of full scale.
    - .4 Space Temperature: Plus or minus 1 deg F.
    - .5 Ducted Air Temperature: Plus or minus 1 deg F.
    - .6 Outside Air Temperature: Plus or minus 2 deg F.
    - .7 Dew Point Temperature: Plus or minus 3 deg F.
    - .8 Temperature Differential: Plus or minus 0.25 deg F.
    - .9 Relative Humidity: Plus or minus 2 percent.
    - .10 Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
    - .11 Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
    - .12 Airflow (Terminal): Plus or minus 10 percent of full scale.

1.7 SYSTEM  
ARCHITECTURE  
(Cont'd)

- .1 (Cont'd)
- .8 (Cont'd)
  - .13 Air Pressure (Space): Plus or minus 0.01-inch wg.
  - .14 Air Pressure (Ducts): Plus or minus 0.1-inch wg.
  - .15 Carbon Monoxide: Plus or minus 5 percent of reading.
  - .16 Carbon Dioxide: Plus or minus 50 ppm.
  - .17 Electrical: Plus or minus 5 percent of reading.
- .2 System shall be provided with a Virus Scan software to protect the BAS against viruses brought in by third party software.

1.8 SHOP DRAWINGS  
AND SAMPLES  
                    

- .1 Submit shop drawings in accordance with Section 01 33 00.
- .2 Contractor shall provide shop drawings or other submittals on all hardware, software, and installation to be provided. No work may begin on any segment of this project until submittals have been successfully reviewed for conformity with the design intent.
- .3 Submittals shall be provided within ten (10) weeks of contract award. Submittals shall include:
  - .1 Direct Digital Control System Hardware:
    - .1 A complete bill of materials of equipment to be used indicating quantity, manufacturer, model number, and other relevant technical data.
    - .2 Manufacturer's description and technical data, such as performance curves, product specification sheets, and installation/maintenance instructions for the items listed below and other relevant items not listed below:
      - .1 Direct Digital Controller (controller panels)
      - .2 Transducers/Transmitters
      - .3 Sensors (including accuracy data)
      - .4 Actuators
      - .5 Valves
      - .6 Relays/Switches
      - .7 Control Panels
      - .8 Power Supply
      - .9 Batteries



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- 1.8 SHOP DRAWINGS .3 (Cont'd)  
AND SAMPLES .1 (Cont'd)  
(Cont'd)
- 
- .10 Operator Interface Equipment
  - .11 Wiring.
  - .3 Points lists for each digital controller. Include termination numbers, device part numbers, signal type and number of wires required to terminate the device.
  - .4 Schematic diagrams for all field sensors and controllers. Provide floor plans of all sensor locations and control hardware.
  - .2 Central System Hardware and Software:
    - .1 A complete bill of material of equipment used, indicating quantity, manufacturer, model number, and other relevant technical data.
    - .2 Manufacturer's description and technical data, such as product specification sheets and installation/maintenance instructions for the items listed below and other relevant items not listed below if provided under this contract:
      - .1 Central Processing Unit or Web Server.
      - .2 Monitors
      - .3 Printers
      - .4 Keyboard
      - .5 Power Supply
      - .6 Battery Backup
      - .7 Interface Equipment Between CPU / Server and Control Panels
      - .8 Operating System Software
      - .9 Operator Interface Software
      - .10 Color Graphic Software
      - .11 Third-Party Software.
    - .3 Schematic diagrams for all control, communication, and power wiring. Provide a schematic drawing of the central system installation. Show all interface wiring to the control system.
    - .4 Riser diagrams of wiring between central control unit and all control panels.
  - .4 Controlled Systems:
-

1.8 SHOP DRAWINGS  
AND SAMPLES  
(Cont'd)

- .4 (Cont'd)
- .1 A schematic diagram of each controlled system. The schematics shall have all control points labeled with point names shown or listed. The schematics shall graphically show the location of all control elements in the system. All control points shall be coordinated with equipment suppliers to ensure compatibility.
- .2 A schematic wiring diagram for each controlled system. Each schematic shall have all elements labeled. Where a control element is the same as that shown on the control system schematic, it shall be labeled with the same name.
- .3 An instrumentation list (Bill of Materials) for each controlled system. Each element of the controlled system shall be listed in table format. The table shall show element name, type of device, manufacturer, model number, and product data sheet number.
- .4 A complete description of the operation of the control system, including sequences of operation. The description shall include and reference a schematic diagram of the controlled system. The description shall also include a list of all I/O points and software points as required by Appendix A. This list shall indicate which points are alarmed and/or trended. Each schematic shall reference a control sequence.
- .5 A schedule for all typical control systems to specifically identify the uniqueness of each individual system.
- .5 Quantities of items submitted shall be reviewed but are the responsibility of the Contractor.
- .6 A description of the proposed process along with all report formats and checklists to be used in the "Control System Demonstration and Acceptance." Refer to Item 3.3 below.
- .7 A BACnet Protocol Implementation Conformance Statement (PICS) for each type of controller and operator interface included in the submittal.

1.9 SCHEDULES

- .1 Within one month of contract award, provide a schedule of the work indicating the following:
- .1 Intended sequence of work items.

1.9 SCHEDULES

(Cont'd)

- .1 (Cont'd)
  - .2 Start dates of individual work items.
  - .3 Duration of individual work items.
  - .4 Planned delivery dates for major material and equipment and expected lead times.
  - .5 Milestones indicating possible restraints on work by other trades or situations.
- .2 Provide monthly written status reports indicating work completed, revisions to expected delivery dates, etc. An updated project schedule shall be included.

1.10 CONTROL SYSTEM  
CHECK-OUT AND  
TESTING DOCUMENTS

- .1 Contractor to submit six (6) copies of all system check out and testing documents for approval. Submittal to include testing procedures, check out sheets for devices, programming and graphics, and a proposed schedule that includes dependencies on other trades work.

1.11 OWNERSHIP OF  
PROPRIETARY MATERIAL

- .1 All project-developed software and documentation shall become the property of the owner. These include, but are not limited to:
  - .1 Project graphic images
  - .2 Record drawings
  - .3 Project database
  - .4 Project-specific application programming code
  - .5 All documentation.

1.12 FACILITIES  
WITH EXISTING  
BUILDING  
AUTOMATION SYSTEMS

- .1 Where a facility has an existing BAS that is to be replaced, modified or upgraded, the Division 25 contractor shall be responsible for ensuring that the entire system (hardware, programming and system graphics) and all integral parts (new and re-used) are in conformance with all requirements of the specifications outlined herein.
- .2 Provide current generation products only. The supply of out-of-date or obsolete products shall not be accepted. The supply of discontinued products or products no longer supported by the manufacturer shall not be accepted.

1.12 FACILITIES  
WITH EXISTING  
BUILDING  
AUTOMATION SYSTEMS  
(Cont'd)

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- .3 Ensure complete interoperability and compatibility between new and existing DDC systems and components. Provide system firmware and/or hardware upgrades to existing DDC panels/modules where required to ensure a complete working system to the satisfaction of the Departmental Representative. Ensure that firmware revision level of all controllers is the most up to date as recommended by the manufacturer and is consistent throughout the facility.
  - .4 For existing Automated Logic installations, provide only native ALC WebCtrl controllers and devices compatible with Exec 6 or Exec B firmware. For all controllers, provide new programming and graphics for specific use with the ALC WebCtrl system.
  - .5 Where an existing DDC panel is re-used, ensure that sufficient controller memory is present to provide for all specified control functions. Provide memory and/or panel upgrades where required to meet system memory requirements.
  - .6 Provide new network communication wiring for interconnection between all DDC panels and interfaces.
  - .7 Existing control wiring and conduit may be re-used only where it complies with the requirements of these specifications and where approved by the Engineer.
  - .8 Provide new end devices (e.g. sensors, transducers, relays) for all system inputs and outputs. Existing end devices may be re-used only where specifically noted on the controls points list or control drawings.
  - .9 Ensure that all re-used DDC panels/modules are upgraded to the latest version of system firmware and system operating software.
  - .10 Provide comprehensive commissioning and verification of all new and re-used system inputs and outputs, end devices and related components.
  - .11 Provide new labelling for wiring, devices and equipment where existing labelling does not meet the requirements of these specifications.
-

1.13 WORK INCLUDED

- .1 Comply with requirements of Mechanical General Requirements Section 23 05 00 and Electrical General Provisions.
- .2 Supply, install and commission a centralized automated computer based Energy Management and Control System (BAS) to meet functional performance requirements of system as herein specified. The BAS shall integrate multiple building functions, including equipment supervision and control, alarm management, energy management and trend data collection.
- .3 Include all computer hardware and software, operator input/output communication devices, standalone digital system controllers, communication interface to digital system controllers and field sensors and control devices required to meet specified performance.
- .4 Include all wiring, conduit, piping, installation, materials, supervision and labor including calibration, commissioning software programming and data base generation, and additional work necessary to provide a complete and fully operating system to the approval of Departmental Representative. Provide a modem to allow access from a remote site.
- .5 Wiring methods shall be as follows:

| Location                  | Type of Wiring         |
|---------------------------|------------------------|
| Exposed                   | Conduit                |
| Drops in Walls            | Conduit                |
| Above Accessible Ceilings | FT6 Plenum Rated Cable |
| Above Hard Ceilings       | Conduit                |

1.14 EQUIPMENT  
STANDARDS AND  
APPROVALS

- .1 All materials and equipment shall be standard components regularly manufactured by Supplier and guaranteed to be available as regular inventory as replacement parts for a minimum period of ten (10) years.
- .2 All electrical and electronic equipment shall be UL and / or NEC approved where such approvals are required by regulatory authorities.

1.14 EQUIPMENT  
STANDARDS AND  
APPROVALS  
(Cont'd)

- .3 All input/output devices shall be ASCII (American Standard for Communication and Information Interchange) coded with standard EIA (Electronic Industry Association) interface.
- .4 Digital controllers shall have capability for accommodating inputs and outputs meeting ISA (Instrument Society of America) standards.
- .5 Automation System to modem interfacing shall conform to EIA RS232C standards. Vendor supplied phone line modems shall be of a type as approved by the Owner.

1.15 ACCEPTANCE  
PROCEDURE

- .1 After installation, submit data relevant to point index, functions, limits, sequences, interlocks, software routines and associated parameters, and other pertinent information for operating system and data base shall be forwarded to Owner's authorized representative.
- .2 Prior to on line operation, a complete demonstration and readout of computer real time responsibilities of surveillance and command shall be performed in the presence of Owner's authorized representative.
- .3 Make adjustments to each device and component to ensure that operations are performed correctly and that all analog values are displayed to accuracy specified. All alarms, start/stop and status conditions shall be checked to ensure proper operation.
- .4 Upon successful completion of online operation, Departmental Representative shall be requested in writing to inspect and approve satisfactory operation of the BAS.
- .5 Complete all outstanding deficiencies as determined by Departmental Representative in his inspection report, after which a resubmission of formal acceptance shall be made. This procedure shall be repeated if necessary until acceptable performance has been established.

1.16 OPERATOR  
INSTRUCTION

- .1 The contractor shall provide a course outline and training materials for all training classes at least six weeks prior to the first class. Training shall be conducted via instructor led sessions, computer-based training, or web-based training. The Consultant may modify any or all of the training course outline and training materials to meet the needs of the Departmental Representative. Review and approval by the Departmental Representative shall be completed at least three weeks prior to the first class.
- .2 Provide a minimum of 40-hours of training for the Departmental staff on programming, trouble shooting, servicing and operation of the complete control system. The allocated time will be used at the Owner's discretion to train approximately six (6) staff members.
- .3 Provide a minimum of six (6) copies of a comprehensive Users Manual which describes in complete detail the application and on line programming features of the system.
- .4 Training shall include an explanation of the drawings, operations and maintenance manuals, a walk through of the site to locate control components, an explanation of the DDC controller and ASC operation/function, and an explanation of the adjustment, calibration, and replacement procedures.

1.17 OPERATING AND  
MAINTENANCE DATA

- .1 Upon completion of installation, submit six (6) copies of record (as-built) documents in 8 ½" x 11" (215 mm x 280 mm) hard cover looseleaf binder. Binders shall not be overfilled. The documents shall be submitted for approval prior to final completion and shall include:
  - .1 Enclose title sheet complete with project name, data, and list of contents.
  - .2 Project Record Drawings. These shall be as-built versions of the submittal shop drawings. One set of magnetic media drawing files shall also be provided, in a format compatible with or convertible to AutoCAD version 12 or higher. (.DWG, .DXF, .VSD, etc.)

1.17 OPERATING AND .1  
MAINTENANCE DATA  
(Cont'd)

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(Cont'd)

.3 Testing and Commissioning Reports and Checklists. Completed versions of all reports and checklists, along with all trend logs, used to meet the requirements of the "Control System Demonstration and Acceptance." Refer to Item 3.3 below.

.4 Operation and Maintenance (O&M) Manual. This shall include as-built versions of the submittal product data. In addition to the information required for submittals, the O&M manual shall include printed, electronic, or on-line help documentation of the following:

.1 Names, addresses, and telephone numbers of contractors installing equipment and the control systems and service representatives of each.

.2 Operators Manual with procedures for operating the control systems, including logging on/off, alarm handling, producing point reports, trending data, overriding computer control, and changing set points and other variables. Either printed or electronic documentation (help files or training materials) are acceptable.

.3 One set of Programming Manuals with a description of the programming language (including syntax), statement descriptions (including algorithms and calculations used), point database creation and modification, program creation and modification, and use of the editor.

.4 Engineering, Installation, and Maintenance Manual(s) that explain how to design and install new points, panels, and other hardware; preventive maintenance and calibration procedures; how to debug hardware problems; and how to repair or replace hardware.

.5 A listing and documentation of all custom software created using the programming language, including the set points, tuning parameters, and object database. Electronic copies of the actual programs may be used for this purpose, if the control logic, set points, tuning parameters, and other objects can be viewed through the supplied programming tools. One set of magnetic/optical media containing files of the software and database also shall be provided.



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|--------------------------------------------------------------------|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.17 OPERATING AND<br>MAINTENANCE DATA<br><u>(Cont'd)</u>          | .1 | (Cont'd)                                                                                                                                                                                                                                                                                                        |
|                                                                    | .4 | (Cont'd)                                                                                                                                                                                                                                                                                                        |
|                                                                    |    | .6 One set of magnetic/optical media containing files of all color graphic screens created for the project, if not included in the magnetic/optical media containing the software and database.                                                                                                                 |
|                                                                    |    | .7 A list of recommended spare parts with part numbers and suppliers.                                                                                                                                                                                                                                           |
|                                                                    |    | .8 Complete original issue documentation, installation, and maintenance information for all third-party hardware provided, including computer equipment and sensors.                                                                                                                                            |
|                                                                    |    | .9 Complete original issue diskettes for all software provided, including operating systems, programming language, operator workstation software, and graphics software.                                                                                                                                        |
|                                                                    |    | .10 Licenses, guarantees, and warranty documents for all equipment and systems.                                                                                                                                                                                                                                 |
|                                                                    |    | .11 Recommended preventive maintenance procedures for all system components, including a schedule of tasks (inspection, cleaning, calibration, etc.), time between tasks, and task descriptions.                                                                                                                |
|                                                                    |    | .12 A complete list of all BACnet objects (soft copy) including their ID's so that future expansion with other BACnet compliant vendors is possible.                                                                                                                                                            |
| <br>                                                               |    |                                                                                                                                                                                                                                                                                                                 |
| 1.18 IDENTIFICATION<br>OF EQUIPMENT<br><u>                    </u> | .1 | Identify each piece of equipment with nameplate identifying equipment and functions with letter and number designation.                                                                                                                                                                                         |
|                                                                    | .2 | Nameplates shall be minimum size, 3" x 1" x 1/4" (75 x 25 x 3.2 mm) thick lamicoated plastic with black face and white center and 1/2" (6.4 mm) high engraved lettering.<br>Nameplates shall be mechanically secured and listed in Operating and Maintenance Data Book.<br>All nameplates shall be pop riveted. |
| <br>                                                               |    |                                                                                                                                                                                                                                                                                                                 |
| <u>1.19 WARRANTY</u>                                               | .1 | Warrant all work as follows:                                                                                                                                                                                                                                                                                    |
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1.19 WARRANTY  
(Cont'd)

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- .1 (Cont'd)
- .1 Labor and materials for the control system specified shall be warranted free from defects for a period of 12 months after final completion and Owner receives beneficial use of the system. Control system failures during the warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to the owner. The contractor shall respond to the owner's request for warranty service within 24-hours during normal business hours.
- .2 All work shall have a single warranty date, even when the owner has received beneficial use due to an early system start-up. If the work specified is split into multiple contracts or a multi-phase contract, then each contract or phase shall have a separate warranty start date and period.
- .3 At the end of the final start-up, testing, and commissioning phase, if equipment and systems are operating satisfactorily to the Consultant, the Consultant shall issue a report indicating that the Control System's Operation has been spot checked and accepted in accordance with the terms of this specification. The date of acceptance shall be the start of warranty.
- .4 At the end of the warranty period, the contractor will upgrade the owner to the latest BAS software available at no cost to the Department.
- .2 Exception: The contractor shall not be required to warrant reused devices, except for those that have been rebuilt and/or repaired. The contractor shall warrant all installation labor and materials, however, and shall demonstrate that all reused devices are in operable condition at the time of engineer's acceptance.
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PART 2 - PRODUCTS

2.1 MATERIALS

- .1 All products used in this project installation shall be new and currently under manufacture and shall be the version currently being sold by the manufacturer for use in new installations. This installation shall not be used as a test site for any new products unless explicitly approved by the Departmental representative in writing. Spare parts shall be available for at least five years after completion of this contract.

2.2 COMMUNICATION

- .1 All networked control products provided for this project shall be comprised of an industry standard open protocol internetwork. Communication involving control components (i.e. all types of controllers and operator interfaces) shall conform to ASHRAE 135-2010 BACnet standard. Networks and protocols proprietary to one company or distributed by one company are prohibited.
- .2 Access to system data shall not be restricted by the hardware configuration of the building management system. The hardware configuration of the BMS network shall be totally transparent to the user when accessing data or developing control programs.
- .1 Software applications, features, and functionality, including administrative configurations, shall not be separated into several network control engines working together.
- .3 All controllers shall have a communication port for temporary connection to a laptop computer or other operator interface device. This connection shall support memory downloads and other operations needed for commissioning and troubleshooting.
- .4 Communication services over the internal network shall result in operator interface and value passing that is transparent to the internal network architecture as follows:
-

2.2 COMMUNICATION  
(Cont'd)

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.4

(Cont'd)

.1 Connection of an operator interface device to any one controller on the network will allow the operator to interface with all other controllers as if that interface were directly connected to the other controllers. Data, status information, control algorithms, etc., for all controllers shall be available for viewing and editing from any one controller on the internal network.

.2 All inputs, outputs, and other control parameters used to integrate control strategies across multiple controllers shall be readable by any other controller on the internal network. All links required to execute the control strategies described in Section 15 90 01 shall be programmed and tested by the contractor. An operator with appropriate password privileges shall be able to edit these links by either typing in a standard object address or using a simple point and click interface.

.3 The time clocks in all controllers shall be automatically synchronized daily via the internal network. An operator change to the master time clock shall be automatically broadcast to all controllers on the internal network.

.4 The internal network shall have the following minimum capacity for future expansion:

.1 Each router or building controller/router on the network backbone shall have routing capacity for 50 controllers.

.2 The network backbone shall have capacity for 50 routers or building controller/routers.

.3 The system shall have an overall capacity for 12,500 building controller, custom application controller, and application specific controller input/output objects.

2.3 OPERATOR  
INTERFACE

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.1

Furnish a web server as shown on the system drawings. Any standard browser connected to the server shall be able to access all information in the system. The server shall reside on the same high-speed network as the building controllers.

2.3 OPERATOR  
INTERFACE  
(Cont'd)

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- .2 Communication between the workstation or server and all controllers the network shall use the BACnet protocol. Communication between the workstation/server and the control network backbone shall use the ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in Annex J of the ASHRAE/ANSI BACnet Specification
- .3 The BAS server and Operator Workstations shall meet the BACnet device profile of an Advanced Workstation Server (B-AWS) and Operator Workstation (B-OWS).
- .4 Server-Client connections
  - .1 The Web based interface shall provide the same functionalities as those available at any other workstation, including operation and configuration capabilities.
  - .2 The Web server client licensing shall be from the same pool of client licenses available or installed client consoles or Windows desktop app clients.
  - .3 Internet connections, ISP services, as well as necessary firewalls or proxy servers shall be provided by the owner as required to support the Web access feature.
- .5 Hardware. Each operator workstation or web server shall consist of the following:
  - .1 Hardware Base. Furnish industry standard hardware that meets or exceeds the DDC System manufacturers recommended specifications and which can meet the response times required by paragraph 1.3 of this section. The hard disk shall be capable of storing all system software, a one year archive of trend data based upon the trend points in Section 25 90 01, and a system database at least twice the size of the database required when the system is accepted. Large systems may use multiple computers to store the required data, provided all computers and network connections are supplied and configured by the Contractor.
- .6 Operator Functions: The Operator Interface shall, as a minimum, provide the capability to execute the following functions:
  - .1 All operator interface functions must be available in clients running in a browser, installed client console, or Windows desktop app.

2.3 OPERATOR  
INTERFACE  
(Cont'd)

- .6 (Cont'd)
- .2 Login/Logout: The operator shall be required to log in and out of the operator interface using a secure password. The operator's login account shall determine what actions he or she can perform while logged into the system.
- .3 Point and click navigation: The operator interface shall be graphic based, allowing the operator to access screens for different pieces of equipment or physical areas through a point and click interface.
- .4 View and adjust equipment properties: With the proper authorization, the operator shall be able to view the status of the controlled equipment and adjust operating parameters such as setpoints, PID gains, on/off controls, sensor calibration, etc.
- .5 View and adjust operating schedules: With the proper authorization, the operator shall be able to view the scheduled operating hours of any schedulable piece of equipment and adjust the schedule as required. Provide a method of selecting the desired schedule and time period, and a graphical display that shows the schedule on a weekly or monthly calendar. Exception schedules and holidays shall be shown clearly on the calendar. Provide a method for allowing several related objects to follow the same schedule.
- .6 View and respond to alarms: With the proper authorization, the operator shall be able to view a list of currently active alarms in the system, acknowledge the alarm, and clear (delete) unneeded alarms.
- .7 View and configure trends: With the proper authorization, the operator shall be able to view a trend graph of any trended point in the system and edit the configuration of the graph to display a specific time period or data range. The operator shall also be able to create custom trend graphs which display data from multiple trended points on the same page.
- .8 View and configure reports: With the proper authorization, the operator shall be able to run a preconfigured report, view the results of this report, and customize the configuration to show data of interest.
-

2.3 OPERATOR  
INTERFACE  
(Cont'd)

- .6 (Cont'd)
    - .9 Manage control system hardware: With the proper authorization, the operator shall be able to view the current status of all control modules, restart (reboot) a control module, and download new control software to the module if required.
    - .10 Manage operator access: With the proper authorization, the operator shall be able to view a list of all operators who can access the system and the activities they can perform while logged in. The operator shall also be able to add new operators, delete existing operators, and edit the access privileges of new or existing operators. (Typically this function is only authorized for a few senior supervisors.)
  - .7 System software
    - .1 Operating System. The workstation/server platform shall be furnished with an industry standard professional grade operating system.
    - .2 Software: Provide the following application software licenses, preloaded on the laptop for the Owner: MS Office Professional, PC anywhere or terminal services, Internet Explorer or equal browser, MS Outlook, Acrobat Reader, CAD Viewer, Micrographx Designer. Set up an icon on the desktop to take the Owner directly to the BAS system login page.
    - .3 System Graphics.
      - .1 The operator workstation software shall be graphically oriented. The contractor shall provide all required graphic screens to provide a summary of the most important data for each controlled zone or piece of equipment, point and click navigation between zones or equipment, and editing of setpoints and other commonly accessed properties.
      - .2 For VAV systems a minimum of the following shall be provided on the graphic screen.
        - .1 Temperature
        - .2 VAV box Setpoint
        - .3 Actual CFM.
        - .4 Temperature Setpoint.
      - .3 For all VAV systems the operator shall be able to adjust the minimum/maximum settings of the VAV boxes and Fan Power Boxes from the Operator Workstation.
-

2.3 OPERATOR  
INTERFACE  
(Cont'd)

.7 (Cont'd)

.3 (Cont'd)

.4 As a minimum, the Contractor shall provide one graphic screen per piece of equipment or occupied zone as well as screens that summarize conditions on each floor of each building included in this contract.

.5 The summary of conditions on each floor shall include a presentation of thermal comfort, to be indicated by means of dynamic colors on the floor plans. The dynamic colors shall indicate the temperature relative to the setpoint of that area. Areas or equipment where an alarm condition exists shall be highlighted by means of color or other visual indicator(s). On the graphic the actual temperature of the area and the setpoint shall be shown.

.6 The Contractor shall also provide the tools and documentation necessary for the customer to edit supplied graphics or create new graphics and integrate them into the system. Using these tools, it shall be possible to add analog and binary values, dynamic text, static text, and animation files to a background graphic.

.7 The Contractor shall also provide the tools and documentation necessary for the customer to edit supplied graphics or create new graphics and integrate them into the system. Using these tools, it shall be possible to add analog and binary values, dynamic text, static text, and animation files to a background graphic.

.8 Graphic display shall include the ability to depict real-time point values dynamically with text or animation.

.9 Navigation through various graphic screens shall be optionally achieved through a hierarchical "tree" structure.

.10 Graphics viewing shall include dynamic pan zoom capabilities.

.11 Graphics viewing shall include the ability to switch between multiple layers with different information on each layer.

.12 Ability to create dashboard views that graphically display system and/ or energy performance. Dashboards will consist of gauges and charts.

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2.3 OPERATOR  
INTERFACE  
(Cont'd)

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.7

(Cont'd)

.4 Custom Graphics. Custom graphic files shall be created with the use of a graphics generation package furnished with the system. The graphics generation package shall be a graphically based system that uses a mouse to add dynamic data and system control symbols to a background graphic saved in an industry standard format such as BMP, JPEG, or GIF. Web-based systems shall be viewable on browsers compatible with the World Wide Web Consortium browser standards. Web graphics shall either require no plug-ins (ex: HTML and JavaScript) or plug-ins that are widely available at no cost to end users. (ex: Active-X and Macromedia Flash.)

.5 Graphics Library. Furnish a complete library of standard HVAC equipment graphics such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. This library also shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. The library shall be furnished in a file format compatible with the graphics generation package program.

.6 System Tools and Applications. The system shall include the following tools and applications, either as an integral part of the operator interface or as a separate stand-alone engineering tool. If provided as an integral part of the interface, the application shall be available from all operator workstations or browser interfaces. If provided as a stand-alone engineering tool, the software shall be installable on any standard IBM compatible PC with no limit on the number of copies that can be installed under the system license. The tools and applications shall provide the following functionality:

.1 Automatic System Database Configuration. Each workstation or server shall store on the hard disk a copy of the current system database, including firmware and hardware for all control modules. This database shall be updated whenever a change is made to the system configuration or to the operating program for any control module. The storage of these data shall be automatic and not require operator intervention.

2.3 OPERATOR  
INTERFACE  
(Cont'd)

.7 (Cont'd)

.6 (Cont'd)

.2 Control module memory download. A system operator with the proper password clearance shall be able to download memory from the system database to any control module in the database from any operator workstation or browser interface.

.3 System Configuration. The system software shall provide a method of configuring the system. This shall allow for future system changes or additions by users under proper password protection.

.4 On-Line Help. Provide a context-sensitive, online help system to assist the operator in operating and editing the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen.

.5 Security. Each operator shall be required to log on to the system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system supervisor shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the functions accessible to viewing and/or changing each system application, editor, and object. The system supervisor shall also have the ability to vary the functions accessible to each user depending on the equipment or geographic location, and to restrict an operator to only viewing and/or editing certain areas or pieces of equipment. Each operator shall automatically be logged off the system if no keyboard or mouse activity is detected. This auto logoff time period shall be adjustable by the system supervisor. All system security data shall be stored in an encrypted format.

.6 System Diagnostics. The system shall automatically monitor the operation of all control modules and I/O points. The failure of any control module or the locking of any I/O point (manual overriding to a fixed value) shall be annunciated to the operator.

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2.3 OPERATOR  
INTERFACE  
(Cont'd)

.7 (Cont'd)

.6 (Cont'd)

.7 Alarm Processing. Any input or status object in the system shall be configurable to alarm in and out of normal state. The operator shall be able to configure the alarm limits, alarm limit differentials, states, and reactions for each object in the system. The system shall be delivered with alarm points configured and enabled as specified in the Sequences of Operation. (Appendix A.) BACnet objects and alarm services shall be used for all alarms.

.8 Alarm Messages. Alarm messages shall use an English language descriptor for the object in alarm in such a way that the operator will be able to recognize the source, location, and nature of the alarm without relying upon acronyms or other mnemonics.

.9 Alarm Reactions. The operator shall be able to configure (by object) what, if any, actions the system workstation or server shall take when an alarm is received. Actions shall include logging, printing, starting programs, displaying messages, sending e-mail, paging, or providing audible annunciation. The operator shall also be able to configure actions for multiple objects at once based upon location, type of alarm, or other meaningful criteria.

.10 Trend Logs. The operator shall be able to program a trend log for any data object in the system. This definition shall include interval, start time, and stop time. Trend logs may also be defined based upon change of value (COV) sampling, rather than interval sampling. Trend data shall be sampled and stored in the control module, with an option to archive data on the hard disk, and be retrievable for use in spreadsheets and standard database programs. The system shall be delivered with trends configured and functioning as specified in the Sequences of Operation (Appendix A.) BACnet trend objects shall be used for all trends.

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2.3 OPERATOR  
INTERFACE  
(Cont'd)

.7 (Cont'd)

.6 (Cont'd)

.11 Alarm and Event Log. The operator shall be able to view all system alarms and change of states from any workstation or browser interface in the system. Events shall be listed chronologically. An operator with the proper security level may acknowledge and clear alarms. Provide an option to archive closed alarms to the hard disk on the workstation/server.

.12 Object and Property Status and Control. Provide a method for the operator to view, and edit if applicable, the status of any object and property in the system. The status shall be available by menu, on graphics, or through custom programs.

.13 Clock Synchronization. The real-time clocks in all building control panels and workstations shall use the BACnet Time Synchronization service. The system also shall be able to automatically synchronize all system clocks daily from the operator workstation/server or other designated device in the system. The system shall automatically adjust for daylight savings and standard time, if applicable.

.14 Reports and Logs. Provide a reporting package that allows the operator to select, modify, or create reports. Custom reports shall be definable as to data content, format, and (for trended data) interval. Provide a method for the operator to obtain a report showing the current status of all objects in a specific piece of equipment, within a specific location, or within the entire system. Provide an option to filter the report by type or status. (e.g., Physical I/O points, points in alarm, locked points, etc.) Report data shall be easily copied to other standard software applications, including spreadsheets and word processing. Reports and logs shall be readily printed to the system printer.

.15 Standard Reports. The following standard system reports shall be provided for this project. Provide ability for the Owner to readily create additional reports for this project.

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2.3 OPERATOR  
INTERFACE  
(Cont'd)

.7 (Cont'd)

.6 (Cont'd)

.1 All Objects: All system (or subsystem) objects and their current values.

.2 Alarm Summary: All current alarms and closed alarms, retained for a user definable period of time.

.3 Logs: The following information shall be logged to a database or text file and maintained for a user configurable period of time:

.1 Alarm History

.2 Trend Data (User selects which trends to archive)

.3 Operator Activity: All significant operator activity, including login/logout, control parameter changes, schedule changes, and acknowledging or clearing (deleting) alarms. Each activity shall be date and time stamped.

.16 Custom Reports. Provide the capability for the operator to easily define any system data into a report which can be launched from the operator interface.

.7 Workstation Applications Editors. The system tools shall support editing of all system applications. Provide editors for each application at the PC workstations or provide software disks that allow the tools to be freely copied onto other engineering workstations.

.1 Custom Application Programming. Provide the tools to create, modify, and debug custom application programming. The operator shall be able to create, edit, and download custom programs at the same time that all other system applications are operating. The system shall be fully operable while custom routines are edited, compiled, and downloaded. The programming language shall have the following features:

2.3 OPERATOR  
INTERFACE  
(Cont'd)

.7 (Cont'd)

.7 (Cont'd)

.1 The language shall be graphically based using function blocks to represent simple control operation, with the function blocks arranged in a logic diagram that clearly shows the flow of the control logic. Function blocks shall directly provide the functions listed below, and a method shall be provided to create custom or compound function blocks. Alternatively, the programming language can be English language oriented, be based on the syntax of BASIC, FORTRAN, C, or PASCAL, and allow for free-form programming (i.e., not column-oriented or "fill in the blanks").

.2 A full-screen character editor/programming environment shall be provided. The editor shall be cursor/mouse-driven and allow the user to insert, add, modify, and delete custom programming code. It also shall incorporate word processing features such as cut/paste and allow blocks of code to be copied to a file library for reuse in other control programs.

.3 The programming language shall allow independently executing program modules to be developed. Each module shall be able to exchange data with and enable or disable other program modules.

.4 The editor/programming environment shall have a debugging/simulation capability that allows the user to step through the program and observe any intermediate values and/or results. The debugger also shall provide error messages for syntax and execution errors.

.5 The programming language shall support conditional statements (IF/THEN/ELSE/ELSE-IF) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.

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2.3 OPERATOR  
INTERFACE  
(Cont'd)

.7 (Cont'd)

.7 (Cont'd)

.6 The programming language shall support floating-point arithmetic using the following operators: add, subtract, multiple, divide, and square root. The following mathematical functions also shall be provided: absolute value and minimum/maximum value from a list of values.

.7 The programming language shall have predefined variables that represent time of day, day of the week, month of the year, and the date. Other predefined variables or simple control logic shall provide elapsed time in seconds, minutes, hours, and days. These elapsed time variables shall be able to be reset by the language so that interval-timing functions can be stopped and started within a program. Values from all of the above variables shall be readable by the language so that they can be used in a program for such purposes as IF/THEN comparisons, calculations, etc.

.8 The language shall be able to read the values of the variables and use them in programming statement logic, comparisons, and calculations.

.9 The programming language shall have predefined variables representing the status and results of the System Software and shall be able to enable, disable, and change the set points of the System Software described below.

2.4 CONTROLLER  
SOFTWARE

.1 Furnish the following applications software for building and energy management. All software applications shall reside and operate in the system controllers. Editing of applications shall be done through the operator workstation/browser interface or at other engineering workstations.

.2 System Security

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2.4 CONTROLLER  
SOFTWARE  
(Cont'd)

- .2 (Cont'd)
    - .1 User access shall be secured using individual security passwords and user names.
    - .2 Passwords shall restrict the user to the objects, applications, and system functions as assigned by the system manager.
    - .3 Building Controllers shall be able to assign a minimum of 50 passwords access and control priorities to each point individually. The logon password (at any Operator Interface or portable operator terminal) shall enable the operator to monitor, adjust and control only the points that the operator is authorized for. All other points shall not be displayed at the Operator Interface or portable terminal. Passwords and priorities for every point shall be fully programmable and adjustable.
    - .4 User Log On/Log Off attempts shall be recorded.
    - .5 The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user-definable.
    - .6 Use of workstation resident security as the only means of access control is not an acceptable alternative to resident system security in the DDC controller software.
  - .3 Scheduling. Provide the capability to schedule each object or group of objects in the system. Scheduling options shall include the following:
    - .1 Weekly Schedule. Provide separate schedules for each day of the week. Each of these schedules shall include up to five start/stop pairs. (10 events)
    - .2 Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. Exception schedules may be defined up to a year in advance. Once an exception schedule has executed, it will be discarded and replaced by the standard schedule for that day of the week.
    - .3 Holiday Schedules. Provide the capability for the operator to define up to 24 special or holiday schedules. These schedules may be placed on the scheduling calendar and will be repeated each year. The operator shall be able to define the length of each holiday period.
-



2.4 CONTROLLER  
SOFTWARE  
(Cont'd)

- .3 (Cont'd)
- .4 Part and Full Occupancy Schedules: Provide the capability for the operator to define part and full occupancy schedules for each time of day schedule. For example where specified the unit shall be able to be started and stopped at the BAS with the outside air damper at a minimum setting for part occupied and a higher setting for full occupied.
- .4 System Coordination. Provide a standard application for the proper coordination of equipment. This application shall provide the operator with a method of grouping together equipment based on function and location. This group may then be used for scheduling and other applications.
- .5 Binary Alarms. Each binary input and binary value object shall be capable of generating an alarm based on an operator-specified state. Provide the capability to enable or disable this alarm. The system shall be delivered with alarms enabled as listed in the Sequence of Operations in Section 25 90 01.
- .6 Analog Alarms. Each analog object shall be capable of generating an alarm based on an operator-specified high and low alarm limit. Provide the capability to enable or disable this alarm. The system shall be delivered with alarms enabled as listed in the Sequence of Operations in Section 25 90 01.
- .7 Alarm Reporting. The operator shall be able to configure the actions the system will take when an alarm is received.
- .8 Remote Communication. The system shall have the ability to automatically contact an operator workstation or server when a critical alarm is received, using either a network connection or, if no network connection is available, a dial out connection over a modem.
- .9 Sequencing. Provide application software based upon the sequences of operation specified to properly sequence chillers, boilers, and pumps.
-

2.4 CONTROLLER  
SOFTWARE  
(Cont'd)

- .10 PID Control. A PID (proportional-integral-derivative) algorithm with direct or reverse action and anti-windup shall be supplied. The algorithm shall calculate a time-varying analog value that is used to position an output or stage a series of outputs. The controlled variable, set point, and PID gains shall be user-selectable.
- .11 Staggered Start. This application shall prevent all controlled equipment from simultaneously restarting after a power outage. The order in which equipment (or groups of equipment) is started, along with the time delay between starts, shall be user-selectable.
- .12 On/Off Control with Differential. Provide an algorithm that allows a binary output to be cycled based on a controlled variable and set point. The algorithm shall be direct-acting or reverse-acting and incorporate an adjustable differential.
- .13 Run-Time Totalization. Provide software that can totalize run-times for any binary input or object. A high runtime alarm shall be assigned, if required, by the operator. The system shall be delivered with run time totalization and alarms configured as specified in the Sequence of Operations in Section 25 90 01.

2.5 BUILDING  
CONTROLLERS  
                    

- .1 General. Provide Building Controllers (BC) as required to achieve the performance specified in the Part 1 Article on "System Performance." Each of these controllers shall meet the following requirements.
    - .1 The building controller shall have sufficient memory to support its operating system, database, and programming requirements.
    - .2 Data shall be shared between networked building controllers.
    - .3 The operating system of the building controller shall manage the input and output communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
    - .4 Controllers that perform scheduling shall have a real-time clock.
-

2.5 BUILDING  
CONTROLLERS  
(Cont'd)

- .1 (Cont'd)
  - .5 The building controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall generate an alarm notification.
  - .6 The Building Controller shall comply with all required aspects of the BACnet Building Controller (B-BC) device profile as outlined in Annex L of the current ASHRAE/ANSI BACnet Standard.
  - .7 The Building Controller shall be able to operate as a standalone panel and shall not be dependent upon any higher level computer or another controller for operation.
- .2 Communication
  - .1 Each building controller shall reside on or be connected to a BACnet network using the ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing. Either the building controllers or separate BACnet Device Routers shall perform BACnet routing if necessary to connect to networks of custom application and application specific controllers.
  - .2 The controller shall provide a service communication port for connection to a portable operator's terminal to connect to networks of custom application and application specific controllers.
  - .3 All Ethernet-capable PCs shall simultaneously direct connect to the Ethernet Management Level Network without the use of an interposing device.
  - .4 Operator Workstation shall be capable of simultaneous direct connection and communication with BACnet, OPC, and MLN networks without the use of interposing devices.
  - .5 When appropriate, any controller residing on the peer-to-peer building level networks shall connect to Ethernet network without the use of a PC or a gateway with a hard drive.
  - .6 Any PC on the Ethernet Management Level Network shall have transparent communication with controllers on the building level networks connected via Ethernet, as well as, directly connected building level networks. Any PC shall be able to interrogate any controller on the building level network.

2.5 BUILDING  
CONTROLLERS  
(Cont'd)

- .2 (Cont'd)
  - .7 Any break in Ethernet communication from the PC to the controllers on the building level networks shall result in an alarm notification at the PC.
  - .8 The standard client and server workstations on the Management Level Network shall reside on industry standard Ethernet utilizing standard TCP/IP, IEEE 802.3
  - .9 Any break in Ethernet communication between the standard client and server workstations on the Management Level Network shall result in a notification within the Windows taskbar at each workstation.
  - .10 Access to the system database shall be available from any standard client workstation on the Management Level Network.
- .3 Environment. Controller hardware shall be suitable for the anticipated ambient conditions.
  - .1 Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).
- .4 Keypad. A local keypad and display or a connection for a portable operator terminal shall be provided for each controller. The keypad shall be provided for interrogating and editing data. An optional system security password shall be available to prevent unauthorized use of the keypad and display. If the manufacturer does not provide this keypad and display, provide a portable operator terminal.
- .5 Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
- .6 Power loss. In the event of the loss of power, there shall be an orderly shutdown of all Building Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 30 days.

2.5 BUILDING  
CONTROLLERS  
(Cont'd)

- .7 Immunity to power and noise. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
- .8 Each Building Level Control Panel shall continuously perform self diagnostics on all hardware modules and network communications. The System Level Control Panel shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication with any system.
- .9 Spare Capacity: Provide enough inputs and outputs to handle the equipment shown to be "future" on drawings and 10% more of each point type. Provide all hardware modules, software modules, processors, power supplies, communication controllers, etc. required to ensure adding a point to the spare point location only requires the addition of the appropriate sensor/actuator and field wiring/tubing.

2.6 ADVANCED  
APPLICATION  
CONTROLLERS  
                    

- .1 General. Provide Advanced Application Controllers (AAC) as required to achieve the performance specified in item 1.3 "System Architecture." Each of these controllers shall meet the following requirements.
  - .1 The advanced application controller shall have sufficient memory to support its operating system, database, and programming requirements.
  - .2 Data shall be shared between networked advanced application controllers.
  - .3 The operating system of the controller shall manage the input and output communication signals to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms.
  - .4 Controllers that perform scheduling shall have a real-time clock.
  - .5 The advanced application controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall generate an alarm notification.

2.6 ADVANCED  
APPLICATION  
CONTROLLERS  
(Cont'd)

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- .1 (Cont'd)
    - .6 The controller shall comply with all required aspects of the BACnet Advanced Application Controller (B-AAC) device profile as outlined in Annex L of the current ASHRAE/ANSI BACnet Standard.
  - .2 Communication
    - .1 Each advanced application controller shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
    - .2 The controller shall provide a service communication port for connection to a portable operator's terminal.
  - .3 Environment. Controller hardware shall be suitable for the anticipated ambient conditions.
    - .1 Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).
    - .2 Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).
  - .4 Keypad. A local keypad and display or a connection for a portable operator terminal shall be provided for each controller. The keypad shall be provided for interrogating and editing data. An optional system security password shall be available to prevent unauthorized use of the keypad and display. If the manufacturer does not provide this keypad and display, provide a portable operator terminal.
  - .5 Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
  - .6 Memory. The building controller shall maintain all BIOS and programming information in the event of a power loss for at least 72-hours.
-

2.6 ADVANCED  
APPLICATION  
CONTROLLERS  
(Cont'd)

- .7 Power loss. In the event of the loss of power, there shall be an orderly shutdown of all controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for the operating system software and firmware.
  - .1 Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
  - .2 Brownout protection and power recovery circuitry protect the controller board from power fluctuations.
  - .3 Battery backup shall be provided to support the real-time clock for 10 years
  - .4 The program and database information stored SDRAM memory shall be battery backed for a minimum of 30 days and up to 60 days. This eliminates the need for time consuming program and database re-entry in the event of an extended power failure.
- .8 Each System Level Control Panel shall continuously perform self diagnostics on all hardware modules and network communications. The System Level Control Panel shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication with any system.

2.7 APPLICATION  
SPECIFIC CONTROLLERS

- .1 General: Provide Application Specific Controllers (ASC) as required to achieve the performance specified in Item 1.3 "System Architecture." Each of these controllers shall meet the following requirements.
  - .1 Each ASC shall be capable of stand-alone operation and shall continue to provide control functions without being connected to the network.
  - .2 Each ASC will contain sufficient I/O capacity to control the target system.
  - .3 The controller shall comply with all required aspects of the BACnet Application Specific Controller (B-ASC) device profile as outlined in Annex L of the current ASHRAE/ANSI BACnet Standard.
- .2 Communication

2.7 APPLICATION

SPECIFIC CONTROLLERS  
(Cont'd)

- .2 (Cont'd)
- .1 The controller shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol. Each network of controllers shall be connected to one building controller.
- .2 Controllers shall operate in stand-alone mode as needed for specific applications if network communication fails.
- .3 Each controller shall have a connection for a laptop computer or a portable operator's tool. This connection shall be extended to a space temperature sensor port where shown.
- .3 Environment. The hardware shall be suitable for the anticipated ambient conditions.
- .1 Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).
- .2 Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).
- .4 Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
- .5 Memory. The application specific controller shall use nonvolatile memory and maintain all BIOS and application programming in the event of a power loss.
- .6 Immunity to power and noise. Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80%. Operation shall be protected against electrical noise of 5-120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
- .7 Transformer. Power supply for the ASC must be rated at a minimum of 125% of ASC power consumption and shall be of the fused or current limiting type.

2.8 BASE BUILDING  
BACKBONE PORTS

- .1 Backbone by Control Contractor.



2.8 BASE BUILDING  
BACKBONE PORTS  
(Cont'd)

- .2 The Control Contractor shall provide the LAN Backbone for the facility.
- .3 On each floor, wing or major mechanical room provide an Ethernet RJ45 connection that allows connection to the BACnet network. An open port shall always be available and shall not require any part of the network to be disconnected. The location shall be accessible to the base building personnel and not in a location where the tenant can restrict the access.
- .4 Base Building Backbone Ports shall be wired and installed by this section.

2.9 SMART ACTUATORS

- .1 General: Provide Smart Actuators (SA) as required to achieve the performance specified in the Part 1 Article on "System Performance." Each of these controllers shall meet the following requirements.
  - .1 Each SA shall be capable of limited stand-alone operation and shall provide default control functions if network communications are lost.
  - .2 Each ASC will contain sufficient I/O capacity to control its controlled device(s).
  - .3 The controller shall comply with all required aspects of the BACnet Smart Actuator (B-SA) device profile as outlined in Annex L of the current ASHRAE/ANSI BACnet Standard.
- .2 Communication
  - .1 The controller shall reside on a BACnet network using the MS/TP Data Link/Physical layer protocol. Each network of controllers shall be connected to one building controller.
  - .2 Each controller shall have a connection for a laptop computer or a portable operator's tool. This connection shall be extended to a space temperature sensor port where applicable.
- .3 Environment. The hardware shall be suitable for the anticipated ambient conditions.
  - .1 Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).
  - .2 Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).

2.9 SMART ACTUATORS  
(Cont'd)

- .4 Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
- .5 Memory. The smart actuator controller shall use nonvolatile memory to maintain all BIOS and application programming (if any) in the event of a power loss. Dynamic control parameters (setpoint, commanded position, etc.) shall be automatically downloaded following a power loss.
- .6 Immunity to power and noise. Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80%. Operation shall be protected against electrical noise of 5-120 Hz and from keyed radios up to 5 W at 1 m (3 ft).

2.10 INPUT/OUTPUT  
INTERFACE

- .1 Hardwired inputs and outputs may tie into the system through building controllers, advanced application controllers, application specific controllers, or smart actuators
- .2 All input points and output points shall be protected such that shorting of the point to itself, to another point, or to ground will cause no damage to the controller. All input and output points shall be protected from voltage up to 24 V of any duration, such that contact with this voltage will cause no damage to the controller.
- .3 Binary inputs shall allow the monitoring of On/Off signals from remote devices. The binary inputs shall provide a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against the effects of contact bounce and noise. Binary inputs shall sense "dry contact" closure without external power (other than that provided by the controller) being applied.
- .4 Pulse accumulation input objects. This type of object shall conform to all the requirements of binary input objects and also accept up to 10 pulses per second for pulse accumulation.

2.10 INPUT/OUTPUT  
INTERFACE  
(Cont'd)

- .5 Analog inputs shall allow the monitoring of low-voltage (0 to 10 VDC), current (4 to 20 mA), or resistance signals (thermistor or RTD). Analog inputs shall be compatible with - and field configurable to - commonly available sensing devices.
- .6 Binary outputs shall provide for On/Off operation or a pulsed low-voltage signal for pulse width modulation control. Binary outputs on building controllers shall have three-position (On/Off/Auto) override switches and status lights. Outputs shall be selectable for either normally open or normally closed operation.
- .7 Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0 to 10 VDC or a 4 to 20 mA signal as required to provide proper control of the output device. Analog outputs on building controllers shall have status lights and a two position (AUTO/MANUAL) switch and manually adjustable potentiometer for manual override. Analog outputs shall not exhibit a drift of greater than 0.4% of range per year.
- .8 Tri-State Outputs. Provide tri-state outputs (two coordinated binary outputs) for control of three point floating type electronic actuators without feedback. Use of three-point floating devices shall be limited to zone control and terminal unit control applications (VAV terminal units, duct-mounted heating coils, zone dampers, radiation, etc.).
- .9 Input/Output points may be of a universal type, i.e., controller input or output may be designated (in software) as either a binary or analog type point with appropriate properties. Application specific controllers are exempted from this requirement.
- .10 System Object Capacity. The system size shall be expandable to at least twice the number of input/ output objects required for this project. Additional controllers (along with associated devices and wiring) shall be all that is necessary to achieve this capacity requirement. The operator interfaces installed for this project shall not require any hardware additions software revisions in order to expand the System.

2.11 POWER SUPPLIES .1  
AND LINE FILTERING

Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in both primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.

.1 DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection and shall be able to withstand a 150% current overload for at least three seconds without trip-out or failure.

.1 Unit shall operate between 0°C and 50°C (32°F and 120°F). EM/RF shall meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.

.2 Line voltage units shall be UL recognized and CSA approved.

.2 Power line filtering.

.1 Transient voltage and surge suppression shall be provided at all workstations and controllers either internally or as an external component to suppress induced voltage transients consistent with:

.1 RF-Conducted Immunity (RFCI) per ENV 50141 (IEC 1000-4-6) at 3 V.

.2 Electro Static Discharge (ESD) Immunity per EN 61000-4-2 (IEC 1000 4 2) at 8 kV air discharge, 4 kV contact.

.3 Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500 V signal, 1 kV power.

.4 Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max)

.5 Isolation shall be provided at all of the main panel's AC input terminals to suppress induced voltage transients consistent with:

.1 IEEE Standard 587 1980

.2 UL 864 Supply Line Transients

.3 .3 Voltage Sags, Surge, and Dropout per EN 61000-4-11 (EN 1000 4-11).

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- 2.12 CONTROL PANELS
- .1 Provide control panels as required for the Energy Management Control System.
  - .2 All indoor control cabinets shall be fully enclosed construction with (hinged door) key-lock latch and removable sub-panels. A single key shall be common to all field panels and sub-panels.
  - .3 All outdoor panels to be NEMA 4 construction.
  - .4 Interconnections between internal and face mounted devices shall be pre-wired with colour coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL listed for 600 volt service, individually identified per control/ interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.
  - .5 Provide ON/OFF power switch with over current protection for control power sources to each local panel.
  - .6 Panels to be labelled in accordance with section 3.13.
  - .7 Provide 120 VAC outlet within the cabinet.
- 2.13 LINE VOLTAGE THERMOSTATS
- .1 Line voltage space thermostat shall be bimetal-actuated, open contact type, or bellows- actuated, enclosed, snap-switch type or equivalent solid-state type, with heat anticipator, UL listed for electrical rating, concealed setpoint adjustment, 13°C to 30°C (55°F to 85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.
  - .2 Provide base and contacts rated for the load being switched.
  - .3 Standard of Acceptance: White Rodgers, Honeywell, Viconics, Johnson Controls, Siemens.
-

2.14 LOW LIMIT  
AIRSIDE THERMOSTATS

- .1 Low-limit thermostats shall be UL listed and CSA approved, vapour pressure type, with an element of 6 m (20 ft) minimum length.
- .2 Element shall respond to the lowest temperature sensed by any 30 cm (1 ft) section.
- .3 Low limit thermostat shall be provided on all air handling units with water and glycol coils directly connected to outside air. Provide one (1) thermostat for every 5 m<sup>2</sup> (54 ft<sup>2</sup>) of duct area.
- .4 Low limit thermostats shall be hardwired to shut down the supply fan, open the heating valve 100% and close all outside air dampers. Only hardwired interlocks will be accepted to protect the unit in both hand and auto operation.
- .5 The low-limit thermostat shall be manual reset only.
- .6 Device shall have adjustable setpoint.
- .7 Thermostat to be set to trip at 2° C (35° F).
- .8 Standard of Acceptance: Siemens, Johnson Controls.

2.15 HIGH LIMIT  
AIRSIDE THERMOSTATS

- .1 High limit thermostats shall be UL listed, liquid filled, rigid bulb type.
- .2 High temperature limits shall be provided as indicated in the Sequence of Operation in Section 25 90 01.
- .3 High limit shall be hardwired to shut down the associated fan.
- .4 Device shall be manual reset only.
- .5 Device shall have adjustable setpoint. Thermostat to be set to trip at 55° C (131° F).
- .6 Standard of Acceptance: Siemens, Johnson Controls, Automated Logic.

2.16 TEMPERATURE  
SENSORS

- .1 General
  - .1 All temperature sensors shall be provided with RTD's as follows:
    - .1 One thousand ohm reference resistance of 70° F nickel wire element with temperature coefficient of 3 ohms/° F. or
    - .2 One hundred ohm reference resistance at 32° F platinum wire element with temperature coefficient of 0.0392 ohm/ohm/° F.
    - .3 24 Vac/dc power supply.
    - .4 4-20 mA, 0-10Vdc or 0-5Vdc outputs compatible with BAS.
    - .5 Electronics accuracy of +/-0.1% of span.
    - .6 Operating temperature range of 0°C to 70°C (32° F to 158° F). OSA operating temperature range of -40°C to 85°C (-40° F to 185° F).
    - .7 Thermistor drift not to exceed 0.1° C (0.18° F) over a 10 year period.
    - .8 RTD and thermistor shall be provided so that the BAS reading is accurate to 0.5° C (0.9° F).
  - .2 Standard of Acceptance: Vaisalla, Rotronics, Minco, Johnson Controls, Siemens.
- .2 Duct Probe Sensors
  - .1 Provide duct probe sensors for single point monitoring based on the following:
    - .1 Duct area is less than 1 m<sup>2</sup> (11 ft<sup>2</sup>).
    - .2 Duct probe shall be 6.35mm (0.25") stainless steel.
- .3 Duct Averaging Sensors
  - .1 Provide duct averaging sensors for monitoring for all ducts greater than 1 m<sup>2</sup> (11 ft<sup>2</sup>).
  - .2 Probe length of 3.66m (12 feet) minimum or 3.25m per m<sup>2</sup>. (1ft per ft<sup>2</sup>) of duct cross-sectional area, whichever is greater.
  - .3 Copper sheathed or plenum rated flexible construction.
  - .4 Suitable supports at all bends and at intermediate points to prevent movement in the air systems.
- .4 Outdoor Air Sensor
  - .1 Provide outdoor air temperature sensors for monitoring as indicated in the sequence of operation.
  - .2 Sensor shall be made of PVC and have a sun and windscreen. Sensor shall be weatherproof.

2.16 TEMPERATURE  
SENSORS  
(Cont'd)

- .4 (Cont'd)
  - .3 Sensor shall be mounted on north facing wall. Consultant to verify exact location.
- .5 Wall Mounted Sensor - LCD Display
  - .1 Provide wall mount sensors as indicated on the drawings and called for in the sequence of operation.
  - .2 Low profile, neutral colour thermostat.
  - .3 LCD display that displays room temperature, outside air temperature and setpoint adjust.
  - .4 Setpoint adjust with range adjustable through the BAS.
  - .5 Occupancy override button with LED.
  - .6 Connection jack for balancing tool on VAV applications.
  - .7 Provide in the following locations: There are no locations where LCD displays are required.
- .6 Wall Mounted Sensor - Adjustable Setpoint
  - .1 Provide wall mount sensors as indicated on the drawings and called for in the sequence of operation.
  - .2 Low profile, neutral colour thermostat.
  - .3 Setpoint adjust with range adjustable through the BAS.
  - .4 Occupancy override button with LED.
  - .5 Connection jack for balancing tool on VAV applications.
  - .6 Provide in the following locations:
    - .1 All sensors in meeting rooms and offices shall be provided with a +/- 3 F temperature adjustment.
- .7 Wall Mounted Sensor - Non Adjustable
  - .1 Provide wall mount sensors as indicated on the drawings and called for in the sequence of operation.
  - .2 Low profile, neutral colour thermostat.
  - .3 Occupancy override button with LED.
  - .4 Connection jack for balancing tool on VAV applications.
  - .5 Provide in the following locations:
    - .1 All sensors in areas accessible to the public such as Lobbies, Corridors, Washrooms and Lounges shall have no adjustment at the sensor.
- .8 Immersion Sensor



2.16 TEMPERATURE  
SENSORS  
(Cont'd)

- .8 (Cont'd)
- .1 Provide immersion sensors as indicated on the drawings. If not shown on the drawings immersion sensors shall be provided as follows:
- .1 150 mm (6") sensors on all pipe that is 150 mm or bigger.
  - .2 100 mm (4") sensors on all pipe that is between 50 mm (2") and 150 mm (6").
  - .3 Provide brass or stainless steel wells.
  - .4 Provide thermal grease to aid in temperature sensing.

2.17 PRESSURE  
SENSORS

- .1 Static Pressure
- .1 Provide static pressure sensors as indicated in the sequence of operation and/or indicated on the points list.
- .2 Provide 4-20 mA, 0-5 VDC or 0-10 VDC output to BAS.
- .3 Accuracy to be 1% of full scale reading.
- .4 Non-linearity not to exceed +/- 0.98% of full scale reading.
- .5 Hysteresis effects not to exceed 0.1% of full scale reading.
- .6 Non-repeatability not to exceed 0.05% of full scale reading.
- .7 Sensor to be able to withstand up to 69 kPa (10 psi) overpressure in either direction.
- .8 Provide sensor range suitable to application. Directional or bi-directional sensors as required.
- .9 Base sensor ranges are as follows (unless stated otherwise and/or not applicable)
- .1 Air handling units supply air static pressure 0 to 1250 Pa (0 to 5 in. w.g.)
  - .2 Room differential pressure -62 Pa to 62 Pa (-0.25 to 0.25 in. w.g.)
  - .3 Building differential pressure -62 Pa to 62 Pa (-0.25 to 0.25 in. w.g.)
- .10 Sensor to incorporate temperature compensation between -18° C to 65° C (0° F to 150° F).
- .11 For air handling units the sensors are to be located in the control panel and tubed to the pick up point. The pick up point is to be at least 2/3 down the longest duct.
- .12 For room and building pressure (and any low pressure reading) the sensor shall be mounted in a location to minimize tube lengths.

2.17 PRESSURE  
SENSORS  
(Cont'd)

- .1 (Cont'd)
  - .13 Outside air readings shall utilize a stainless steel aerator to diffuse the effects of wind. Location to be determined with the consultant.
  - .14 Standard of Acceptance: Setra, Ashcroft, Mamac.
- .2 Hydraulic Pressure
  - .1 Provide pressure sensors as indicated on the drawings.
  - .2 Provide 4-20 mA, 0-5 VDC or 0-10 VDC output to BAS.
  - .3 Accuracy to be 0.25% of full scale reading.
  - .4 Non-linearity effects not to exceed 0.22% of full scale reading.
  - .5 Hysteresis effects not to exceed 0.1% of full scale reading.
  - .6 Non-repeatability not to exceed 0.05% of full scale reading.
  - .7 Sensor to have shock and vibration protection.
  - .8 Sensor to be able to withstand overpressurization of up to double the pressure range without any effect on the sensor.
  - .9 Provide sensor range suitable to application.
  - .10 Sensor to incorporate temperature compensation between -20° C to 80° C (-4° F to 176° F).
  - .11 Sensor response time to be 5 milliseconds.
  - .12 Sensor to be 17-4 PH stainless steel.
  - .13 Standard of Acceptance: Setra, Ashcroft, Mamac.
- .3 Hydraulic Differential Pressure
  - .1 Provide pressure sensors as indicated on the drawings.
  - .2 Provide 4-20 mA, 0-5 VDC or 0-10 VDC output to BAS.
  - .3 Accuracy to be 0.25% of full scale reading.
  - .4 Non-linearity effects not to exceed 0.2% of full scale reading.
  - .5 Hysteresis effects not to exceed 0.1% of full scale reading.
  - .6 Non-repeatability not to exceed 0.05% of full scale reading.
  - .7 Sensor drift not to exceed 0.5% of full scale reading over a 1 year period.
  - .8 Sensor to have shock and vibration protection.

2.17 PRESSURE  
SENSORS  
(Cont'd)

- .3 (Cont'd)
  - .9 Provide sensor range suitable to application.
  - .10 Sensor to incorporate temperature compensation between -1° C to 65° C (30° F to 150° F).
  - .11 Sensor response time to be less than 50 milliseconds.
  - .12 Standard of Acceptance: Setra, Ashcroft, Mamac.

2.18 OPERATOR  
WORKSTATION

- .1 Provide a PC for the BAS Server database. Provide the latest model of the nominal speed, RAM and memory for a commercial office grade PC from a named brand manufacturer. Minimum requirements and accessories shall be:
  - .1 Processor: Intel 7 series or AMD equal
  - .2 3GHz processor speed minimum 6M cache
  - .3 20GB Ram, Dual Channel, DDR3 SDRam at 1333MHz minimum
  - .4 16x R/W CD and DVD
  - .5 320GB Hard disk space, 7200RPM
  - .6 Video Card with 512 MB RAM
  - .7 USB Ports
  - .8 NIC Card
  - .9 101 key enhanced keyboard, Mouse, power strip.
  - .10 UPS for 15 minute backup.
- .2 Provide a wide screen, active matrix LCD, flat panel type monitor that supports a minimum display resolution of no less than 1920 x 1080 pixels, Energy Star compliant 32-bit color. The display shall have a minimum of 21-inch visible area in diagonal measurement. Separate controls shall be provided for color, contrasts and brightness. The screen shall be non-reflective.
- .3 A data line will be provided by the Owner to the location where the main control panel is located for this facility.

2.19 PRINTER

- .1 Provide a laser printer.

2.20 VARIABLE  
FREQUENCY DRIVES

- .1 The variable frequency drives shall be connected utilizing BACNET MS/TP. The following points for the drive shall be provided at the BAS.
  - .1 Binary Inputs to Drive
    - .1 Remote Start/Stop command.
  - .2 Analog Outputs from Drive
    - .1 Reference (% speed)
    - .2 Frequency (Hz)
    - .3 Motor Current (Amps)
    - .4 Power (KW)
    - .5 Hours Run.
  - .3 Binary Outputs from Drive
    - .1 KWH Counter (KW consumption)
    - .2 Motor Run Status
    - .3 Tripped Status
    - .4 External Fault (Safety Interlock).

2.21 CURRENT  
SENSORS FOR AIR  
HANDLING UNITS,  
PUMPS AND FAN

- .1 Provide DC current sensors self powered, with insertion impedance loss less than 0.0006 ohms under all conditions. End-to-end accuracy +/- 2% of full scale at each range.
- .2 Refer to the points list to identify where current sensors are required and where current switches are required. Where current sensors are required status inputs for pump and fan motors shall use current sensors to indicate motor status condition.
- .3 The confirmation of fan status for systems with variable frequency drives shall be provided by a connection for status to the variable speed drive rather than a current switch.

2.22 CURRENT  
SWITCHES FOR FAN  
COILS, REMOTE  
EXHAUST FANS ETC.

- .1 Refer to the points list to identify which systems require current sensors and which systems require current switches.
- .2 Provide DC current switch self powered, with insertion impedance loss less than 0.0006 ohms under all conditions. End-to-end accuracy +/- 2% of full scale at each range.
- .3 Status inputs for motors shall use current switches to indicate motor status condition.

2.23 HYDRONIC FLOW  
METERS FOR VARIABLE  
VOLUME PUMPING  
APPLICATIONS

- .1 Single turbine flow meter suitable for measuring electrically conductive water based liquids. The meter shall provide an isolated 4-20 mA and 0-10 V analog output signal that is linear with the flow rate.
- .2 The meter accuracy shall be as follows:
  - .1 0.5% of reading at calibrated velocity
  - .2 1% of reading from 3 to 30 ft/s (10:1 range)
  - .3 2% of reading from 0.4 to 20 ft/s (50:1 range).
- .3 The sensing method shall be electronic impedance sensing (non magnetic and non photoelectric).
- .4 Meter shall be suitable for pipe sizes 1 ¼" to 72" nominal.
- .5 Supply voltage shall be 24+-4 V AC/DC at 100 mA
- .6 The liquid temperature range shall be 180° F continuous with 200° F peak.
- .7 The ambient temperature range shall be -5 to 160° F (-20 to 70° C).
- .8 Operating pressure shall be 400 psi maximum.
- .9 Pressure drop shall be less than 1 psi at 20 ft/s in a 1 ½" pipe decreasing in larger pipes and lower velocities.
- .10 An analog voltage output of 0-10 V and a current output of 4 - 20mA shall be available. Coordinate with the control contractor regarding which option to utilize.
- .11 The flow meter shall be wet calibrated in the factory against primary volumetric standards directly traceable to NIST Certification of calibration shall be provided with the meter and inserted into the Maintenance Manuals.
- .12 The flow meter shall be installed utilizing a Hot tap (meter shall be inserted through a ball valve and shall be capable of being retracted through the ball valve prior to shutting the valve. This method shall allow the meter to be removed from the pipe system for maintenance without shutting down the system.

2.23 HYDRONIC FLOW  
METERS FOR VARIABLE  
VOLUME PUMPING  
APPLICATIONS  
(Cont'd)

- .13 The wetted metal components shall be electroless nickel plated brass.
- .14 The electronics enclosure shall be weathertight aluminum.
- .15 The electrical connections shall be for 4-20 mA or 0-10 V output. A second analog output for the Control Contractor shall be provided at the meter.
- .16 Standard of Acceptance: Onicon F-1111 single turbine meter, Biancett.

2.24 HIGH-LIMIT  
THERMOSTATS

- .1 Thermostats shall have liquid filled insertion probe.
- .2 Range shall be from 3.9 degrees Celsius to 101.7 degrees Celsius.
- .3 Switch shall be snap acting and rated for 16 amperes at 120V AC or 8 amps at 575V AC, as required.
- .4 Thermostat shall have manual reset feature.
- .5 Provide one thermostat for each square metre of duct area.
- .6 Thermostats shall be CSA approved and enclosure dust tight.
- .7 Provide in the supply air duct for each air handling system.

2.25 DIFFERENTIAL  
PRESSURE TRANSMITTER

- .1 The transmitter shall have an operating range to suit the application such that the controlled value is mid range.
- .2 The transmitter output shall be a linear proportional signal 20 to 105 kPa over the full operating range, or 0 to 5 volts.
- .3 Install the transmitter to keep the low reference pressure input line as short as possible.

2.26 START/STOP  
MOTOR CONTROL  
RELAYS

- .1 Relays shall be field interchangeable to either momentary or maintained latching switching action as required by the application.
- .2 Relays shall be plug in interchangeable, mounted on a circuit board with field wiring connecting to screw terminals or a mass termination assembly.
- .3 Contact ratings shall be 10 amperes at 220V AC.

2.27 DAMPER STATUS  
SWITCHES

- .1 Damper status switches shall be magnetic contact type switch activated by damper blade movement and mounted securely on damper frame.
- .2 Select damper switch with contact rating of 5 amperes at 120V AC, CSA approved.

2.28 FLOW SWITCHES

- .1 Select flow switches for the pipe size and flow rate.
- .2 The flow switch shall have a paddle with three segments for selecting optimum size suited for pipe sizes from 25 mm to 150 mm.
- .3 Temperature rating 121 degrees Celsius.
- .4 Pressure rating 1030 kPa.
- .5 Contact rating 8 amps at 120V AC.
- .6 Switch shall be CSA approved.

2.29 DAMPER  
ACTUATORS

- .1 Electronic direct coupled actuation shall be provided.
-

2.29 DAMPER  
ACTUATORS  
(Cont'd)

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- .2 The actuator shall be direct coupled over the shaft, enabling it to be mounted directly to the damper shaft without the need for connecting linkage. The fastening clamp assembly shall be of a "V" bolt design with associated "V" shaped toothed cradle attaching to the shaft for maximum strength and eliminating slippage. Spring return actuators shall have a "V" lamp assembly of sufficient size to be directly mounted to an integral jackshaft of up to 1.05 inches when the damper is constructed in this manner. Single bolt or set screw type fasteners are not acceptable.
- .3 The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the entire rotation of the actuator. Mechanical end switches or magnetic clutch to deactivate the actuator at the end of rotation are not acceptable.
- .4 For power failure/safety applications, an internal mechanical spring return mechanism shall be built into the actuator housing. Non mechanical forms of fail safe operation shall not be acceptable.
- .5 All spring return actuators shall be capable of both clockwise or counter clockwise spring return operation by simply changing the mounting orientation.
- .6 Proportional actuators shall accept a 0 to 10 VDC or 0 to 20 mA control input and provide a 2 to 10 VDC or 4 to 20 mA operating range. An actuator capable of accepting a pulse width modulating control signal and providing full proportional operation of the damper is acceptable. All actuators shall provide a 2 to 10 VDC position feedback signal. A feedback signal shall be provided for all damper actuators. Damper actuators shall provide a true analog signal from a feedback potentiometer on the actuator.
- .7 All 24 VAC/VDC actuators shall operate on Class 2 wiring and shall not require more than 10VA for AC or more than 8 watts for DC applications. Actuators operating on 120 VAC power shall not required more than 10 VA. Actuators operating on 230 VAC shall not require more than 11 VA.



2.29 DAMPER  
ACTUATORS  
(Cont'd)

- .8 All non spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 in lb torque capacity shall have a manual crank for this purpose.
- .9 All modulating dampers shall have an external, built in switch to allow the reversing of direction of rotation.
- .10 Actuators shall be provided with a conduit fitting and a minimum three foot electrical cable and shall be pre wired to eliminate the necessity of opening the actuator housing to make electrical connections.
- .11 Actuators shall be UL listed and shall be certified as meeting correct safety requirements and recognized industry standards.
- .12 Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque and shall have a 2 year manufacturers warranty, starting from the date of installation.
- .13 Actuators shall be listed under the ULC Standard 873 and Canadian Standards Association.
- .14 Standard of Acceptance: Belimo, Siemens, Johnson Controls.

2.30 CONTROL VALVES

- .1 Control valves for the chilled water, glycol and hot water systems shall be as follows:
  - .2 General
    - .1 All characteristics of control valves shall be suitable for the required operation. Operators are to be 24 VAC, receiving 0 to 10 VDC or 4 to 20 mA proportional control signals.
    - .2 Control valves to be sized for a pressure drop equal to the coil they serve but shall not exceed 4 psi (27.6 kPa).
    - .3 Provide 2 way or 3 way valves as indicated on the drawings, sequence of operation and schematics.
  - .3 Service

2.30 CONTROL VALVES  
(Cont'd)

| Service               | Type                  | Spring Return |
|-----------------------|-----------------------|---------------|
| Air Handling Units    | Globe Valves          | Yes           |
| Reheat Coils          | Full Port Ball Valves | No            |
| Convectors            | Full Port Ball Valves | No            |
| Fan Coils             | Full Port Ball Valves | No            |
| Differential Pressure | Full Port Ball Valves | Yes           |
| Control Valves        | or Globe Valves       |               |

.4 Default Setup

|                        |                                             |                                                                              |
|------------------------|---------------------------------------------|------------------------------------------------------------------------------|
| 2 way no spring return | 2 Volts or 4 mA.                            | Fail in last position on loss of power.                                      |
| 2 way spring return    | 2 Volts or 4 mA                             | Fail open for heating applications and fail closed for cooling applications. |
| 3 way no spring return | A to AB closed with 2 Volts signal or 4 mA. | Fail in last position on loss of power.                                      |
| 3 way spring return    | A to AB closed with 2 Volts signal or 4 mA. | Fail open for heating applications and fail closed for cooling applications. |

.5 Globe Style  
.1 Valve Body

2.30 CONTROL VALVES .5  
(Cont'd)

.1 (Cont'd)

- .1 Valves ½" to 2" (12 mm to 50 mm) shall be bronze body, NPT screw type, and shall be rated for ANSI Class 250 working pressure. The operating temperature range shall be 20 degrees F to 250 degrees F (-7 C to 120 C).
- .2 Valves 2 ½" and larger shall be cast iron body, flanged type, and shall be rated for ANSI Class 125 working pressure. The operating temperature range shall be 32 F to 250 F (-7 C to 120 C).
- .3 Seats shall be single seat, metal to metal.
- .4 Modulating butterfly valves to comply with the requirements for high performance butterfly valves.
- .5 Providing combined butterfly valves rather than a 3-way control valves is acceptable.
- .6 Flow type for two way control valves shall be equal percentage. Flow type for three way control valves or combined butterfly valves shall be linear.
- .7 All valves shall have stainless steel stems to ASTM A582 Type 303 and EPDM O ring packing.
- .8 Manufacturer shall provide an unconditional two year warranty from the date of installation.
- .9 Close off rating shall be class IV (0.1% of CV).
- .10 Maximum differential pressure for Modulating Service shall be as follows:

| Differential Pressure  | Type            |
|------------------------|-----------------|
| Up to 25 psi (173 kPa) | Bronze          |
| Up to 50 psi (345 kPa) | Stainless Steel |

- .11 Minimum close off pressures shall be as follows:

| Size           | Close Off Pressure<br>psi (kPa) |
|----------------|---------------------------------|
| 1/2" (12 mm)   | 250 (1724)                      |
| 3/4" (20 mm)   | 186 (1282)                      |
| 1" (25 mm)     | 121 (834)                       |
| 1-1/4" (32 mm) | 75 (517)                        |
| 1-1/2" (40 mm) | 48 (331)                        |
| 2" (50 mm)     | 30 (207)                        |

2.30 CONTROL VALVES  
(Cont'd)

.5 (Cont'd)  
.1 (Cont'd)

|                |          |
|----------------|----------|
| 2-1/2" (65 mm) | 97 (668) |
| 3" (75 mm)     | 63 (434) |
| 4" (100 mm)    | 39 (268) |
| 5" (125 mm)    | 25 (172) |
| 6" (150 mm)    | 17 (117) |

.12 Standard of Acceptance: Belimo,  
Johnson Controls, Automated Logic,  
Honeywell, Siemens.

.2 Valve Actuator - Globe Style

.1 The actuator shall be UL listed.

.2 The actuator shall be maintenance  
free with reversible motor complete with  
visual indication of valve position and  
manual adjustment in the power off  
position.

.3 Actuators shall be direct coupled to  
the valve.

.4 Actuators shall be installed in  
accordance with Valve Manufacturers  
specifications.

.5 The valve actuator shall be capable  
of providing the minimum torque required  
for proper valve close off for the  
required application.

.6 The actuator shall be proportional.  
All proportional valves shall be positive  
positioning, and respond to a 2-10 VDC or  
4-20 mA signal with a load resistor.  
Proportional units shall have a position  
feedback signal corresponding to the  
actual valve position which can be wired  
back to the control system.

.7 When power is applied to the actuator  
the actuator shall initialize. This  
initialization shall determine the stroke  
length and enable the actuator to set the  
minimum and maximum limits of the supplied  
control signal, thereby utilizing the  
entire control signal range. Feedback,  
running time and other parameters shall be  
automatically adjusted to the effective  
stroke.

.8 Motor stall protection shall be  
provided.

.9 Valve actuator shall have an  
unconditional two year warranty.

2.30 CONTROL VALVES .5  
(Cont'd)

(Cont'd)  
.2 (Cont'd)

.10 Standard of Acceptance: Belimo,  
Johnson Controls, Honeywell, Automated  
Logic, Siemens.

.6 Full Port Ball Valves ½" to 2" (12 mm to 50 mm)

.1 Valve Body

.1 Forged brass body with or without  
nickel plating, NPT screw type. The  
operating temperature shall be 0 to 212 F  
(-18 C to 100 C).

.2 The valves shall have an ISO type  
4 bolt flange for mounting actuator in any  
orientation parallel or perpendicular to  
the pipe. A non metallic thermal isolation  
adapter shall separate flange from  
actuator with high temperature materials  
rated for continual use at greater than  
the application temperature. Valve  
assemblies without thermal isolation as  
described above are not acceptable.

.3 The isolation adaptor shall also  
provide stable direct coupled mechanical  
connection between the valve body and  
actuator and prevent lateral or rotational  
forces from affecting the stem and its  
packing O rings.

.4 All control ball valves shall be  
furnished with stainless steel ball and  
stem and fiberglass reinforced Teflon  
seats and seals. The valves shall have a  
blow out proof stem design. Each valve  
shall be tested by the Valve Manufacturer.

.5 Two way valves shall be equal  
percentage. All control ball valves shall  
have a flow characterized disc in the  
inlet of the valve to provide this equal  
percentage flow response. The minimum CV  
of the valves shall 2.1. This is to ensure  
that the characterizing disc is a V shape  
rather than pin holes.

.6 Three way valves shall be mixing  
valves. The A port shall be equal  
percentage, B port shall have a modified  
linear bypass which shall yield 70% of the  
flow of the A port to give constant AB  
flow. The minimum CV of the valves shall  
2.1. This is to ensure that the  
characterizing disc is a V shape rather  
than pin holes.

2.30 CONTROL VALVES .6  
(Cont'd)

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(Cont'd)

.1 (Cont'd)

.7 Characterized disc shall be held securely by a keyed ring. Machined shoulder in the valve body with end cap is also acceptable.

.8 The stem packing shall consist of two O rings designed for on/off service or modulating service and requiring no maintenance.

.9 Valve pressure rating shall be 600 psi ( $\frac{1}{2}$ " to 1-1/4") and 400 psi ( $1\frac{1}{2}$ " to 2".)

.10 Close off pressure shall be 200 psi.

.11 Manufacturer shall provide a 2-year unconditional warranty from the date of installation.

.12 Standard of Acceptance: Belimo, Bray ST2 or Control Manufacturers ball valve provided that they have a ball valve with characterized disc.

.2 Valve Actuator - Ball Valve

.1 The actuator shall be UL listed under standard 873 and CSA Class 4813.02.

.2 Actuators shall be direct coupled to the valve with a single screw.

.3 Actuators shall be applied according to the manufacturers specifications.

.4 The valve actuator shall be capable of providing the minimum torque required for proper valve close off for the required application.

.5 Each actuator shall have current limiting circuitry or microprocessor overload protection incorporated in its design to prevent damage to the actuator.

.6 The actuator shall be proportional. All proportional valves shall be positive positioning, and respond to a 2-10 VDC or 4-20 mA signal with a load resistor. Proportional units shall have a position feedback signal corresponding to the actual valve position which can be wired back to the control system.

.7 All control valves shall have a visual position indicator and an attached 3 foot cable for easy installation to a junction box.

.8 Manufacturer shall provide an unconditional two year warranty from the date of installation.

- 2.30 CONTROL VALVES .6 (Cont'd)  
(Cont'd) .2 (Cont'd)  
.9 Standard of Acceptance: Belimo, Bray  
or Control Manufactures Control valve  
provided they have a valve with a  
characterization disc.

PART 3 - EXECUTION

- 3.1 INSTALLATION .1 Installation shall include computer  
programming, drawings, supervision, adjusting,  
validating and checkout, cable, and field  
wiring necessary for complete operational  
system including generation of color graphics.
- .2 Supply and install all low or high voltage  
wiring from electrical panels/outlets to  
central hardware and remote field processing  
units and all other equipment (provided or  
supplied only by controls contractor)  
requiring power. .
- .3 Supply and install all wiring necessary for  
system operation including tie ins from system  
control relays into motor starting circuits.  
Wiring and conduit shall be installed in neat  
and workmanlike manner, concealed where  
possible, and meet standards of  
Electrical Divisions.
- .4 Sensors which are shown wall mounted shall have  
wiring concealed in wall construction.
- .5 Sensors shall be mounted 5 ft (1500 mm) from  
floor to center unless shown otherwise.
- .6 Duct mounted devices shall be mounted on panels  
with bases plumb and level. Duct panels shall  
be dampened to eliminate detrimental vibration.
- .7 Operators shall be mounted on shop fabricated  
brackets built to transmit torque or forces to  
ductwork panels or supports which can absorb  
these forces without distortion or fatigue.
- .8 Local control panels shall be mounted in  
accessible convenient wall locations as shown  
on the drawings.

### 3.1 INSTALLATION (Cont'd)

- .9 Where sensors are specified to be in outside air, they shall be installed so as not to be affected by exhaust air or reverse warm air flow through air supply units.
- .9 Outside air sensors shall be installed in the locations shown on the drawings.
- .10 Safety control loops such as low temperature detectors shall be hard wired into the associated system magnetic starter. The primary function shall not be performed by software in this case.
- .11 Cooperate with the air balance technicians during balancing of the system.

### 3.2 SUBMITTALS

- .1 Submit shop drawings for review prior to installation and in accordance with Section 01 33 00.

### 3.3 TRAINING

- .1 Provide training for a designated staff of owner's representatives. Training shall be provided via self-paced training (Web-based, or Computer-Based Training), classroom training, or a combination of training methods.
- .2 The training shall enable the students to do the following:
  - .1 Day-to-day Operators: Proficiently operate the system.
    - .1 Proficiently operate the system.
    - .2 Understand control system architecture and configuration.
    - .3 Understand DDC system components.
    - .4 Understand system operation, including DDC system control and optimizing routines (algorithms).
    - .5 Operate the workstation and peripherals.
    - .6 Log on and off of the system.
    - .7 Access graphics, point reports, and logs.
    - .8 Adjust and change system set points, time schedules, and holiday schedules.



3.3 TRAINING

(Cont'd)

- .2 (Cont'd)
  - .1 (Cont'd)
    - .9 Recognize common HVAC system malfunctions by observation of the system graphics, trend graphs, and other system tools.
    - .10 Understand system drawings and Operation and Maintenance manual.
    - .11 Understand the job layout and location of control components.
    - .12 Access data from the DDC controllers.
    - .13 Operate portable operator's terminals.
  - .2 Advanced Operators:
    - .1 Create and change system graphics.
    - .2 Create, delete, and modify alarms, including configuring alarm reactions.
    - .3 Create, delete, and modify point trend logs (graphs) and multi-point trend graphs.
    - .4 Configure and run reports.
    - .5 Add, remove, and modify system's physical points
    - .6 Create, modify, and delete programming.
    - .7 Add operator interface station.s
    - .8 Add a new control module to the system.
    - .9 Download OS and custom applications programming to a control module.
    - .10 Configure and calibrate I/O points.
  - .3 System Managers/Administrators:
    - .1 Maintain software and prepare backups.
    - .2 Interface with job-specific, third-party operator software.
    - .3 Add new users and understand password security procedures.
- .3 These objectives will be divided into three logical groupings. Participants may attend one or more of these, depending on level of knowledge required.
  - .1 Day-to-day Operators
  - .2 Advanced Operators
  - .3 System Managers/Administrators.
- .4 Provide course outline and materials in accordance with the Part 1 "Submittals" of this specification. The instructor(s) shall provide one copy of training material per student.

3.3 TRAINING  
(Cont'd)

- .5 The instructor(s) shall be factory-trained instructors experienced in presenting this material.
- .6 Classroom training shall be done using a network of working controllers representative of the installed hardware.

3.4 COORDINATION  
WITH THE TAB  
CONTRACTOR

- .1 The contractor shall furnish to the Test and Balance Contractor a single set of all tools necessary to interface to the control system for test and balance purposes.
- .2 The contractor shall provide training to the Test and Balance Contractor in the use of these tools. This training will be planned for a minimum of 4 hours.
- .3 In addition, the contractor shall provide a qualified technician to assist in the test and balance process, until the first 20 terminal units are balanced.
- .4 The tools used during the test and balance process by the Test and Balance Contractor will be returned in good working condition at the completion of the testing and balancing.

## PART 1 - GENERAL

- |                                      |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|--------------------------------------|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>1.1 RELATED INSTRUCTIONS</u>      | .1 | This section of the specification shall be read in conjunction with and shall be governed by the requirements outlined in Section 23 05 00 of the specification.                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|                                      | .2 | To be read in conjunction with Section 25 05 01 of the specification.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|                                      | .3 | Comply with the General Requirements of Electrical Divisions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <u>1.2 SHOP DRAWINGS AND SAMPLES</u> | .1 | Submit shop drawings in accordance with Section 01 33 00.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|                                      | .2 | Submittals shall include:<br>.1 A minimum six (6) copies of shop drawings shall be submitted and shall consist of a complete list of equipment and materials, including manufacturer's descriptive and technical literature, catalogue cuts, and installation instructions. Shop drawings shall also contain complete wiring, routing, schematic diagrams, tag number of devices, software descriptions, calculations, and any other details required to demonstrate that the system will function properly. Drawings shall show proposed layout and installation of all equipment and the relationship to other parts of the work. |

## PART 2 - AIR

- |                                    |    |                                                                                                                                                                                                                                                                                                                                  |
|------------------------------------|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>2.1 AIR HANDLING UNIT NO. 1</u> | .1 | General<br>.1 The unit serves the Administration Office Area.<br>.2 The air handling unit consists of a supply fan (F-1) and a loose return fan (F-2).<br>.3 The unit will operate as a variable volume unit.<br>.4 While the subsequence mentions imperial units of measurement, all BAS points will only display metric units. |
|                                    | .2 | Initial Temperature and Humidity Setpoints                                                                                                                                                                                                                                                                                       |

2.1 AIR HANDLING  
UNIT NO. 1  
(Cont'd)

| Device                                 | Method                                                    | Equipment | Action |
|----------------------------------------|-----------------------------------------------------------|-----------|--------|
| <b>Low Limit<br/>Thermostat</b>        | Hard Wired to                                             | AH-SF-F1  | Off    |
|                                        | Variable Frequency<br>Drives by Controls<br>Contractor    | RF-RF-F2  | Off    |
| <b>Fire Alarm</b>                      | Hard Wired to                                             | AH-SF-F1  | Off    |
|                                        | Variable Frequency<br>Drives by Electrical<br>Contractor. | RF-RF-F2  | Off    |
| <b>High Supply<br/>Air Temperature</b> | Software Shutdown                                         | AH-SF-F1  | Off    |
|                                        |                                                           | RF-RF-F2  | Off    |
| <b>High Return<br/>Air Temperature</b> | Software Shutdown                                         | AH-SF-F1  | Off    |
|                                        |                                                           | RF-RF-F2  |        |

\$PAGE10

.3 Initial Temperature and Humidity Setpoints

|                | Temperature   | Humidity (% RH)                                                                       |
|----------------|---------------|---------------------------------------------------------------------------------------|
| <b>Heating</b> | 22 C (71.6 F) | 30% RH                                                                                |
| <b>Cooling</b> | 24 C (75.2 F) | 55% RH (Design<br>condition, Unit<br>does not have a<br>dehumidification<br>sequence. |

.4 System Start Up

.1 System start up shall be by the Operator at the Operator workstation or by time of day scheduling. The schedule for the unit shall be established prior to system start up.

.5 System Shut Down

.1 System shut down shall be by the Operator or time of day schedule.

.6 Equipment Start Up

.1 If any of the variable frequency drives are in their Local control position, indicate this on the system graphic.

2.1 AIR HANDLING

UNIT NO. 1

(Cont'd)

.6

(Cont'd)

.2 If any of the shut down alarms are still active, the BAS shall not be allowed to start up the equipment.

.3 On system start up command start the return fan at minimum speed. Confirm that the fan is running at the variable frequency drive. If the fan is not running within 30 seconds commence an auto shutdown and alarm at the BAS.

.4 Once the return fan is running, send a start up command to the supply fan at minimum speed. Confirm that the fan is running at the variable frequency drive. If the fan is not running within 30 seconds commence auto shutdown and alarm at the BAS.

.5 Wait for the supply fan and return fan to both be running at minimum speed. Once they are at minimum speed enable the temperature and humidity controls.

.6 Enable the air flow stations.

.7 Ramp up the speed of the variable frequency drive to bring the supply air static pressure to setpoint. Monitor the supply air volume at the flow station. The return fan shall track the supply fan utilizing the return air flow station.

.8 If the air flows are not within 10% of setpoint within 5 minutes alarm at the BAS.

.9 Enable pressure and air flow alarms. If the static pressure in the supply air ductwork is in excess of 2" WC, alarm at the BAS. If the static pressure in the supply air ductwork is in excess of 3" WC alarm at the BAS and shut down the system.

.10 20 minutes after the air handling unit is running enable the space temperature setpoint and space humidity setpoint alarms.

.7

Equipment Shut Down

.1 Equipment shut down shall be by the operator at the Operator Workstation or time-of-day scheduling.

.2 Close the cooling valve.

.3 Modulate the heating coil control valve to maintain 18C (65 F) in the mixed air plenum when outdoor air temperatures are below 2C.

.4 Shut down the return fan.

.5 Shut down the supply fan.

.6 Close the exhaust air damper and the outside air damper and open the mixed air damper.

.8

Alarm Shut Down

2.1 AIR HANDLING

UNIT NO. 1

(Cont'd)

.8

(Cont'd)

.1 In alarm shut down shut down the return fan.

.2 Shut down the supply fan.

.3 Close all heating and cooling valves.

.4 Close the exhaust air damper and the outside air damper and open the mixed air damper.

.5 Show the unit as Alarm Shut Down on the graphic display.

.6 Alarms that cause an alarm shut down are as follows:

.1 Fire alarm.

.2 Low Limit Thermostat.

.3 High supply air temperature. (66.5°C (152°F)).

.4 High return air temperature. (66.5°C (152°F)).

.5 Supply fan failure.

.6 High supply air static pressure.  
(Above 3" wc.)

.7 Failure of the return fan.

.8 Low limit supply air temperature alarm  
(Less than 45 °F (7.2 °C)).

.7 The following alarms shall not cause fan shutdown.

.1 Room temperature alarms.

.2 Any duct mounted temperature or relative humidity alarm up until it reaches its high limit or limit setpoint.

.8 Occupied Mode

.1 In the occupied mode the minimum setting for the outside air damper shall be set to maintain a minimum outside air flow rate 2500 cfm.

.9 Unoccupied Mode

.1 In the unoccupied mode the unit shall be off and the space temperature shall be reset to 18 C (65 F). The perimeter electric baseboard heaters shall be utilized to maintain the space at this temperature. If any of the space temperature sensors indicates a temperature below 15.6 °C (60 °F) the unit shall be restarted in full recirculation mode and shall raise the space temperature to setpoint.

2.1 AIR HANDLING

.8 (Cont'd)

UNIT NO. 1

.9 (Cont'd)

(Cont'd)

.2 Once the space reaches setpoint the unit shall shut off. If the space temperature sensor/sensors indicate a temperature above 27 °C (80 °F) the unit shall be restarted in full recirculation mode and shall lower the space temperature to setpoint. Once the space reaches setpoint the unit shall shut off.

.10 Air Volume Control

.1 The supply air, return and outside air volumes provided by this system are to be measured by air flow stations.

.2 Control the supply air static pressure 2/3 downstream in the supply duct initially at 250 Pa (1.0 in w.g.) setpoint subject to a high limit fan discharge static pressure setpoint of 500 Pa (2 in w.g.) by adjusting the setting of the variable frequency drive.

.3 The static pressure setpoint shall be reset by the Variable Air Volume requests for additional air. Refer to the variable air volume box control sequence for the method to reset the static pressure setpoint.

.4 If a static pressure of 500 Pa (2 in w.g.) is reached within the supply air duct alarm at the BAS. If a static pressure of 750 Pa (3 in w.g.) is reached automatically stop the supply fan and alarm at the BAS. Unit shall be restarted by manual restart.

.5 Control the differential air quantity between the supply and return air by air flow measurement, to a setpoint established by the difference between fan volumes at design flow by adjusting the setting of the variable frequency drives.

.11 Minimum Outside Air

.1 The minimum outside air for the unit shall be set at 2500cfm.

.2 The outside air damper shall modulate as required to maintain the outside air flow rate based on the air flow station. The exhaust air damper shall be fully closed and the return damper shall be fully open.

.3 When the unit is in free cooling mode the exhaust air damper shall modulate in conjunction with the outside air and return air dampers to provide free cooling.

.12 Humidity Control

---

- 2.1 AIR HANDLING .8 (Cont'd)
- UNIT NO. 1 .12 (Cont'd)
- (Cont'd)
- .1 Humidity control shall consist of a direct injection steam humidifier. Each device shall have its own PID loop.
- .2 The return air relative humidity shall be utilized to control the humidity within the space.
- .13 Setpoint
- .1 The low limit setpoint shall be set for 30% RH (operator adjustable).
- .14 Low Limit Setpoint Output
- .1 When the relative humidity level is below the low limit setpoint modulate the control valve at the direct injection humidifier to maintain the exhaust air relative humidity at setpoint.
- .2 If the supply air relative humidity is above 95% limit the humidifier control valve position to maintain this setpoint.
- .3 If the air flow station is indicating that there is no supply air flow the humidifier steam control valve shall be locked in the 100% closed position.
- .4 If the return air relative humidity is more than 5% below setpoint for a period of 20 minutes alarm at the BAS.
- .15 Temperature Control
- .1 Temperature control shall be provided by a chilled water cooling coil, heating coil and free cooling dampers and hot water convectors.
- .2 The supply air temperature shall be controlled between 53° F (11.7° C) and 65° F (18.3°C).
- .3 The supply air temperature shall be reset based on outside air temperature utilizing the following:

**Outside Air Temperature**

**Hot Water Supply Temperature**

28 C (-18F)  
12.8C (50F)

18.3C (65F)  
13.3C (55F)

**Free Cooling**

15.5C (66F)  
15.5C (66F)  
32.2C (90F)

37.8C (55F)  
37.8C (55F)  
37.8C (55F)

.4 Note the BAS will provide a 2°C (3.5°F) deadband on the disabling of free cooling.



2.1 AIR HANDLING

.8

(Cont'd)

UNIT NO. 1

.15 (Cont'd)

(Cont'd)

.5 If the supply air temperature is more than 11 F (5.5° C) above or below setpoint for a period of 10 minutes alarm at the BAS.

.6 If the supply air temperature drops below 45° F (7.2 °C) alarm at the BAS and initiate an automatic shut-down.

.16 Chilled Water Cooling

.1 When the supply air temperature is above the supply air temperature setpoint the chilled water cooling coil control valve shall be modulated as required to maintain setpoint.

.2 The chilled water control valve shall be allowed to be manually overridden by the operator at the BAS.

.3 The chilled water control valve shall be allowed to be manually overridden by the operator at the BAS.

.17 Heating

.1 When the supply air temperature is below the supply air temperature setpoint the heating coil control valve shall be modulated as required to maintain setpoint.

.2 The maximum supply air temperature setpoint shall be 65° F (18.3° C).

.3 The heating control valve shall be allowed to be manually overridden by the operator at the BAS.

.18 Filters

.1 The pressure differential alarm across the following filters shall be monitored at the BAS using a differential pressure switch.

.1 Merv 7 (30%).

.2 Merv 14 (95%) outside air intake filter.

.2 The pressure differential alarm shall be displayed on the system graphic.

.3 An alarm shall be initiated if the filter differential exceeds the following setpoints:

.1 Merv 7 - 1" (250 Pa).

.2 Merv 14 - 1.5" (375 Pa).

.19 Trends

.1 The BAS will continuously trend the following data:

.1 Supply air temperature.

.2 Return air temperature.

.3 Mixed air temperature.

2.1 AIR HANDLING  
UNIT NO. 1  
(Cont'd)

- .8 (Cont'd)  
.19 (Cont'd)  
.4 Status of Supply Fan and Return Fan.  
.5 Return air relative humidity.  
.6 Supply air static pressure.  
.7 Filter differential pressure switch status.  
.8 Outside, Supply and Return air flow.  
.9 System Graphics  
.1 The system graphic will show the following:  
.2 All of the above.  
.3 Status of the unit (Running, Off, Auto Shutdown).  
.4 Supply and Return air relative humidity.  
.5 Supply air temperature setpoint, humidity setpoint and mode of operation of the unit.  
.6 Status of low limit thermostat.  
.7 Operating Condition for cooling coil control valves, heating control valves and humidity control valve.  
.10 Provide the monitoring and control points as listed on the point schedule.

2.2 AIR FLOW  
STATIONS  
                    

- .1 9 Flow stations shall be provided in accordance with the following table:

| AH Unit                      | Supply Air | Return Air | Outside Air | Exhaust Air |
|------------------------------|------------|------------|-------------|-------------|
| AHU-1 Administration Offices | Yes        | Yes        | Yes         | --          |

2.3 VARIABLE  
VOLUME PUMPING  
                    

- .1 This shall apply to the following systems:  
.1 Hot water heating pumps.  
.2 Provide the following:  
.1 Differential pressure sensors.  
.1 Differential pressure sensor to be located towards the end of the piping system a minimum of 3/4 of the way down the system.  
.2 There shall be one differential pressure sensor for each system installed in the locations shown on the schematic for each system.

2.3 VARIABLE  
VOLUME PUMPING  
(Cont'd)

- .2 (Cont'd)
  - .1 (Cont'd)
    - .3 Each of the differential pressure sensors in the system will provide a 4-20 mA signal to the BAS to indicate process variable condition.
    - .2 Provide temperature sensors in the supply and return lines of the variable volume pumping system. Refer to the schematic for the number of sensors required. Sensors must be a matching pair and shall be calibrated on site utilizing an ice bath to confirm that they are a matching pair.
    - .3 Provide an inline flow meter in the supply line of each boiler. Provide a minimum of 4 diameter straight run upstream of the meter.
  - .3 System Graphics shall display the following:
    - .1 Each differential pressure sensor operating point.
    - .2 Current differential pressure setpoint.
    - .3 Pump on/off.
    - .4 Operating speed of each pump.
    - .5 System flow.
  - .4 BAS shall utilize the flow meter and the temperature sensors to calculate the total amount of btu/hr the system is utilizing.
  - .5 Trends
    - .1 Current Trends
      - .1 Actual System Differential Pressure (Each Sensor).
      - .2 System Differential Pressure setpoint.
      - .3 Supply Flow.
      - .4 Supply Temperature.
      - .5 Return Temperature.
    - .2 Historical Trends complete with time and date.
      - .1 Peak Daily Load (Btu/hr).
      - .2 Peak Daily Flow (gpm).
      - .3 Total Daily Load (Btu).
      - .4 Total Daily Flow (gpm).
      - .5 Total Load for (Identify Month@ (Btu).
      - .6 Total Flow for (Identify Month@ gpm).
      - .7 The operator shall be able to display the last 12 months of data at the computer terminal.
  - .6 Provide the following in the event of equipment failure:

2.3 VARIABLE  
VOLUME PUMPING  
(Cont'd)

- .6 (Cont'd)
- .1 If the variable frequency drive(s), pump(s), flow meter or differential pressure sensor(s) fail initiate an alarm at the BAS.
  - .2 In the event of a system differential pressure failure, due to a pump failure, variable frequency drive failure or overload fault, the BAS shall automatically initiate a timed sequence of event to start the remaining pump set(s) in the variable speed mode. A message on the display shall indicate the fault, pump/motor or VFD. Subsequent failures shall initiate a timed sequence of events to the variable speed mode as available.
  - .3 In the event of the failure of a zone sensor/transmitter, its process variable signal shall be removed from the scan/compare program. Alternative zone sensor/transmitters, if available, shall remain in the scan/compare program for control.
  - .4 In the event of failure to receive all zone process variable signals the variable frequency drives shall continue to operate at their last known position and a critical alarm shall be initiated at the BAS.
  - .5 If a pump is supposed to be running and the VFD indicates that it has failed start the next pump in sequence and alarm at the BAS.

2.4 HOT WATER  
HEATING PLANT  
                    

- .1 General
- .1 The system serves the following systems:
    - .1 Administration area heating system.
    - .2 Perimeter convector
    - .3 Unit heaters.
    - .4 Force Flow Heaters.
    - .5 Reheat Coils.
  - .2 The system is a variable volume pumping system.
  - .3 The Boiler system consists of the following:
    - .1 Two Hot Water heating pumps each sized for 100% of the heating load. The system is a variable volume pumping system and the pumps are on emergency power.
    - .2 Three hot water heating boilers. B-3 is a backup boiler. Each boiler is on emergency power.

2.4 HOT WATER  
HEATING PLANT  
(Cont'd)

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- .1 (Cont'd)
  - .4 Open/Close boiler control valves to be hardwired interlocked to the boiler control panel such that the burner can be enabled only when the valve is fully open. If the valve is not in the fully open position the burner shall be disabled.
- .2 Alternation of Equipment
  - .5 Pumps P1 and P2 will be alternated to equalize run times.
  - .6 Under normal operating conditions the building should be satisfied utilizing only one boiler. Boiler B-1 and B-2 will alternate to equalize run times.
  - .7 Pumps/Boilers will be designated lead and standby.
  - .8 Alternations will occur every Wednesday morning at 7:45 am.
  - .9 If no pumps/boilers are running the system will alternate the equipment designations.
  - .10 If a pump/boiler is running the system shall start the new pump and confirm operation before shutting down the pump that is scheduled to be turned off.
- .2 Scheduling
  - .1 When the outside air temperature drops below 15.6 C (60° F) for a period of 20 minutes the hot water heating system shall be activated.
  - .2 If the outside air temperature rises above 18.3 C (65° F) for a period of 20 minutes the hot water heating system shall be deactivated.
  - .3 Provide an outside air temperature sensor.
- .3 System Start-Up
  - .1 On system activation the boiler system shall be activated.
  - .2 Open the open/close control valve at the inlet to the lead boiler and confirm the valve position. Activate the lead boiler.
  - .3 If the boiler goes into alarm initiate a critical alarm at the BAS and start the lag boiler.
  - .4 Send a signal to start the lead pump at minimum speed and confirm the pump is running at the variable frequency drive.
  - .5 If the pump fails to start automatically start the lag pump and alarm at the BAS. If the lag pump fails to start initiate a critical alarm at the BAS.

2.4 HOT WATER  
HEATING PLANT  
(Cont'd)

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- .3 (Cont'd)  
.6 If one boiler is unable to maintain the hot water system at setpoint send a signal to activate the lag boiler. Send a signal to start the lag pump and confirm the pump is running at the variable frequency drive. Initiate a general alarm at the BAS indicating that a second boiler is required to meet the heating load.

- .4 Temperature Control  
.1 The system shall send a signal to the boiler control panel to maintain the hot water supply temperature at setpoint based on the following reset schedule:

| Outside Air Temperature | Hot Water Supply Temperature |
|-------------------------|------------------------------|
| -28 C (-18 F)           | 93.3 C (200 F)               |
| 15.6 C (60 F)           | 37.8 C (100 F)               |

- .5 Pump Operation  
.1 The BAS shall analyze the current differential pressure operating point for the differential pressure sensor against the differential pressure setpoint.  
.2 When all set points are satisfied by the process variable, the pump speed shall remain constant at the optimum energy consumption level. If the input from the flow sensor indicates that the operating pumps are approaching the end of curve point, the controller shall automatically stage on lag pumps as required to bring all pumps back to an acceptable operating point.  
.3 The system has been designed to have one pump active and one pump standby. On rare occasions it may be necessary to run both pumps.  
.4 If the setpoint cannot be satisfied by the designated lead pump, the BAS shall initiate a timed sequence of events to stage a lag pump.  
.5 The lag pump will accelerate resulting in the lead pump(s) decelerating until they equalize speed.  
.6 Further change in process variable will cause the pumps to change speed together.  
.7 When the set point criteria can be safely satisfied with fewer pumps, the BAS shall initiate a timed de stage sequence and continue variable speed operation.

2.4 HOT WATER  
HEATING PLANT  
(Cont'd)

---

- .5 (Cont'd)
    - .8 When only one pump is operating the minimum speed of the pump motor as commanded by the variable frequency drive shall be 40%. Monitor the flow in the system and modulate the control valve in the bypass line as required to ensure that the pump does not dead head.
  - .6 Differential Pressure Control
    - .1 The initial differential pressure setpoint shall be 7 psi (operator adjustable).
    - .2 If the pump is running at minimum speed and the pressure is above setpoint modulate open the differential control valve to maintain the system pressure at setpoint.
  - .7 Alarms
    - .1 HVAC Critical
      - .1 Pumps are commanded on and status is not received (10 minute delay).
      - .2 Low pressure alarm from system static pressure sensor.
      - .3 Two boilers are required and one boiler or pump has failed.
      - .4 Initiate a critical alarm if one of the boiler control panels indicates that it has gone into alarm.
    - .2 HVAC General
      - .1 The system is running and the supply water temperature drops more than 20° F below setpoint (10 minute delay).
      - .2 The system is running and the supply water temperature rises above 200° F (93° C) (10 minute delay).
      - .3 Pump failure if only one boiler is required to meet the load.
      - .4 Boiler failure if only one boiler is required to meet the load.
      - .5 The system is running and the differential pressure is +/- 3 psi from setpoint.
    - .3 HVAC Maintenance
      - .1 Pump status is on and the pumps are commanded off (10 minute delay).
      - .2 The system is put into manual mode of operation.
  - .8 Monitoring
    - .1 Hot water heating supply and return temperatures.
    - .2 Pump Status
    - .3 Boiler status.
    - .4 Boiler firing rate.
-

2.4 HOT WATER  
HEATING PLANT  
(Cont'd)

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- .8 (Cont'd)
  - .5 Boiler alarm.
- .9 Trends
  - .1 All Hot Water Heating supply and return temperatures.
  - .2 Differential pressure actual value and setpoint.
  - .3 % speed of the variable frequency drives.
  - .4 Flow
  - .5 Boiler status and percent fire.

2.5 ADMINISTRATION  
AREA SECONDARY  
HOT WATER HEATING  
SYSTEM

---

- .1 General
  - .1 The system serves:
    - .1 Perimeter radiation
    - .2 Force flow heaters.
  - .2 The Secondary hot water heating system consists of the following:
    - .1 A north-west administration zone (Pump P6 and P7) and a south-west administration zone (Pump P4 and P5).
    - .2 Each zone consists of a 3-way control valve and two hot water heating circulator pumps each sized for 100% of the heating load. The existing pneumatic 3-way control valves have been replaced with new DDC 3-way control valves.
    - .3 The system is a constant volume pumping system and the pumps are on emergency power.
- .2 Alternation of Equipment
  - .1 Pumps P6 and P7 will be alternated to equalize run times.
  - .2 Pumps P4 and P5 will be alternated to equalize run times.
  - .3 Pumps will be designated lead and standby.
  - .4 Alternations will occur every Wednesday morning at 7:45 am.
  - .5 If no pumps are running the system will alternate the equipment designations.
  - .6 If a pump/ is running the system shall start the new pump and confirm operation before shutting down the pump that is scheduled to be turned off.
- .3 Scheduling
  - .1 When the outside air temperature drops below 15.6 C (60° F) for a period of 20 minutes the hot water heating system shall be activated.



2.5 ADMINISTRATION  
AREA SECONDARY  
HOT WATER HEATING  
SYSTEM  
(Cont'd)

- .3 (Cont'd)
  - .2 If the outside air temperature rises above 18.3 C (65° F) for a period of 20 minutes the hot water heating system shall be deactivated.
  - .3 Provide an outside air temperature sensor.
- .4 System Start-Up
  - .1 Send a signal to start the lead pump and confirm the pump is running.
  - .2 If the pump fails to start automatically start the lag pump and alarm at the BAS. If the lag pump fails to start initiate a critical alarm at the BAS.
- .5 Temperature Control
  - .1 The system shall send a signal to the 3-way control valve to maintain the hot water supply temperature at setpoint based on the following reset schedule:

| Outside Air Temperature | Hot Water Supply Temperature |
|-------------------------|------------------------------|
| -28 C (-18 F)           | 93.3 C (200 F)               |
| 15.6 C (60 F)           | 37.8 C (100 F)               |
- .6 Alarms
  - .1 HVAC Critical
    - .1 Pumps are commanded on and status is not received (10 minute delay).
  - .2 HVAC General
    - .1 The system is running and the supply water temperature drops more than 20° F below setpoint (10 minute delay).
    - .2 The system is running and the supply water temperature rises above 200° F (93° C) (10 minute delay).
    - .3 Pump failure.
  - .3 HVAC Maintenance
    - .1 Pump status is on and the pumps are commanded off (10 minute delay).
    - .2 The system is put into manual mode of operation.
- .7 Monitoring
  - .1 Hot water heating supply and return temperatures.
  - .2 Pump Status.
  - .3 3-way control valve.
  - .4 3-way control valve.
  - .5 Pump alarm.
- .8 Trends

2.5 ADMINISTRATION  
AREA SECONDARY  
HOT WATER HEATING  
SYSTEM  
(Cont'd)

- .8 (Cont'd)  
.1 All Hot Water Heating supply and return temperatures.

2.6 CONTROL OF  
CHILLED WATER  
SYSTEM

- .1 General  
.1 The chilled water system provides chilled water to the air handling unit in the main building.  
.2 All equipment is powered on normal power.  
.3 The system consists of one pump and one air cooled chiller CH-1.
- .2 Safeties  
.1 All safeties listed in this section will override all operational control sequences unless explicitly stated not to.  
.2 If a pump failure occurs the BAS will disable the pump and alarm at the BAS. Once a failure has occurred, the equipment will be disabled from the system until its failure status is reset to normal. Pump failure will be cleared once run status is received on the pump.  
.3 Each pump can be manually taken out of service by the operator. When this is done, the BAS will remove the equipment from service until the operator returns it back to normal service. The operator may choose to do this when performing maintenance on a selected piece of equipment.
- .3 Communication  
.1 The BMS shall communicate with the chillers utilizing BACNET.  
.2 The following points shall be displayed/utilized at the BMS.  
.1 Inputs.  
.1 Chiller enable/disable command.  
.2 Chilled water setpoint.  
.3 Current limit setpoint.  
.2 Outputs.  
.1 Run modes (starting, running, shutting down).  
.2 State (Alarm, run enabled, local control, limited).  
.3 Active chilled water setpoint.  
.4 Active current limit setpoint.  
.5 Evaporator leaving water temperature.  
.6 Unit Power Consumption (KW).

2.6 CONTROL OF  
CHILLED WATER  
SYSTEM  
(Cont'd)

- .3 (Cont'd)
  - .2 (Cont'd)
    - .7 Evaporator entering water temperature.
    - .8 Condenser entering water temperature (Heat Reclaim only).
    - .9 Condenser leaving water temperature. (Heat Reclaim Only).
  - .3 Alarm description.
    - .1 Compressor starts.
    - .2 Compressor run time.
- .4 System Start-up
  - .1 The chilled water system is a constant volume pumping system. Chilled water pump is designated as Pump P8.
  - .2 On command to start on outside air temperature or operator command the BAS shall start the chilled water pump.
  - .3 On confirmation of pump status the BAS shall start the air cooled chiller CH-1. If the chiller does not start, alarm at the BAS.
- .5 System Shut Down
  - .1 The system shall shut down on Operator command or when the outside air temperature drops below 10 C (50 F) for a period of 10 minutes.
  - .2 When the system shuts off the pumps shall shut off.
- .6 Monitoring
  - .1 Chilled water supply and return temperatures as indicated on the schematic.
- .7 Alarms
  - .1 HVAC Critical
    - .1 Pump is commanded on and status is not received (10 minute delay).
    - .2 Chiller failure alarm is received.
    - .3 Chilled water supply temperature is in excess of 15.6 C (60 F).
  - .2 HVAC General
    - .1 The system is running and the supply water temperature is +/- 2°C (3.6°F) from setpoint (10 minute delay).
    - .2 A low pressure alarm is received from the expansion tank.
    - .3 The system differential pressure is above 220 kPa (15 psi).
  - .3 HVAC Maintenance
    - .1 Pump status is on and the pump is commanded off (10 minute delay).

## 2.6 CONTROL OF CHILLED WATER SYSTEM (Cont'd)

- .7 (Cont'd)
- .3 (Cont'd)
- .8 Trends
  - .1 Chilled water supply and return temperatures.
- .9 System Graphics
  - .1 The system graphic will show the following:
    - .1 Chilled water supply and return temperature setpoint.
    - .2 Actual chilled water supply and return temperatures.
    - .3 Pump Status
    - .4 Chiller Status.

## 2.7 FAN COILS

- .1 The fan coils shall be capable of being enabled/disabled at the BAS. They are intended to run 24 hours per day.
- .2 The following fan coils have been provided.

| Fan Coil# | Room Served    | Control Sequence    |
|-----------|----------------|---------------------|
| FC-1      | Central Stores | Temperature Control |
| FC-2      | LAN Room       | Monitor Status      |
| FC-3      | LAN Room       | Monitor             |

- .3 Monitor the status of the fan with a current switch. Alarm at the BAS on fan failure.
- .4 Fan Coils Controlled Based on Temperature Control (FC-1)
  - .1 Provide a temperature sensor with each room served by the unit.
  - .2 Space temperature shall be set at 26.7C (75F)
  - .3 The D/X cooling shall be staged on/off as required to maintain the space temperature at setpoint.
- .5 Alarms (Events)
  - .1 HVAC General
    - .1 The space temperature rises more than 5C (9F) above the cooling setpoint (10 minute delay).
    - .2 Supply air temperature drops below 4.4C (40F).
- .6 Trends
  - .1 Space Temperatures
  - .2 Fan Status
- .7 System Graphics
  - .1 The system graphic will show the following
    - .1 All of the above

## 2.7 FAN COILS

### (Cont'd)

#### .2 Cooling setpoint

2.8 SUPPLY FAN .1 For the following fans provide controls as follows:  
TEMPERATURE CONTROL

| Supply Fan | Serves      | Operation   |
|------------|-------------|-------------|
| SF-24      | Boiler Room | Temperature |

- .2 Temperature Operation
  - .1 When the space temperature reaches 75o F the supply fan shall be activated.
  - .2 The space temperature sensor operating through a digital controller shall maintain space temperature at 75o F by modulating the outside air, relief and return air dampers as required to maintain temperature setpoint.
  - .3 Monitor status with a current switch. On fan failure alarm at the EMCS.
  - .4 When the outside air temperature rises above 80 o F the supply fan shall be deactivated.
- .3 Alarms (Events)
  - .1 HVAC General
    - .1 Alarm on fan failure.
- .4 System Graphics
  - .1 The system graphic will show the fan status and the mode of operation for the system.
  - .2 For supply that are modulating based on temperature the supply fan status, space temperature and damper position shall be displayed.

2.9 ADJUSTMENTS .1 Adjust and set thermostats, temperature sensors, humidity sensors, damper operators, relays and other components to proper settings to give required performance. Cooperate with other sections during testing and balancing of each mechanical system to ensure each total system operates to approval.  
SERVICE & WARRANTY

|                               |    |                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------------------------------|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>2.9 ADJUSTMENTS</u>        | .2 | Temperature control system shown and specified herein shall be warranted free from defects in materials and workmanship and shall be serviced without charge (except for damage from lack of maintenance of other causes) for one year after date of start of lien period. If, within this period, any equipment herein described is proved to be defective in workmanship or materials, it shall be replaced or repaired without charge. |
| <u>SERVICE &amp; WARRANTY</u> |    |                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <u>(Cont'd)</u>               |    |                                                                                                                                                                                                                                                                                                                                                                                                                                           |

|                        |    |                                                                                                |
|------------------------|----|------------------------------------------------------------------------------------------------|
| <u>2.10 SUBMITTALS</u> | .1 | Submit shop drawings for review prior to installation and in accordance with Section 01 33 00. |
|------------------------|----|------------------------------------------------------------------------------------------------|

**AIR HANDLING UNIT SCHEDULE**  
**Parry Sound CCG Base**  
**HVAC Upgrades to Main Building**

Tag No: **AH-1**

Date: 1/29/2015

CEL Project No.: 13403

Revision No.:

| Tag No.     | Unit Location | Name | Marine Lights | Min. Outdoor Air Flow [CFM] | Weight [kg] | Manufacturer | Model No.  | Remarks |
|-------------|---------------|------|---------------|-----------------------------|-------------|--------------|------------|---------|
| <b>AH-1</b> | Main Building |      | Yes           | 2,500                       |             | Daikin       | CAH031GDAM |         |

**FAN SCHEDULE**

| Tag No. | CFM    | ESP [in.wg] | Fan RPM | Motor |    |    |      |      |         |     |            | Size | Manufacturer | Model No. | Remarks |
|---------|--------|-------------|---------|-------|----|----|------|------|---------|-----|------------|------|--------------|-----------|---------|
|         |        |             |         | V     | Ph | HP | BHP  | Type | Starter | MCA | Power Type |      |              |           |         |
| F-1     | 15,000 | 1.75        | 2319    | 575   | 3  | 25 | 20.1 | ODP  | VFD     |     | Normal     | 20   | Daikin       |           |         |
|         |        |             |         |       |    |    |      |      |         |     |            |      |              |           |         |
|         |        |             |         |       |    |    |      |      |         |     |            |      |              |           |         |
|         |        |             |         |       |    |    |      |      |         |     |            |      |              |           |         |
|         |        |             |         |       |    |    |      |      |         |     |            |      |              |           |         |
|         |        |             |         |       |    |    |      |      |         |     |            |      |              |           |         |

**FAN SOUND POWER LEVEL SCHEDULE**

Sound Power Level RE: 10<sup>-12</sup> Watts

| Tag No. | Inlet |    |    |    |    |    |    |    |         | Discharge |    |    |    |    |    |    |    |         |
|---------|-------|----|----|----|----|----|----|----|---------|-----------|----|----|----|----|----|----|----|---------|
|         | 1     | 2  | 3  | 4  | 5  | 6  | 7  | 8  | Average | 1         | 2  | 3  | 4  | 5  | 6  | 7  | 8  | Average |
| F-1     | 86    | 91 | 81 | 81 | 72 | 62 | 50 | 37 |         | 86        | 91 | 81 | 81 | 72 | 62 | 50 | 37 |         |
|         |       |    |    |    |    |    |    |    |         |           |    |    |    |    |    |    |    |         |
|         |       |    |    |    |    |    |    |    |         |           |    |    |    |    |    |    |    |         |
|         |       |    |    |    |    |    |    |    |         |           |    |    |    |    |    |    |    |         |
|         |       |    |    |    |    |    |    |    |         |           |    |    |    |    |    |    |    |         |
|         |       |    |    |    |    |    |    |    |         |           |    |    |    |    |    |    |    |         |

**HYDRONIC COIL SCHEDULE**

| Tag No. | Air PD [in.wg] | Face Velocity [FPM] | Entering Air Temperature |         | Leaving Air Temperature |         | Fluid      | GPM | ΔP [FT] | EWT [°F] | LWT [°F] | Size [inch] |        | Fins Per Inch | Rows | Remarks                               |
|---------|----------------|---------------------|--------------------------|---------|-------------------------|---------|------------|-----|---------|----------|----------|-------------|--------|---------------|------|---------------------------------------|
|         |                |                     | DB [°F]                  | WB [°F] | DB [°F]                 | WB [°F] |            |     |         |          |          | Width       | Height |               |      |                                       |
| CCI-1   | 0.9            | 542                 | 77.5                     | 65      | 55.1                    | 53.8    | Glycol 40% | 99  | 11.9    | 42       | 52.2     | 83          | 24     | 7             | 5    | Total = 505 MBH<br>Sensible = 368 MBH |

| AIR HANDLING UNIT SCHEDULE |      |     |    |  |      |  |       |    |     |     |     |  |  |   | Tag No: AH-1 |                 |
|----------------------------|------|-----|----|--|------|--|-------|----|-----|-----|-----|--|--|---|--------------|-----------------|
| Parry Sound CCG Base       |      |     |    |  |      |  |       |    |     |     |     |  |  |   |              |                 |
| HCI-1                      | 0.12 | 563 | 43 |  | 68.8 |  | Water | 36 | 3.5 | 180 | 160 |  |  | 9 | 1            | Total = 180 MBH |
|                            |      |     |    |  |      |  |       |    |     |     |     |  |  |   |              |                 |
|                            |      |     |    |  |      |  |       |    |     |     |     |  |  |   |              |                 |
|                            |      |     |    |  |      |  |       |    |     |     |     |  |  |   |              |                 |
|                            |      |     |    |  |      |  |       |    |     |     |     |  |  |   |              |                 |

| HUMIDIFICATION UNIT SCHEDULE |                            |         |
|------------------------------|----------------------------|---------|
| Tag No.                      | Steam Capacity<br>[Lbs/hr] | Remarks |
| HUI-1                        | 102                        |         |
|                              |                            |         |

Remarks:

1. New unit to be attached to existing ductwork and piping

2. Unit shall be provided with marine lights in all sections

3. return fan is separate from unit and location in the third floor fan room. Refer to return fan schedule for further details

4. Variable speed drives shall be provided for S/A fan. Fan motor shall be premium efficiency motor.

5. Unit shall be installed on 6" concrete pad

6. Minimum outdoor airflow is 2500 cfm

7. humidifier grid shall be capable of supplying 102 lbs/hr. Refer to humidifier specifications.schedule for further details.

8. Cooling coil shall be based on 40% propylene glycol.

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**HYDRONIC BOILER SCHEDULE**  
**Parry Sound CCG Base**  
**HVAC Upgrades to Main Building**

Date: 2015/11/06  
 CEL Project No. 13403  
 Revision No.: 0

| Tag No. | Fuel    | Input MBH | Output MBH | EWT (C) | LWT (C) | V/Ph  | Manufacturer | Model No. | Boiler dBa High Fire | Comments |
|---------|---------|-----------|------------|---------|---------|-------|--------------|-----------|----------------------|----------|
| B-01    | GAS     | 1112      | 1078       | 43.3    | 60      | 120/1 | VIESSMANN    | CM2-311   |                      |          |
| B-02    | GAS     | 1112      | 1078       | 43.3    | 60      | 120/1 | VIESSMANN    | CM2-311   |                      |          |
| B-03    | GAS/OIL | 934       | 794        | 76.6    | 93.3    | 120/1 | VIESSMANN    | VD2A-230  |                      |          |
|         |         |           |            |         |         |       |              |           |                      |          |
|         |         |           |            |         |         |       |              |           |                      |          |
|         |         |           |            |         |         |       |              |           |                      |          |
|         |         |           |            |         |         |       |              |           |                      |          |
|         |         |           |            |         |         |       |              |           |                      |          |
|         |         |           |            |         |         |       |              |           |                      |          |
|         |         |           |            |         |         |       |              |           |                      |          |
|         |         |           |            |         |         |       |              |           |                      |          |
|         |         |           |            |         |         |       |              |           |                      |          |
|         |         |           |            |         |         |       |              |           |                      |          |
|         |         |           |            |         |         |       |              |           |                      |          |

**Remarks:**

1. Provide double acting barometric draft regulator located within 5-7 ft from the breaching outlet located at the back of the boiler.
2. Provide one 120/1 power connection for the boiler controls and one 208/3 power connection for the fan motor.
3. Boilers B-01 and B-02 shall be capable of resetting the water temperature that will be operating outside of condensing mode up to a temperature of 93.3C.

**Crossey Engineering Ltd.**

**AIR COOLED CHILLER SCHEDULE**  
**Parry Sound CCG Base**  
**HVAC Upgrades to Main Building**

**Date:2015/11/06**  
**CEL Project No.:13403**  
**Revision No.: 0**

|                               |           |
|-------------------------------|-----------|
| Tag No.                       | CH-01     |
| Design Capacity Tons          | 36.6      |
| Power Input KW                | 40.4      |
| Kw/ton Design Duty            | 40.4/36.6 |
| Kw/ton 75% Design Duty        |           |
| Kw/ton 50% Design Duty        |           |
| APLV                          |           |
| Refrigerant Charge LBS        | 42        |
| Refrigerant type              | R410A     |
| <b>Evaporator</b>             |           |
| EWT °F                        | 52        |
| LWT °F                        | 42        |
| USGpm                         | 95.8      |
| Pressure Drop FT              | 21.8      |
| Number of Passes              |           |
| Fouling Factor (°F.ft².h/Btu) | 0.00010   |
| <b>Condenser</b>              |           |
| EWT °F                        |           |
| LWT °F                        |           |
| USGpm                         |           |
| Pressure Drop FT              |           |
| Number of Passes              |           |
| Fouling Factor                |           |
| V/ph                          | 575/3     |
| Manufacturer                  | Daikin    |
| Model No.                     | AGZ040E   |
| Max Motor Lra                 | 14 A      |
| MCA                           | 66.9 A    |
| Operating Weight Lbs          | 2964      |
| Overall Sound Power           | 89 dBA    |

**Remarks:**

- Air cooled chiller. Condenser specs as follows:  
Ambient Air temperature: 95 °F  
Fan Diameter: 30 in  
Fan motor horsepower: 1.5 hp  
Fan speed: 1140 RPM  
Low Ambient control to 32 °F  
Unit Airflow: 40400 CFM

**Crossey Engineering Ltd.**

**FAN COIL UNIT SCHEDULE**  
**Parry Sound CCG Base**  
**HVAC Upgrades to Main Building**

**Revision No.: 0**

| Tag No. | Location Served | Air  |          | Motor |      |    | Starter | Type                                      | Manufacturer | Model No.   | Remarks          |
|---------|-----------------|------|----------|-------|------|----|---------|-------------------------------------------|--------------|-------------|------------------|
|         |                 | CFM  | ESP (in) | V/ph  | BHP  | HP |         |                                           |              |             |                  |
| FCU-01  | CENTRAL STORES  | 1500 | 1.00     | 575/3 | 1.15 | 2  |         | TopHorizontal-CCW rotation-Forward curved | Daikin       | LAH003A     | DX Fan Coil Unit |
| FCU-02  | LAN ROOM        |      |          | 208/1 |      |    |         |                                           | Liebert      | DME020E-PH7 | 1.5 ton unit     |
| FCU-03  | LAN ROOM        |      |          | 208/1 |      |    |         |                                           | Liebert      | DME020E-PH7 | 1.5 ton unit     |
|         |                 |      |          |       |      |    |         |                                           |              |             |                  |

**FAN COIL UNIT PERFORMANCE DATA**

| Tag No. | Location Served | Air  | Chilled Water Cooling (20% PG) |              |     |     |     |           | DX Cooling   |              |           |          |            |           |
|---------|-----------------|------|--------------------------------|--------------|-----|-----|-----|-----------|--------------|--------------|-----------|----------|------------|-----------|
|         |                 | CFM  | EAT db/wb °F                   | LAT db/wb °F | EWT | LWT | GPM | MBH TC/SC | EAT db/wb °F | LAT db/wb °F | Coil Rows | Coil FPI | SST/SCT °F | MBH TC/SC |
| CD-01   | CENTRAL STORES  | 1500 | -                              | -            | -   | -   | -   | -         | 76.5/65.5    | 59.4/58.3    | 4         | 12       | 53         | 33.9/28.1 |
| CD-02   | LAN ROOM        |      |                                |              |     |     |     |           |              |              |           |          |            |           |
| CD-03   | LAN ROOM        |      |                                |              |     |     |     |           |              |              |           |          |            |           |
|         |                 |      |                                |              |     |     |     |           |              |              |           |          |            |           |

**FAN COIL UNIT SCHEDULE**  
**Parry Sound CCG Base**  
**HVAC Upgrades to Main Building**

**Revision No.: 0**

**Remarks:**

1. MS – Magnetic Starter
2. Unit shall be on Normal Power.
3. Condensing Unit CD-1 shall be paired with DX fan coil unit FC-1:
  - a. Refplus model OCZ-035-1H1-8D
  - b. 95 deg.F design ambient
  - c. 575V/3 phase
  - d. MCA = 8.05A
  - e. R-410A refrigerant
  - f. Provide low ambient kit, unit will be operational in the winter.
  - g. 3.8 tons
  - h. Approximate weight of 650 lbs
4. Fan Coil unit FC-1 shall have an electric heating Coil with the following performance:
  - a. Heater Size: 9.0 KW
  - b. Total Capacity: 30726 Btu/hr
  - c. EAT: 63F
  - d. LAT: 82F
  - e. MROPDA: 15
5. Condensing unit CD-2 shall be paired with FC-2 and CD-3 shall be paired with FC-3:
  - a. Liebert condensing unit model PFH020A-PL7
  - b. 95 deg.F design ambient
  - c. 208/1 phase
  - d. FLA = 12.1 Amps
  - e. R-407C refrigerant
  - f. Provide low ambient kit, unit will be operational in the winter.
  - g. 1.5 tons
  - h. Approximate weight of 200 lbs
6. Mechanical contractor shall be responsible for hiring a refrigeration contractor to size and route the refrigerant lines from the fan coil units to the roof mounted condensing units.

**Crossey Engineering Ltd.**

**FAN COIL UNIT SCHEDULE**  
**Parry Sound CCG Base**  
**HVAC Upgrades to Main Building**

**Revision No.: 0**

**HUMIDIFIER SCHEDULE**  
**Parry Sound CCG Base**  
**HVAC Upgrades to Main Building**

Date: 2015/11/06  
 CEL Project No. 13403  
 Revision No.: 0

| Tag No. | Face Size<br>HxW<br>In x In | CFM    | S/A<br>Temp °F | Load<br>Lbs/hr | Steam<br>PSI | Absorption<br>Distance | Space Conditions |        | Manufacturer | Model No. |
|---------|-----------------------------|--------|----------------|----------------|--------------|------------------------|------------------|--------|--------------|-----------|
|         |                             |        |                |                |              |                        | Temp °F          | Hum. % |              |           |
| H-1     | 18.6x24.2                   | 15,000 | 55             | 86.1           | -            | 11"                    | 75               | 30     | Dri-Steem    | VM-34     |

**Remarks:**

- 1) Minimum water conductivity of 2 grains/gallon
- 2) To be installed in location of existing humidifier.
- 3) Electrical Info:
  - a. 600V/3 Phase
  - b. 32.7 Amps

**Crossey Engineering Ltd.**

**LOUVRED PENTHOUSE SCHEDULE**  
**Parry Sound CCG Base**  
**HVAC Upgrades to Main Building**

Date: 2015/11/06  
 CEL Project No. 13403  
 Revision No.: 0

| Tag No. | CFM  | Size Of Penthouse mm | Room Opening mm | No. of Active Slides | Manufacturer  | Remarks |
|---------|------|----------------------|-----------------|----------------------|---------------|---------|
| LP-01   | 2250 | 1050(W)x1400(H)      | 550x550         | 2                    | Price – JE443 | Note 1  |
|         |      |                      |                 |                      |               |         |
|         |      |                      |                 |                      |               |         |
|         |      |                      |                 |                      |               |         |
|         |      |                      |                 |                      |               |         |
|         |      |                      |                 |                      |               |         |
|         |      |                      |                 |                      |               |         |
|         |      |                      |                 |                      |               |         |
|         |      |                      |                 |                      |               |         |
|         |      |                      |                 |                      |               |         |
|         |      |                      |                 |                      |               |         |
|         |      |                      |                 |                      |               |         |

**Remarks:**

1. Ventilation air outlet and supply air inlet separated by baffle.
2. Provide bird and insect screen for all louvred penthouses.

**Crossey Engineering Ltd.**



**NEUTRALIZING TANK SCHEDULE**  
**Parry Sound CCG Base**  
**HVAC Upgrades to Main Building**

Date: 2015/11/06  
 CEL Project No. 13403  
 Revision No.: 0

| Tag No. | SYSTEM            | CAPACITY         |                   | DIMENSION     |                | MAKE/MODEL #    | REMARKS |
|---------|-------------------|------------------|-------------------|---------------|----------------|-----------------|---------|
|         |                   | EMPTY<br>[USGAL] | ACTUAL<br>[USGAL] | WIDTH<br>[mm] | LENGTH<br>[mm] |                 |         |
| NT-01   | HOT WATER HEATING | -                | 70L/h             | 300           | 400            | VIESSMANN / N70 | -       |
| NT-02   | HOT WATER HEATING | -                | 70L/h             | 300           | 400            | VIESSMANN / N70 | -       |
|         |                   |                  |                   |               |                |                 |         |
|         |                   |                  |                   |               |                |                 |         |
|         |                   |                  |                   |               |                |                 |         |
|         |                   |                  |                   |               |                |                 |         |
|         |                   |                  |                   |               |                |                 |         |

**Remarks:**

1.

**PUMP SCHEDULE**  
**Parry Sound CCG Base**  
**HVAC Upgrades to Main Building**

Date: 2015/11/06  
 CEL Project No. 13403  
 Revision No.: 0

| Tag No. | Service | Location       | GPM  | Head Ft. | Motor |      |      |      | Manufacturer | Model No. | Remarks |
|---------|---------|----------------|------|----------|-------|------|------|------|--------------|-----------|---------|
|         |         |                |      |          | V/Ph  | BHP  | HP   | Rpm  |              |           |         |
| P-01    |         | BOILER RM.     | 130  | 70       | 575/3 | 4.01 | 7.5  | 1200 | Armstrong    | 4380      | 3X3X13  |
| P-02    |         | BOILER RM.     | 130  | 70       | 575/3 | 4.01 | 7.5  | 1200 | Armstrong    | 4380      | 3X3X13  |
|         |         |                |      |          |       |      |      |      |              |           |         |
| P-04    |         | MECHANICAL RM. | 26.2 | 43       | 575/3 | 0.7  | 1.5  | 1800 | Armstrong    | 1060-1.5D |         |
| P-05    |         | MECHANICAL RM. | 26.2 | 43       | 575/3 | 0.7  | 1.5  | 1800 | Armstrong    | 1060-1.5D |         |
| P-06    |         | MECHANICAL RM. | 22.3 | 36       | 575/3 | 0.26 | 0.75 | 1800 | Armstrong    | H-H64     |         |
| P-07    |         | MECHANICAL RM. | 22.3 | 36       | 575/3 | 0.26 | 0.75 | 1800 | Armstrong    | H-H64     |         |
|         |         |                |      |          |       |      |      |      |              |           |         |
|         |         |                |      |          |       |      |      |      |              |           |         |
|         |         |                |      |          |       |      |      |      |              |           |         |
|         |         |                |      |          |       |      |      |      |              |           |         |
|         |         |                |      |          |       |      |      |      |              |           |         |

**Remarks:**

1. All pumps that are over 20 HP shall be provided with thermistor.
2. Refer to Section 15010 of the specification
3. Pumps P-01 and P-02 shall be provided with Variable Frequency Drives.

**Crossey Engineering Ltd.**

**Date: 2015/11/06**  
**CEL Project No. 13403**  
**Revision No.: 0**

**Remarks:**

1. Fan installed in third floor Fan Room.
2. Provide vibration isolation springs.
3. Provide flexible duct connection on inlet and outlet.
4. Fan shall come in section to fit through a single door.
5. Variable speed drives shall be provided for this R/A fan c/w a premium efficiency motor.

**Crossey Engineering Ltd.**

**SUPPLY FAN SCHEDULE**  
**Parry Sound CCG Base**  
**HVAC Upgrades to Main Building**

Date: 2015/11/06  
 CEL Project No. 13403  
 Revision No.: 0

| Tag No. | Location Served | CFM  | Max<br>Sound<br>Sones | E Sp<br>I.W.C. | Fan<br>Rpm | Motor |     |       | Manuf<br>acture<br>r | Model No. | Controls | Remarks |
|---------|-----------------|------|-----------------------|----------------|------------|-------|-----|-------|----------------------|-----------|----------|---------|
|         |                 |      |                       |                |            | V/Ph  | BHP | HP    |                      |           |          |         |
| SF-24   | BOILER ROOM     | 1500 | -                     | 0.35           | 1331       | 120/1 | 0.2 | 4-Mar | Cook                 | 120QMX    | BAS      |         |
|         |                 |      |                       |                |            |       |     |       |                      |           |          |         |
|         |                 |      |                       |                |            |       |     |       |                      |           |          |         |
|         |                 |      |                       |                |            |       |     |       |                      |           |          |         |
|         |                 |      |                       |                |            |       |     |       |                      |           |          |         |
|         |                 |      |                       |                |            |       |     |       |                      |           |          |         |
|         |                 |      |                       |                |            |       |     |       |                      |           |          |         |
|         |                 |      |                       |                |            |       |     |       |                      |           |          |         |
|         |                 |      |                       |                |            |       |     |       |                      |           |          |         |
|         |                 |      |                       |                |            |       |     |       |                      |           |          |         |
|         |                 |      |                       |                |            |       |     |       |                      |           |          |         |

**Remarks:**

Crossey Engineering Ltd.

**13403 - VARIABLE VOLUME BOX TYPE SCHEDULE****PARRY SOUND CCB BASE REFURBISHMENT****HVAC Upgrades to Main Building****Date: 2015-11-04****CEL Project No. 13403****Revision No.: 0**

| Type Tag | Size                | Inlet Size   | Manufacturer | Model    | Remarks |
|----------|---------------------|--------------|--------------|----------|---------|
| B        | 12"x8" (305x203)    | 125 mm (5")  | E.H. PRICE   | SDV 8000 |         |
| D        | 12"x10" (305x254)   | 175 mm (7")  | E.H. PRICE   | SDV 8000 |         |
| E        | 12"x10" (305x254)   | 200 mm (8")  | E.H. PRICE   | SDV 8000 |         |
| F        | 14"x12.5" (356x318) | 225 mm (9")  | E.H. PRICE   | SDV 8000 |         |
| G        | 14"x12.5" (356x318) | 250 mm (10") | E.H. PRICE   | SDV 8000 |         |
| H        | 16"x15" (406x381)   | 350 mm (14") | E.H. PRICE   | SDV 8000 |         |
|          |                     |              |              |          |         |
|          |                     |              |              |          |         |

**Remarks:**

1. VAV BOX SHALL BE COMPLETE WITH DDC CONTROLS AND ALL NECESSARY DDC COMPONENTS INCLUDING THERMOSTAT
2. REFER TO SPECIFICATIONS FOR ATTENUATOR INFORMATION

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## PART 1 - GENERAL

### 1.1 REFERENCES

- .1 Adhere to the latest Canadian Standards Association (CSA International)
  - .1 CSA-C22.1-15, Canadian Electrical Code, Part 1 (23rd Edition), Safety Standard for Electrical Installations.
  - .2 CAN3-C235-83, Preferred Voltage Levels for AC Systems, 0 to 50,000 V.
- .2 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).
- .3 The Ontario Electrical Safety Code, and all bulletins (Ontario).
- .4 Electrical Safety Authority (ESA) requirements and local applicable codes and regulations.

### 1.2 DESIGN REQUIREMENTS

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

### 1.3 SUBMITTALS

- .1 Submittals: in accordance with Section 01 45 00.
  - .2 Product Data: submit WHMIS MSDS.
  - .3 Shop drawings:
    - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario.
    - .2 Submit 6 number of copies of drawings and product data to authority having jurisdiction.
    - .3 If changes are required, notify Departmental Representative of these changes before they are made.
-

1.3 SUBMITTALS  
(Cont'd)

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- .4 Quality Control: in accordance with Section 01 45 00.
  - .1 Provide CSA certified equipment and material.
  - .2 Where CSA certified equipment and material is not available, submit such equipment and material to authority having jurisdiction for special approval before delivery to site.
  - .3 Submit test results of installed electrical systems and instrumentation.
  - .4 Permits and fees: in accordance with General Conditions of contract. Pay associated fees. Departmental Representative will provide drawings and specifications required by Electrical Inspection Department and Supply Authority at no cost.
  - .5 Submit, upon completion of Work, load balance report as described in PART 3 - Load Balance.
  - .6 Submit certificate of acceptance from Electrical Safety Authority having jurisdiction upon completion of Work to Departmental Representative.
  - .7 Submit fire alarm testing and verification certificate upon completion of work.
  - .8 Submit emergency lighting level (in LUX) for all public areas (corridors, etc.) and rooms that have more than 60 people.

1.4 QUALITY  
ASSURANCE

---

- .1 Quality Assurance: in accordance with Section 01 11 00.
  - .2 Qualifications: electrical Work to be carried out by qualified, licensed electricians who hold valid Master Electrical Contractor license or apprentices as per the conditions of Provincial Act respecting manpower vocational training and qualification.
    - .1 Employees registered in provincial apprentices program: permitted, under direct supervision of qualified licensed electrician, to perform specific tasks.
    - .2 Permitted activities: determined based on training level attained and demonstration of ability to perform specific duties.
  - .3 Site Meetings:
    - .1 In accordance with Section 01 31 19.
-

- |                                                   |    |                                                                                                                                              |
|---------------------------------------------------|----|----------------------------------------------------------------------------------------------------------------------------------------------|
| <u>1.4 QUALITY<br/>ASSURANCE<br/>(Cont'd)</u>     | .4 | Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.                          |
| <u>1.5 DELIVERY,<br/>STORAGE AND<br/>HANDLING</u> | .1 | Material Delivery Schedule: provide Departmental Representative with schedule within weeks after award of Contract.                          |
|                                                   | .2 | Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 21. |
| <u>1.6 SYSTEM STARTUP</u>                         | .1 | Instruct Departmental Representative and operating personnel in operation, care and maintenance of systems, system equipment and components. |

## PART 2 - PRODUCTS

- |                                        |    |                                                                                                                                                                                                                                                            |
|----------------------------------------|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>2.1 MATERIALS AND<br/>EQUIPMENT</u> | .1 | Provide material and equipment in accordance with Section 01 11 00.                                                                                                                                                                                        |
|                                        | .2 | Material and equipment to be CSA certified. Where CSA certified material and equipment are not available, obtain special approval from authority having jurisdiction before delivery to site and submit such approval as described in PART 1 - Submittals. |
|                                        | .3 | Factory assemble control panels and component assemblies.                                                                                                                                                                                                  |
| <u>2.2 WARNING SIGNS</u>               | .1 | Warning signs: in accordance with requirements of authority having jurisdiction.                                                                                                                                                                           |
| <u>2.3 WIRING<br/>TERMINATIONS</u>     | .1 | Ensure lugs, terminals, screws used for termination of wiring are suitable for either copper or aluminum conductors.                                                                                                                                       |
-



## 2.4 EQUIPMENT IDENTIFICATION

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

### NAMEPLATE SIZES

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

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

## 2.5 WIRING IDENTIFICATION

- .1 Identify wiring with permanent indelible identifying markings, coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour coding: to CSA-C22.1.
- .4 Use colour coded wires in communication cables, matched throughout system.

## 2.6 CONDUIT AND CABLE IDENTIFICATION

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

|                          | Prime  | Auxiliary |
|--------------------------|--------|-----------|
| up to 250 V              | Yellow |           |
| up to 600 V              | Yellow | Green     |
| Telephone                | Green  |           |
| Other                    | Green  | Blue      |
| Communication<br>Systems |        |           |
| Fire Alarm               | Red    |           |
| Emergency<br>Voice       | Red    | Blue      |

## 2.7 FINISHES

- .1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.

## 2.8 DISTRIBUTION SYSTEM

- .1 120/208V, 3-phase, 4-W, 60 Hz. and 347/600V, 3-phase, 4-W, 60 Hz.
- .2 Inform other Divisions of electrical system characteristics.

2.9 WIRING SYSTEM

- .1 Power and lighting circuits in EMT and/or described in other sections.
- .2 Use heavy wall rigid conduit where required by codes.
- .3 RW-90, XLPE insulated wire for panel feeder and branch circuits, GTF insulated wire for final fixture connection.
- .4 #12 AWG minimum wire size, #10 AWG or larger shall be stranded.
- .5 Copper conductors.
- .6 Size branch circuits and panel feeders for maximum 2% voltage drop.
- .7 Provide insulated green ground conductor in all EMT conduits.
- .8 Provide nylon insulated bushings on the ends of all conduits in junction boxes, pullboxes, panelboards, etc.
- .9 Minimum size conduit for lighting and power circuits is 21 mm.

2.10 GROUNDING

- .1 Ground equipment with approved conductors and connectors.
- .2 Make tests required by code and authorities having jurisdiction.

2.11 MOTOR AND  
CONTROL WIRING

- .1 Provide wiring and connections for motors and electrical equipment supplied under other Divisions.
- .2 Mechanical Divisions shall wire control circuits 50 volts and under.

2.12 PANELBOARD

- .1 Provide panelboard of the circuit breaker type.
- .2 Install branch circuit breakers shown on panel schedule.

2.12 PANELBOARD  
(Cont'd)

- .3 Panel to be in dead front metal cabinet with hinged door and catches.
- .4 Breakers: toggle type, bolt-on, quick-make, quick-break, 40°C ambient temperature compensated and trip-free of operating handles on overloads.
- .5 Lock-on handle devices for breakers not controlling lighting. 2P and 3P breakers to be with single handle common trip type.
- .6 Typed directory card showing load supplied by each circuit, mounted inside cabinet door. Updated panel directories as required to reflect all work done under this project.
- .7 Mount panel at 1500 mm above finished floor with the top of panel not higher than 2000 mm.
- .8 Copper bus with neutral of same ampere rating as mains.
- .9 Provide two 27 mm spare empty conduits from recessed panels into ceiling space above panel and terminate in an accessible location.

2.13 OUTLET BOXES

- .1 Light fixture outlet boxes: standard, octagonal or square as required.
- .2 Switch outlet boxes: standard, single or ganged as required.
- .3 Receptacle outlet boxes: standard.
- .4 Steel construction.
- .5 Standard FS conduit fittings for surface mounted outlets in exposed areas.

2.14 SWITCHES

- .1 Specification grade, toggle type, 20 amps, 120V back and side wired, chrome plated yoke, silver cadmium oxide contacts, switch mechanism on neoprene cushion.
  - .2 Locate switches on latch side of door, 1.2m above finished floor unless noted otherwise.
-

- 2.15 RECEPTACLES
- .1 Specification grade, 15 amp, 125 volt, AC, 'U' ground parallel blade slots, triple wiping contacts, double grounding terminals, break-off feature for separate feeds, built-in strap in plastic moulded body and back and side wiring terminals.
  - .2 Locate receptacles 400 mm above finished floor unless noted otherwise.
  - .3 Provide outlets with various configurations as indicated on electrical drawings.

- 2.16 COVER PLATES
- .1 Common cover plate at ganged outlet boxes. Split plates not allowed.

- 2.17 FIXTURE MOUNTING
- .1 Provide mounting and supports required for safe installation to Departmental Representative's satisfaction.

- 2.18 LIGHTING FIXTURES
- .1 Provide lighting fixtures with lamps as illustrated in electrical standard details.
  - .2 Shop drawings to consist of catalogue cuts and photometric data from an independent test lab.

- 2.19 FLUORESCENT FIXTURES
- .1 Ballast: electronic high power factor, energy saving type automatic resetting, thermal protection, pressure sensitive capacitor protection, lowest sound level available.
  - .2 Body: minimum 0.952 mm thick (20 gauge) steel, white baked enamel finish, reflectance value minimum 85%.
  - .3 Lens: 100% pure acrylic, low brightness, sparkling crystal prismatic pattern, maximum efficiency, and direct glare control. ULC certified.
  - .4 CSA rated for continuous row mounting.
-

- |                                       |    |                                                                                                                                                                                                              |
|---------------------------------------|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>2.20 LAMPS</u>                     | .1 | Fluorescent lamps: T8 lamps, 1220 mm length unless specified otherwise, bi-pin, rapid start, premium grade, 18,000 hour life expectancy, 3,200 initial lumen output, cool/warm white.                        |
| <u>2.21 DISCONNECT SWITCHES</u>       | .1 | Heavy duty, quick-make, quick-break.                                                                                                                                                                         |
| <u>2.22 FIRE ALARM SYSTEMS</u>        | .1 | Refer to Section 28 31 00.                                                                                                                                                                                   |
| <u>2.23 WORK IN EXISTING BUILDING</u> | .1 | The Work of the specification shall be read in conjunction with and be governed by the requirements with this section.                                                                                       |
|                                       | .2 | Maintain life safety systems to all existing buildings at all times during construction.                                                                                                                     |
|                                       | .3 | Maintain electrical continuity to all portions of existing building during all work. Submit letter to Owner requesting off-hours shut-down. Provide all temporary power and wiring required to achieve this. |
| <u>2.24 AS-BUILT DRAWINGS</u>         | .1 | Obtain CAD drawings from Consultant to do CAD as-built drawing.                                                                                                                                              |
|                                       | .2 | Submit CAD as-built drawings at the end of the project for review and approval.                                                                                                                              |
|                                       | .3 | Using PWGSC layering system.                                                                                                                                                                                 |
| <u>2.25 ELECTRICAL COMMISSIONING</u>  | .1 | Related Sections<br>.1 This section of the Specification shall be read in conjunction with and be governed by the requirements of Division 01.                                                               |
-

2.26 SUMMARY OF  
COMMISSIONING

- .1 Commissioning (Cx) is a systematic quality process of ensuring that building systems perform and interact according to the Owner's and the Design Engineers' Project Requirements and contract documents.
- .2 Desired Outcomes
  - .1 A commissioned building provided optimized energy and occupant comfort, and sets the stage for minimal operation and maintenance costs. It serves as a tool for both the Owner and the Contractor to minimize post-occupancy remedial work.
- .3 Commissioning Goals
  - .1 The Commissioning Process for a project typically focuses on systems and assemblies having to do with the performance objectives meeting the Owner's Project Requirements (OPR). Contractors, associated Sub-Contractors, equipment and material Suppliers are to support and ensure the requirements for commissioning are met in their respective work.

2.27 DEFINITIONS

- .1 Owner's Project Requirements (OPR)
    - .1 The documentation of the functional performance requirements of the facility and the Owner's expectations of how it will be used and operated. This document is analogous to what has traditionally been referred to as the Owner Program.
  - .2 Basis of Design (BOD)
    - .1 A project-specific set of assumptions and design parameters for system and product selections to meet the OPR and applicable regulatory requirements.
  - .3 Commissioning Agent (CxA)
    - .1 An Owner designated member, not otherwise associated with the Architectural and Engineering Teams or the Contractor's Team. The CxA facilitates and coordinates the commissioning activities. Involvement of CxA shall not void any guarantees or warranties nor shall it relieve the Contractor of any contractual responsibilities.
  - .4 Deficiency/Issue
-

- 2.27 DEFINITIONS (Cont'd)
- .4 (Cont'd)
    - .1 A condition in the installation or function of a component or system that is not in compliance with the construction contract documents and/or Owner's requirements.
  - .5 Start-up/Pre-Functional The initial starting or activating of dynamic equipment, including the checkout of components and devices and completing static installation checklists.
  - .6 Functional Performance Testing (FPT)
    - .1 Testing performed by the Construction Team to verify that specific components, assemblies, systems, and integrated systems function and perform in accordance with the Owner's objectives and the contract documents. Tests are generally performed after the Contractor's start-up and initial checkouts are completed.
- 2.28 COMMISSIONING PLAN
- .1 The CxA will develop a Commissioning Plan unique to the project.
  - .2 The Commissioning Plan identifies the strategies, aspects, and responsibilities within the commissioning process for all project team members.
  - .3 The Commissioning Plan contains the following information:
    - .1 Commissioning Program Overview
      - .1 Goals and objectives
      - .2 General project information
      - .3 Systems to be commissioned.
    - .2 Commissioning Team
      - .1 Team members, roles, and responsibilities.
      - .2 Communication protocol, coordination, meetings, and management.
    - .3 Commissioning Process Activities
      - .1 Documenting the owner's project requirements.
      - .2 Preparing the basis of design.
      - .3 Developing systems functional performance test procedures.
      - .4 Verifying systems performance.
      - .5 Reporting deficiencies and the resolution process.
    - .4 List of systems and assemblies to be commissioned.
-



2.28 COMMISSIONING PLAN  
(Cont'd) .3 (Cont'd)  
.5 The Contractor and the Sub-Contractors shall carryout commissioning activities as per the Commissioning Plan.

2.29 COMMISSIONING DOCUMENTATION  
DOCUMENTATION .1 The Commissioning Process includes a significant documentation and paper component. Commissioning documents include but are not limited to:  
.1 Drawings and Specifications.  
.2 Shop Drawings.  
.3 Pre-Functional Check Sheets.  
.4 OEM/Contractor Start Up/Test Forms and Records.  
.5 As Built Drawings.  
.6 Functional Performance Test Plans and Results.

### PART 3 - EXECUTION

3.1 GENERAL  
GENERAL .1 Turnover all existing equipment that is no longer required to the Owner. Remove from site any equipment that the Owner may decide upon. Package all HID fixtures individually.  
.2 Protect all removed (to be retained) equipment from damage. Replace damaged equipment.  
.3 Provide temporary power feeder from new electrical room to existing 600A service until permanent feeder is installed.

3.2 COMMISSIONING  
PROCESS

---

- .1 Commissioning Meetings
    - .1 Commissioning during the Construction Phase begins with a team kick off meeting, conducted by the CxA, where the Commissioning Plan is reviewed with the Commissioning Team and roles and responsibilities are clarified. Additional meetings will be held throughout construction, to be conducted by the CxA with the Commissioning Team and if required with other necessary parties attending (for example, a supplier of a product or system), to plan, scope, coordinate, and schedule ongoing commissioning activities and resolve issues/problems. The commissioning meetings will normally be at the call of the CxA in coordination with the Commissioning Team.
  - .2 Pre-Functional Verification
    - .1 The Electrical Contractor will develop the Pre-Functional Check Sheets and provide to the Commissioning Agent for review. These pre-functional check sheets are to be completed by the Contractor during their normal installation and start up process.
    - .2 The equipment start up shall be in accordance with all related specifications and OEM requirements. The installing Contractor or Sub-Contractor shall under their own direction, plan, execute and document the installation verification and perform start up and checkout. The Contractor needs to verify that other building systems being installed will not compromise the operation and functional performance of the commissioned systems.
    - .3 Notify the CxA a minimum of two (2) weeks in advance of equipment and system start up and/or installation verification testing. The CxA verifies the Contractor completed check sheets, checks installation and the startup checks/documentation.
    - .4 Evaluation of the results will be conducted by the CxA. The CxA will evaluate whether the installed systems meet the criteria for the project.
  - .3 Functional Performance Testing
    - .1 All Pre-Functional Check sheets and Processes shall be completed and signed off by the CxA prior to starting equipment or system Functional Performance Testing
-

3.2 COMMISSIONING  
PROCESS  
(Cont'd)

- .3 (Cont'd)
- .2 Systems functional performance testing occurs once all system components are installed, energized, programmed, and otherwise ready for operation.
- .4 Testing includes each process in the sequence of operation under central and packaged equipment control.
- .5 Systems performance testing relies on the testing procedures developed by the CxA specifically for the systems to be tested.
- .6 All equipment / systems shall be functionally tested by the Contractor and Subs prior to demonstration to the CxA. It is the responsibility of the Contractor and Subs to ensure all equipment /systems are functioning properly according to the contract documents before this demonstration occurs.
- .7 The Contractor is required to demonstrate functional performance to the CxA, as required by the CxA. The CxA will evaluate whether the system performance meets the criteria set forth by contract documents and the Owner's project requirements.
- .8 Evaluation of the results will be conducted by the CxA. The CxA will evaluate whether the installed systems meet the criteria for the project.

3.3 SYSTEMS TO BE  
COMMISSIONED

- .1 Lighting and Electrical Distributions.
- .2 Life Safety.

3.4 ELECTRICAL  
CONTRACTOR  
RESPONSIBILITIES

- .1 The Contractor shall be responsible for the commissioning process detailed here and in the Electrical Specifications sections.
- .2 The Contractor shall coordinate and cooperate with the General and Mechanical Contractor as detailed in the specification sections of the Mechanical and Electrical Specifications.

3.4 ELECTRICAL  
CONTRACTOR  
RESPONSIBILITIES  
(Cont'd)

- .3 The Contractor shall only utilize employees with previous experience in testing procedures as they relate to a particular subject.
- .4 The Contractor shall hire the Manufacturers' technicians who will conduct tests on their equipment.
- .5 Provide a schedule showing commissioning activities and milestones and allow adequate time for testing, commissioning and re-work if required.
- .6 Explain and ensure the Sub-Contractors understand commissioning requirements.
- .7 Establish and keep separate record of tests, during construction and the post construction phase.
- .8 Understand quality standards contained in the specifications and ensure by inspections, review by others and testing that they are being met by the Sub-Contractors.
- .9 Arrange samples, test equipment, etc., required by specifications.
- .10 Ensure Sub-Contractors' testing is performed and complete prior to turnover.
- .11 Develop Pre-Functional Check Sheets.
- .12 Completion of Pre-Functional Check Sheets and Functional Performance Test Plans.

Commissioning Team Roles and Responsibilities

| Commissioning<br>Activities<br>and<br>Milestones | OEM(s) | Contractor(s) | Consultant(s)<br>& Designers | Owner | Commissioning<br>Agent(CxA) |
|--------------------------------------------------|--------|---------------|------------------------------|-------|-----------------------------|
|--------------------------------------------------|--------|---------------|------------------------------|-------|-----------------------------|

|                       |  |                                |         |         |          |
|-----------------------|--|--------------------------------|---------|---------|----------|
| Commissioning<br>Plan |  | Provides input<br>re: schedule | Reviews | Reviews | Develops |
|-----------------------|--|--------------------------------|---------|---------|----------|

|                                       |  |              |  |         |        |
|---------------------------------------|--|--------------|--|---------|--------|
| Briefing<br>Contractors<br>Milestones |  | Participates |  | Attends | Briefs |
|---------------------------------------|--|--------------|--|---------|--------|

3.4 ELECTRICAL  
CONTRACTOR  
RESPONSIBILITIES  
(Cont'd)

| Pre-Functional<br>Check Sheets                                       | Develops/<br>Executes                                                   |                                                                         |                                              | Reviews                                                                   |
|----------------------------------------------------------------------|-------------------------------------------------------------------------|-------------------------------------------------------------------------|----------------------------------------------|---------------------------------------------------------------------------|
| Pre-Functional<br>Inspection<br>(Installation<br>& start-up)         | Performs<br>start-up<br>as<br>required                                  | Performs<br>start-up<br>and executes<br>Pre-Functional<br>Check Sheet   | Witness<br>as<br>Required                    | Review<br>installation<br>& start-up<br>execution<br>and<br>documentation |
| Functional<br>Performance<br>Testing Plans                           | Assists<br>with<br>development<br>and<br>execution<br>where<br>required | Assists<br>with<br>development<br>and<br>execution<br>where<br>required | Reviews<br>and<br>comments<br>as<br>required | Develops<br>test<br>procedures                                            |
| Functional<br>Performance<br>Testing and<br>Verification<br>\$PAGE10 | Demonstrates<br>operation<br>to CxA                                     | Demonstrates<br>operation<br>to CxA                                     | Witness<br>as<br>required                    | Witness,<br>verify and<br>document<br>results                             |

## PART 1 - GENERAL

- |                             |     |                                                                                                                                                                         |
|-----------------------------|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>1.1 GENERAL</u>          | .1  | General                                                                                                                                                                 |
|                             | .1  | Section 01 91 13 - General Commissioning (Cx) Requirements                                                                                                              |
|                             | .2  | Section 01 91 31 - Commissioning (Cx) Plan                                                                                                                              |
|                             | .3  | Section 01 91 33 - Commissioning Forms.                                                                                                                                 |
|                             | .4  | Section 01 91 41 - Commissioning Training.                                                                                                                              |
|                             | .5  | Section 01 91 51 - Building Management Manual (BMM).                                                                                                                    |
|                             | .2  | The Electrical Contractor to meet all additional requirements noted in the referenced documents above as well as the work identified within the related sections below. |
|                             | .3  | Acronyms:                                                                                                                                                               |
|                             | .1  | AFD - Alternate Forms of Delivery, Service Provider.                                                                                                                    |
|                             | .2  | BAS - Building Automation System (Also referred to EMCS).                                                                                                               |
|                             | .3  | BMM - Building Management Manual.                                                                                                                                       |
|                             | .4  | EMCS - Energy Monitoring and Control Systems.                                                                                                                           |
|                             | .5  | ICL - Installation Check Lists                                                                                                                                          |
|                             | .6  | PI - Product Information (Forms).                                                                                                                                       |
|                             | .7  | PV - Performance Verification (Forms).                                                                                                                                  |
|                             | .8  | FPT - Functional Performance Test (Plans).                                                                                                                              |
|                             | .9  | TAB - Testing, Adjusting and Balancing.                                                                                                                                 |
|                             | .10 | OEM - Original Equipment Manufacturer.                                                                                                                                  |
|                             | .11 | LSC - Life Safety Compliance.                                                                                                                                           |
|                             | .12 | SOP - Standard Operating Procedures.                                                                                                                                    |
|                             | .13 | M&E - Mechanical and Electrical.                                                                                                                                        |
|                             | .14 | M&E DB - Mechanical and Electrical Database.                                                                                                                            |
|                             | .15 | WHMIS - Workplace Hazardous Materials Information System                                                                                                                |
|                             | .16 | MSDS - Material Safety Data Sheet.                                                                                                                                      |
|                             | .17 | OPR - Owner's Project Requirements.                                                                                                                                     |
| <u>1.2 RELATED SECTIONS</u> | .1  | See Div 01 and 26 project specifications.                                                                                                                               |
| <u>1.3 RESPONSIBILITIES</u> | .1  | See Div 01 and 26 project specifications                                                                                                                                |
|                             | .1  | Design Consultant                                                                                                                                                       |
|                             | .2  | Electrical Contractor - Construction:                                                                                                                                   |
-

1.3  
RESPONSIBILITIES  
(Cont'd)

.1 (Cont'd)

.2 (Cont'd)

.1 General:

.1 The Electrical Contractor shall be responsible for the commissioning process detailed within the Electrical Specifications Sections.

.2 The Electrical Contractor shall conform to the commissioning requirements detailed in Electrical Specification and the Commissioning Specifications in Division 01.

.3 The Electrical Contractor shall coordinate and cooperate with the Mechanical Contractor as detailed in Specification sections of the Mechanical and Electrical Specifications and as required to meet all commissioning requirements.

.4 Assign a Commissioning Coordinator who will have the required decision making authority/commissioning expertise and who is dedicated to the commissioning process.

.5 Explain and ensure all Sub-Contractors understand the commissioning requirements. The Electrical Contractor shall schedule all commissioning tasks required to be completed by their Sub Contractors.

.6 If the project has phases the Record Drawings shall be submitted at the completion of each phase. The Electrical Contractor shall at the end of the project submit a full consolidated set of recordings.

.2 Meetings:

.1 Throughout the Construction Schedule the Electrical Contractor shall be required to attend regular commissioning and punch list meetings.

.2 Once the Electrical Contractor has completed the test forms, there will be detailed meetings with the Design Consultant, Commissioning Manager and Electrical Contractor to discuss the testing methods and test forms to ensure that when start-up occurs the testing will go smoothly.

1.3  
RESPONSIBILITIES  
(Cont'd)

.1 (Cont'd)

.2 (Cont'd)

.3 Throughout the duration of the equipment and systems start up phase of the project the Electrical Contractor shall attend punch list meetings.

.3 Equipment Start up:

.1 The Electrical Contractor shall provide notification of the scheduled date of completion for each system or key item of electrical distribution equipment in writing to the Commissioning Manager and Design Consultant a minimum of ten (10) working days prior to start-up.

.2 Prior to providing notification of completion, the Electrical Contractor shall review the work site and ensure all of the above are complete. In addition all labeling must be complete.

.3 Upon notice of scheduled completion separate walk thoughts shall be scheduled with the Electrical Contractor.

.4 The Electrical Contractor shall participate in construction complete walkthroughs for each system, sub-system or key item of electrical distribution equipment. Any items found to be not complete will be documented on a punch list. Items that are deemed to be essential for test run must be completed prior to the equipment or system being turned on.

.5 The Electrical Contractor shall participate in Health and Safety walkthroughs for each system, sub-system or key item of electrical distribution equipment prior to the equipment being started.

.4 Commissioning Test Forms:

.1 Rectify deficiencies documented in the PI, installation, start up, or PV functional performance Test Forms.

.2 Complete and assist with forms for PI, installation start-up and PV testing with Electrical Contractor.

.3 Complete and assist with form for all integration systems performance testing with Electrical Contractor.



1.3  
RESPONSIBILITIES  
(Cont'd)

.1 (Cont'd)

.2 (Cont'd)

.4 Update, create and complete forms as specified.

.5 Electrical Contractor Testing:

.1 The Electrical Contractor and the Commissioning Manager will develop lists of tasks and schedules for building systems performance testing and demonstration. The Electrical Contractor will prepare and distribute to the commissioning Manager a start-up schedule which the Electrical Contractor shall utilize in developing their schedule.

.2 Working with the Electrical Contractor and the Commissioning Manager, the Electrical Contractor shall schedule testing of the electrical equipment and systems in accordance with the Contract Documents and the Program established by the Electrical Contractor and the Commissioning Manager. A detailed schedule shall be provided a minimum of four (4) weeks prior to the equipment or system being turned on. Schedule shall break down the testing into individual components, equipment, sub-systems and systems. The schedule shall provide adequate time for testing and commissioning of each system.

.3 During the testing of systems the Electrical Contractor shall make available skilled tradesmen to effect trouble shooting and effect repairs. During start-up and performance testing same day repair and trouble shooting of equipment shall be provided.

.4 The Electrical Contractor shall conduct tests as detailed by the Electrical Contractor in the Installation, Performance, Start-Up and Integrated Systems test forms (IBS). The test forms shall be filled out by the Electrical Contractor and shall be witnessed by the Commissioning Manager.

1.3  
RESPONSIBILITIES  
(Cont'd)

.1 (Cont'd)

.2 (Cont'd)

.5 The Electrical Contractor shall document the results of all tests conducted during the construction and the post construction phase and shall fill out documentation in accordance with Commissioning Manager requirements.

.6 The Electrical Contractor shall ensure that Sub Contractors' testing is performed and complete in accordance with the Electrical Contractor's requirements.

.6 Progress Payments:

.1 Set aside in billing breakdown funds for commissioning, testing, manuals, demonstration training, and all other commissioning activities.

.7 Sub-trades and Outside the Design Consultants:

.1 Understand quality standards contained in the specifications and ensured by inspections, site visits and document revisions that they are being met by the Sub Contractors.

.2 The Electrical Contractor shall keep records of their testing in accordance with Commissioning Manager's requirements.

.8 Maintenance Manuals

.1 Assemble documentation; Manuals, Record drawings, commissioning forms, prior to turn over and training.

.2 Maintenance manuals shall be put together immediately upon completion of the submittal of shop drawings.

.3 All maintenance manuals shall be formatted as per PWGSC Standards - Commissioning Standard.

.4 Provide any information required to satisfy the requirements of Section 01 91 51 Building Management Manuals (BMM) and as requested by Design Consultant and the Commissioning Manager for completion of the BMM.

.9 Building Turnover and Staff Training - Electrical Contractor:

.1 Arrange training sessions with the Design Consultant, Electrical Contractor and Commissioning Manager.

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- |                  |    |          |
|------------------|----|----------|
| 1.3              | .1 | (Cont'd) |
| RESPONSIBILITIES | .2 | (Cont'd) |
| <u>(Cont'd)</u>  |    |          |
- .2 Schedule clear interface between construction and Owner' operation of equipment.
- .3 Testing and turnover procedures to be approved by the Design Consultant, Commissioning Manager and Commissioning Manager a minimum of sixty (60) days prior to the first test/system or equipment scheduled turnover.
- .3 Commissioning Forms
- .1 The Commissioning Manager will be generating the PI, installation, start-up, PV and integrated systems commissioning test forms that are to be completed by the Electrical Contractor.
- 
- |                              |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|------------------------------|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.4 INTEGRATED               | .1 | If there is a requirement for detailed Simulated Performance Verification Testing of Integrated Systems. The detail of these simulated performance verification tests of integrated/interconnected systems will be developed during the construction period of the project. The Electrical Contractor will play a major part in supporting and participating in these simulated performance verification tests of integrated/interconnected systems. |
| <u>BUILDING SYSTEMS(IBS)</u> | .2 | The integrated/interconnected systems performance tests are in addition to the Performance Verification Tests (PV).                                                                                                                                                                                                                                                                                                                                  |
|                              | .3 | Integrated/interconnected performance testing will be completed as a minimum on the following integrated/Interconnected systems:                                                                                                                                                                                                                                                                                                                     |
|                              | .1 | As per electrical specifications.                                                                                                                                                                                                                                                                                                                                                                                                                    |
- 
- |                   |    |                                   |
|-------------------|----|-----------------------------------|
| 1.5 BUILDING      | .1 | As per electrical specifications. |
| MANAGEMENT MANUAL |    |                                   |
| <u>(BMM)</u>      |    |                                   |
-

1.6 DEVELOPMENT OF  
ELECTRICAL SYSTEMS  
OPERATION AND  
MAINTENANCE SOP'

- .1 Standard Operating Procedures (SOP) Manual
  - .1 Electrical SOP Manual will be developed for each system within that discipline, containing information:
    - .1 Relating to the detailed description of each system,
    - .2 Relating to day-to-day operation of the system.
    - .3 Permitting the operating personnel to make decisions which are in complete agreement with the Client's requirements within the limits of the installed system.
  - .2 The Electrical Contractor to cooperate and support the Design Consultant by providing required data, information, and identifying electrical system, normal operating conditions and settings as well as safety requirements during start-up, verification, commissioning, adjustments in operating procedures.
  - .3 Development: The SOP Manual to be produced by the Design Consultant.
    - .1 Phase 1 - Design Stage - the SOP Manual to include:
      - .1 The area and its function served by the electrical system,
      - .2 Floor plans indicating zoning of electrical systems.
      - .3 Drawings, schematics and descriptions of the system, sub systems, equipment, components, functions and input/output parameters of each controller, start-up and shut down procedures.
      - .4 Brief narrative description of the sequence of operations and its components.
    - .2 Phase 2 - Contract Documents to be 90% complete & include:
      - .1 Detailed narrative descriptions of the sequence of operations.
      - .2 Necessary emergency procedures for the electrical systems.
      - .3 Details of its relationship to all other systems.
    - .3 Phase 3 - Construction, the Design Consultant to bring the SOP Manual to 99% completion prior to pre start up inspections.

1.6 DEVELOPMENT OF  
ELECTRICAL SYSTEMS  
OPERATION AND  
MAINTENANCE SOP'  
(Cont'd)

- .1 (Cont'd)
- .3 (Cont'd)
- .4 Phase 4 - Development Construction - Commission Stage, the SOP Manual is brought to 100% completion at least six (6) weeks prior to issuance of the Interim Certificate of Completion, using data obtained during start-up, verification and commissioning. This will include:
  - .1 Documenting control systems as finally set,
  - .2 Instructions for operating under normal and emergency conditions.
  - .3 Details of response to emergency situations.
  - .5 Phase 5 - Development Operation, it may be necessary to make further changes to reflect operation under varying conditions of occupancy.
- .4 Organizations of the SOP Manual: In general, the contents to be arranged as follows:
  - .1 Section 1: Information directory: To provide easy access to all information, it should include:
    - .1 Table of contents listing all systems in the building,
    - .2 List of equipment for each system, cross-referenced to the Operating and Maintenance Manual.
  - .2 Section 2: Drawings, diagrams, areas served, schematics, wiring diagrams and system description. To include, but not necessarily limited to:
    - .1 Drawings, schematics, diagrams, charts identifying electrical systems and the area(s) served by each system.
    - .2 For each electrical system:
      - .1 Drawings, schematics, diagrams, with a narrative description,
      - .2 Operational tolerances of systems, equipment and components,
      - .3 Manufacturers' recommendations for operation under all normal and emergency conditions.

1.6 DEVELOPMENT OF  
ELECTRICAL SYSTEMS  
OPERATION AND  
MAINTENANCE SOP'  
(Cont'd)

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.1 (Cont'd)  
.4 (Cont'd)

.4 Cross-references to the approved TAB and PV reports for each system - located in the appropriate section of PART 5 - SUPPORTING APPENDICES.

.3 Section 3: Operating standards, operating logs, operating routines, procedures, BAS data: To be clearly understandable to building operators and the Property Manager and to include, but not necessarily limited to:

- .1 required standards of performance,
- .2 operating logs to monitor performance,
- .3 reporting requirements for all licensing and inspections as applicable,
- .4 identity of all activities associated with normal and abnormal operation,
- .5 details of load-shedding procedures,
- .6 operating checklists,
- .7 seasonal start-up and shut-down procedures,
- .8 BAS data to include system schematics, input/output summaries, complete with alarm limits for each device, copy of the actual program language.

.9 all special or codified (i.e. Labour Canada regulations and amendments) procedures relating to environmental control, health and safety, and productive work environment.

.4 Section 5: Troubleshooting Information: To include:

- .1 Elementary questionnaires,
- .2 Simple walk-through inspections.

1.6 DEVELOPMENT OF ELECTRICAL SYSTEMS OPERATION AND MAINTENANCE SOP' (Cont'd)

.1 (Cont'd)

.4 (Cont'd)

.3 sophisticated diagnostic or expert analysis (depending upon the complexity of the system and the technical expertise of the O&M personnel). The intent is to allow Users of this manual to isolate probable causes in an orderly and efficient manner.

1.7 THE COMMISSIONING PROCESS

.1 The Commissioning process consists of the following:

.1 Processing and completion of Shop Drawings and Record Drawings.

.2 Installation inspection of all Electrical Equipment and completion of all associated Testing.

.3 Independent Testing Contractor's participation and documentation.

.4 Performance Testing of Electrical Equipment and Systems.

.5 Performance Testing of Integrated / Interconnected Systems.

.6 Participation in all Commissioning and Punch List Meetings.

.7 Participation in the Completion of Operating and Maintenance Manuals.

.8 Participation in the Completion of Systems Operating Manuals.

.9 Staff Operating Training.

.10 Preparation and Completion of all Commissioning Forms.

.11 Warranties.

.2 Shop Drawings and Record Drawings:

.1 Conform to specification requirements for shop drawings and Record drawings.

.3 Installation Inspection and Equipment Verification / Checks:

.1 The Electrical Contractor shall coordinate with the Design Consultant, Design and Quality Assurance Authority and the Commissioning Manager who will be inspecting the electrical installation.

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1.7 THE  
COMMISSIONING  
PROCESS  
(Cont'd)

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- .3 (Cont'd)
- .2 The Electrical Contractor shall notify the Commissioning Manager when each piece of equipment is ready for inspection for PI, installation, start up and performance verification (PV) testing. The Electrical Contractor shall provide a detailed schedule for each system, sub-system and each piece of equipment.
- .3 The Electrical Contractor shall rectify any deficiencies found by the Commissioning Manager or Design Consultant during the commissioning process.
- .4 Testing of Equipment and Systems:
- .1 The Electrical Contractor shall be responsible for all tests detailed in the Contract Documents and those tests required by a manufacturer as part of their installation requirements and as outlined by the Commissioning Manager. The Electrical Contractor shall be responsible for completing the PI,

Start-up and Performance Test (PV) forms.

.2 The Electrical Contractor shall only utilize employees with previous experience in Testing Procedures as they relate to a particular subject.

.3 The Electrical Contractor shall inform the Design Consultant and the Commissioning Manager, in writing, who they intend to use along with a list of relevant experience and projects completed. The Design Consultant retains the right to accept or reject the proposed individual.

.4 The Electrical Contractor shall hire the manufacturers' technicians who will conduct required start-up and/or programming and testing on their equipment.

.5 The Electrical Contractor shall cooperate with the Independent Testing Electrical Contractor to provide assistance during the testing procedures.

.6 All performance tests shall be witnessed by the Electrical Contractor and Commissioning Manager. If tests are not witnessed and forms are signed, the tests shall be repeated at the Electrical Contractor's expense.

.7 Commissioning Meetings and Reporting:



1.7 THE  
COMMISSIONING  
PROCESS  
(Cont'd)

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- .4 (Cont'd)
    - .1 The Electrical Contractor shall include the schedule for all tests in the Construction Schedule.
    - .2 The Commissioning meetings will be held as separate meetings from the regular construction meetings. The testing schedules and the results of all tests shall be reviewed.
    - .8 All testing forms and reports associated with the electrical systems shall be directed to the General Contractor with copies to the Design Consultant, Commissioning Manager and PWGSC Project Manager.
    - .9 The forms and reports to be issued shall include:
      - .1 Shop drawings
      - .2 Completed Equipment Product Information (PI) Forms.
      - .3 Completed Installation Check Lists (ICL).
      - .4 Completed Performance Verification (PV) Test Forms.
      - .5 Completed Integrated System Test Forms.
      - .6 Reports resulting from tests.
      - .7 Testing Schedule.
      - .8 Manufacturers' Certificates, Verification and Test results.
      - .9 Operating and Maintenance Manuals.
  - .5 Staff and Operator Training:
    - .1 The Electrical Contractor and equipment manufacturers shall provide operator training for each system and its associated equipment.
    - .2 The training shall be provided by qualified technicians or electricians and shall be conducted in a classroom and at the equipment or system.
    - .3 The training sessions shall be scheduled, coordinated and videotaped by the General Contractor and turned over to the Commissioning Manager.
    - .4 Each training session shall be structured to cover the following:
      - .1 Operating and Maintenance Manual.
      - .2 Operating Procedures.
      - .3 Maintenance Procedures.
      - .4 Trouble shooting Procedures.
-

1.7 THE  
COMMISSIONING  
PROCESS  
(Cont'd)

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- .5 (Cont'd)
    - .5 The manufacturers or service representatives name, address and phone number.
    - .6 Submit a course outline to the PWGSC Project Manager, Manager, the Design Consultant, and the Commissioning Manager before training commences. Provide course documentation for up to ten (10) people.
  - .6 System Demonstration and Building Turnover:
    - .1 The system demonstration and building turnover to Owner's staff shall occur when:
      - .1 The installation is complete.
      - .2 The acceptance test conducted by the Electrical Contractor and the Design Consultant has been 100% completed successfully.
      - .3 Training has been completed.
    - .2 Equipment Operating and Maintenance Manuals have been accepted:
      - .1 Shop drawings have been updated.
      - .2 Record drawings have been 100% completed.
      - .3 The Commissioning process has been 100% completed successfully and the system operation accepted by the Electrical Contractor.
      - .4 The Deficiency Punch Lists have been completed in their entirety.
    - .3 The systems demonstration shall be conducted by the Electrical Contractor and manufacturers. The demonstration shall cover all operational and maintenance requirements and a physical demonstration of equipment installation and operation.
  - .7 Test Forms:
    - .1 The Electrical Contractor and manufacturers shall fill out the forms prepared by the Electrical Contractor during PI, installation, start-up and PV testing.
    - .2 The Commissioning Index of Forms shall be maintained by the Electrical Contractor in order to track the progress of the Commissioning Process.
    - .3 The Commissioning Index of Forms shall be maintained by the Electrical Contractor in order to track the progress of the Commissioning Process.
  - .8 Warranties:
-

1.7 THE  
COMMISSIONING  
PROCESS  
(Cont'd)

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- .8 (Cont'd)
  - .1 Equipment and system warranties shall not begin until the system demonstration and turnover has been conducted successfully and accepted by the Commissioning Manager. The Electrical Contractor shall fill out the Warranty Form(s) listing the equipment and systems and the start and finishing dates for the Warranty period.
  - .2 Refer to the Specifications for the requirements during the Warranty period.
  - .3 The Commissioning Manager, the Design Consultants and the Electrical Contractor shall review the performance of the systems. If the performance is satisfactory, then no further action needs to be taken. If unsatisfactory, then the Electrical Contractor will be instructed to correct all deficiencies, at his cost, to the satisfaction of the three parties.
- .9 Commissioning Phases One to Six:
  - .1 Commissioning process spans various phases:
    - .1 Commissioning Phase 1
      - .1 The planning phase, where the risks, uncertainties and vulnerabilities are assessed.
      - .2 Establishes the extent of commissioning, time and budget for commissioning.
      - .3 Occurs during project at start of Contract Documents.
    - .2 Commissioning Phase 2
      - .1 Establishes technical requirements such as test requirements and standards.
      - .2 Finalization of single-line schematic diagram for electrical distribution.
      - .3 Occurs during latter stage Commissioning Phase 3 of Contract Documents.
    - .3 Commissioning Phase 3
      - .1 The implementation phase where dcommissioning is developed.
      - .2 Electrical Contractor should have made available all finalized shop drawings.

1.7 THE  
COMMISSIONIN  
PROCESS  
(Cont'd)

.9 (Cont'd)

.3 The quality and extent of commissioning is determined and finalized in agreement with the client.

.4 A master index is developed with all elements of the electrical systems.

.5 Commissioning forms such as PI, installation, start-up and PV Test Forms are developed in this phase.

.6 Occurs early in the Contract Administration Stage.

.4 Commissioning Phase 4

.1 The verification and commissioning before the equipment is turned over to Owner.

.2 All equipment received is checked against approved PI, installation, start-up and PV Test Forms.

.3 It is important to check in this phase that the equipment received has gone through the necessary factory tests.

.4 A Design Consultant would have witnessed some of the factory tests carried out to ensure that the tests are conducted in accordance with the required standards.

.5 Start-up and operation instructions received from the equipment manufacturers are reviewed in this phase.

.6 All deficiencies are reported to the Electrical Contractor and rectified before equipment is turned over to Owner for beneficial use.

.7 Occurs later on in the Contract Administration phase.

.5 Commissioning Phase 5

.1 The performance verification of the complete electrical system functionally integrated with all the other systems in operation within the facility.

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1.7 THE  
COMMISSIONING  
PROCESS  
(Cont'd)

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- .9 (Cont'd)
    - .2 Optimization, fine-tuning and post-occupancy commissioning is done in this phase.
    - .3 Occurs later on in the Contract Administration phase.
  - .6 Commissioning Phase 6
    - .1 Final Commissioning Report is submitted to the Design Consultant for review by the Commissioning Manager.
    - .2 The PWGSC Design and Quality Assurance Authority and PWGSC Project Manager review and accept the Final Commissioning Report on behalf of the Owner.
  - .10 Framework:
    - .1 All equipment in the electrical system is grouped into systems and sub systems for commissioning purposes. Documentation for PI, installation, start-up and PV will encompass all equipment given in the following framework.
  - .11 Documentation Guidelines:
    - .1 The Electrical Contractor completing the PI, installation, startup and PV test forms shall follow a consistent approach. Good documentation practice is essential in realizing the objectives of commissioning and to keep track of all commissioning related activities.
  - .12 Documentation shall be:
    - .1 Completed in permanent black ink only.
    - .2 Legible - can be easily read.
    - .3 Accurate - all information is correct.
    - .4 Timely - done at the appropriate time.
    - .5 Clear - can be understood by anyone who reads it.
    - .6 Consistent - done the same way each time.
    - .7 Complete - all required entries are made.
    - .8 Factual - what is written shall be what actually occurred.
  - .13 Correcting Mistakes: When mistakes are made accidentally while documenting, there shall be a standard way to correct the mistakes. Correct notation for documenting an entry error is to note Entry Error. Steps to follow:
    - .1 Cross out the error with a single line.
-

1.7 THE  
COMMISSIONIN  
PROCESS  
(Cont'd)

- .13 (Cont'd)
  - .2 Write the correct entry above the incorrect entry.
  - .3 Initial the correction.
- .14 Before passing on the documentation, it shall be checked to make sure that it is timely, accurate, permanent, legible, complete, clear, consistent and factual.
- .15 Submitted documentation which has not been reviewed will be rejected in its entirety by the Design Consultant.
- .16 Roles and Responsibilities:
  - .1 Activities, roles and responsibilities are clearly defined in commissioning plans. Commissioning activities, coordinated with all other activities in the project, will optimize the benefits of commissioning.

## PART 1 - GENERAL

|                                                |    |                                                                                                                                                                                                              |
|------------------------------------------------|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>1.1 REFERENCES</u>                          | .1 | CSA International                                                                                                                                                                                            |
|                                                | .1 | CAN/CSA-C22.2 No.18 - 98 (R2003), Outlet Boxes, Conduit Boxes and Fittings.                                                                                                                                  |
|                                                | .2 | CAN/CSA-C22.2 No.65-03 (R2008), Wire Connectors (Tri-National Standard with UL 486A-486B and NMX-J-543-ANCE-03).                                                                                             |
|                                                | .2 | National Electrical Manufacturers Association (NEMA)                                                                                                                                                         |
| <u>1.2 ACTION AND INFORMATIONAL SUBMITTALS</u> | .1 | Submit in accordance with Section 01 33 00.                                                                                                                                                                  |
|                                                | .2 | Product Data:                                                                                                                                                                                                |
|                                                | .1 | Submit manufacturer's instructions, printed product literature and data sheets for wire and box connectors and include product characteristics, performance criteria, physical size, finish and limitations. |
| <u>1.3 CLOSEOUT SUBMITTALS</u>                 | .1 | Submit in accordance with Section 01 78 00.                                                                                                                                                                  |
|                                                | .2 | Operation and Maintenance Data: submit operation and maintenance data for wire and box connectors for incorporation into manual.                                                                             |
| <u>1.4 DELIVERY, STORAGE AND HANDLING</u>      | .1 | Deliver, store and handle materials in accordance with Section 01 61 00 and with manufacturer's written instructions.                                                                                        |
|                                                | .2 | Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.                                                                |
|                                                | .3 | Storage and Handling Requirements:                                                                                                                                                                           |
|                                                | .1 | Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.                                                                                   |
|                                                | .2 | Store and protect wire and box connectors from nicks, scratches, and blemishes.                                                                                                                              |
|                                                | .3 | Replace defective or damaged materials with new.                                                                                                                                                             |

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## PART 2 - PRODUCTS

- 2.1 MATERIALS
- .1 Pressure type wire connectors to: CAN/CSA-C22.2 No.65, with current carrying parts of copper sized to fit copper conductors as required.
  - .2 Fixture type splicing connectors to: CAN/CSA-C22.2 No.65, with current carrying parts of copper sized to fit copper conductors 10 AWG or less.
  - .3 Bushing stud connectors: to 1Y-2 to consist of:
    - .1 Connector body and stud clamp for stranded copper conductors.
    - .2 Clamp for stranded copper conductors.
    - .3 Stud clamp bolts.
    - .4 Bolts for copper conductors.
    - .5 Sized for conductors as indicated.

## PART 3 - EXECUTION

- 3.1 EXAMINATION
- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for wire and box connectors installation in accordance with manufacturer's written instructions.
    - .1 Visually inspect substrate in presence of Departmental Representative.
    - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
    - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.
- 3.2 INSTALLATION
- .1 Remove insulation carefully from ends of conductors and cables and:
    - .1 Apply coat of zinc joint compound on aluminum conductors prior to installation of connectors.
-



3.2 INSTALLATION  
(Cont'd)

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- .1 (Cont'd)
- .2 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CAN/CSA-C22.2 No.65.
- .3 Install fixture type connectors and tighten to CAN/CSA-C22.2 No.65. Replace insulating cap.
- .4 Install bushing stud connectors in accordance with 1Y-2.

3.3 CLEANING

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

## PART 1 - GENERAL

- |                                           |    |                                                                                                                     |
|-------------------------------------------|----|---------------------------------------------------------------------------------------------------------------------|
| <u>1.1 PRODUCT DATA</u>                   | .1 | Provide product data in accordance with Section 01 33 00.                                                           |
| <u>1.2 DELIVERY, STORAGE AND HANDLING</u> | .1 | Packaging Waste Management: remove for reuse and return of packaging materials in accordance with Section 01 74 11. |

## PART 2 - PRODUCTS

- |                            |    |                                                                                                                                                                                                                                                                                                                            |
|----------------------------|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>2.1 BUILDING WIRES</u>  | .1 | Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.<br>.1 Copper conductors: size as indicated, with 600V insulation of cross-linked thermosetting polyethylene material rated RW90, Non-Jacketted.<br>.2 Copper conductors: size as indicated, with thermoplastic insulation type T90 Nylon rated at 600 V. |
| <u>2.2 ARMOURED CABLES</u> | .1 | Conductors: insulated, copper size as indicated.                                                                                                                                                                                                                                                                           |
|                            | .2 | Type: AC90.                                                                                                                                                                                                                                                                                                                |
|                            | .3 | Armour: interlocking type fabricated from galvanized steel strip.                                                                                                                                                                                                                                                          |
|                            | .4 | Type: ACWU90 jacket over thermoplastic armour and compliant to applicable Building Code classification for this project.                                                                                                                                                                                                   |
|                            | .5 | Connectors: anti short connectors.                                                                                                                                                                                                                                                                                         |
| <u>2.3 CONTROL CABLES</u>  | .1 | Type: LVT: soft annealed copper conductors, sized as indicated:<br>.1 Insulation: thermoplastic.<br>.2 Sheath : armour of closely wound aluminum wire.                                                                                                                                                                     |
-

- 2.3 CONTROL CABLES  
(Cont'd)
- .2 Type: low energy 300 V control cable: stranded annealed copper conductors sized as indicated  
LVT: soft annealed copper conductors, sized as indicated:
    - .1 Insulation: TWH.
    - .2 Shielding: tape coated with paramagnetic material over each conductors.
    - .3 Overall covering: polyethylene jackets.
  - .3 Type: 600 V stranded annealed copper conductors, sizes as indicated:
    - .1 Insulation: RW90.
    - .2 Shielding: magnetic tape conductors.
    - .3 Overall covering: thermoplastic jacket.

### PART 3 - EXECUTION

- 3.1 FIELD QUALITY CONTROL
- .1 Perform tests in accordance with Section 26 05 01.
  - .2 Perform tests using method appropriate to site conditions and to approval of Departmental Representative and local authority having jurisdiction over installation.
  - .3 Perform tests before energizing electrical system.
- 3.2 GENERAL CABLE INSTALLATION
- .1 Terminate cables in accordance with Section 26 05 20.
  - .2 Cable Colour Coding: to Section 26 05 01.
  - .3 Conductor length for parallel feeders to be identical.
  - .4 Lace or clip groups of feeder cables at distribution centres, pull boxes, and termination points.
  - .5 Wiring in walls: typically drop or loop vertically from above to better facilitate future renovations. Generally wiring from below and horizontal wiring in walls to be avoided unless indicated.
-

|                                                      |    |                                                                                                                                                   |
|------------------------------------------------------|----|---------------------------------------------------------------------------------------------------------------------------------------------------|
| 3.2 GENERAL CABLE<br>INSTALLATION<br><u>(Cont'd)</u> | .6 | Provide numbered wire collars for control wiring. Numbers to correspond to control shop drawing legend. Obtain wiring diagram for control wiring. |
|------------------------------------------------------|----|---------------------------------------------------------------------------------------------------------------------------------------------------|

|                                              |    |                                                                                          |
|----------------------------------------------|----|------------------------------------------------------------------------------------------|
| 3.3 INSTALLATION OF<br><u>BUILDING WIRES</u> | .1 | Install wiring as follows:<br>.1 In conduit systems in accordance with Section 26 05 34. |
|----------------------------------------------|----|------------------------------------------------------------------------------------------|

|                                               |    |                                             |
|-----------------------------------------------|----|---------------------------------------------|
| 3.4 INSTALLATION OF<br><u>ARMoured CABLES</u> | .1 | Group cables wherever possible on channels. |
|-----------------------------------------------|----|---------------------------------------------|

|                                              |    |                                    |
|----------------------------------------------|----|------------------------------------|
| 3.5 INSTALLATION OF<br><u>CONTROL CABLES</u> | .1 | Install control cables in conduit. |
|                                              | .2 | Ground control cable shield.       |

PART 1 - GENERAL

- |                                          |    |                                                                                                                                |
|------------------------------------------|----|--------------------------------------------------------------------------------------------------------------------------------|
| <u>1.1 SECTION INCLUDES</u>              | .1 | Materials and installation for connectors and terminations.                                                                    |
| <u>1.2 RELATED SECTIONS</u>              | .1 | Section 26 05 32 - Outlet, Boxes, Conduit Boxes and Fittings.                                                                  |
| <u>1.3 REFERENCES</u>                    | .1 | Canadian Standards Association<br>.1 CSA C22.2 No.41-07, Grounding and Bonding Equipment.                                      |
| <u>1.4 PRODUCT DATA</u>                  | .1 | Submit product data in accordance with Section 01 33 00.                                                                       |
| <u>1.5 WASTE MANAGEMENT AND DISPOSAL</u> | .1 | Separate and recycle waste materials in accordance with Section 01 74 11.                                                      |
|                                          | .2 | Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Departmental Representative. |

PART 2 - PRODUCTS

- |                                        |    |                                                                                                  |
|----------------------------------------|----|--------------------------------------------------------------------------------------------------|
| <u>2.1 CONNECTORS AND TERMINATIONS</u> | .1 | Copper compression connectors to CSA C22.2 as required sized for conductors.                     |
|                                        | .2 | Junction boxes with respective pothead for conductor cables in accordance with Section 26 05 31. |

PART 3 - EXECUTION

- |                         |    |                                                 |
|-------------------------|----|-------------------------------------------------|
| <u>3.1 INSTALLATION</u> | .1 | Bond and ground as required to CSA C22.2 No.41. |
|-------------------------|----|-------------------------------------------------|

## PART 1 - GENERAL

- |                                           |    |                                                                                                                                                                                                                              |
|-------------------------------------------|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>1.1 RELATED REQUIREMENTS</u>           | .1 | Section 26 05 01.                                                                                                                                                                                                            |
| <u>1.2 REFERENCES</u>                     | .1 | American National Standards Institute /Institute of Electrical and Electronics Engineers ( ANSI/IEEE 837-2014)<br>.1 ANSI/IEEE 837-2014, IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding.    |
| <u>1.3 ACTION AND INFORMATIONAL</u>       | .1 | Submit in accordance with Section 01 33 00.                                                                                                                                                                                  |
| <u>SUBMITTALS</u>                         | .2 | Product Data:<br>.1 Submit manufacturer's instructions, printed product literature and data sheets for grounding equipment and include product characteristics, performance criteria, physical size, finish and limitations. |
| <u>1.4 CLOSEOUT SUBMITTALS</u>            | .1 | Submit in accordance with Section 01 78 00.                                                                                                                                                                                  |
|                                           | .2 | Operation and Maintenance Data: submit operation and maintenance data for grounding equipment for incorporation into manual.                                                                                                 |
| <u>1.5 DELIVERY, STORAGE AND HANDLING</u> | .1 | Deliver, store and handle materials in accordance with Section 01 61 00 and with manufacturer's written instructions.                                                                                                        |
|                                           | .2 | Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.                                                                                |
|                                           | .3 | Storage and Handling Requirements:<br>.1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.<br>.2 Store and protect grounding equipment.             |
-

|                                                      |                                                                    |
|------------------------------------------------------|--------------------------------------------------------------------|
| 1.5 DELIVERY,<br>STORAGE AND<br>HANDLING<br>(Cont'd) | .3 (Cont'd)<br>.3 Replace defective or damaged materials with new. |
|------------------------------------------------------|--------------------------------------------------------------------|

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## PART 2 - PRODUCTS

|               |                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2.1 EQUIPMENT | .1 Clamps for grounding of conductor: size as required to electrically conductive underground water pipe.                                                                                                                                                                                                                                                                                                                                         |
|               | .2 Grounding conductors: bare stranded copper, soft annealed, size as required.                                                                                                                                                                                                                                                                                                                                                                   |
|               | .3 Insulated grounding conductors: green, copper conductors, size as required.                                                                                                                                                                                                                                                                                                                                                                    |
|               | .4 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to: <ul style="list-style-type: none"> <li>.1 Grounding and bonding bushings.</li> <li>.2 Protective type clamps.</li> <li>.3 Bolted type conductor connectors.</li> <li>.4 Thermit welded type conductor connectors.</li> <li>.5 Bonding jumpers, straps.</li> <li>.6 Pressure wire connectors.</li> </ul> |

## PART 3 - EXECUTION

|                             |                                                                                         |
|-----------------------------|-----------------------------------------------------------------------------------------|
| 3.1 INSTALLATION<br>GENERAL | .1 Provide new grounding where required and connect to existing grounding system.       |
|                             | .2 Install connectors in accordance with manufacturer's instructions.                   |
|                             | .3 Protect exposed grounding conductors from mechanical injury.                         |
|                             | .4 Use mechanical connectors for grounding connections to equipment provided with lugs. |
|                             | .5 Soldered joints not permitted.                                                       |

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|-----------------------------------------|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3.1 INSTALLATION<br>GENERAL<br>(Cont'd) | .6 | Install bonding wire for flexible conduit, connected at both one ends to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.          |
|                                         | .7 | Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.                                                                       |
|                                         | .8 | Bond single conductor, metallic armoured cables to cabinet at supply end, and provide non-metallic entry plate at load end.                                                                                    |
| 3.2 EQUIPMENT<br>GROUNDING              | .1 | Install grounding connections to typical equipment included in, but not necessarily limited to following list. Frames of motors, starters, control panels, panels.                                             |
| 3.3 FIELD QUALITY<br>CONTROL            | .1 | Perform tests in accordance with Section 26 05 01.                                                                                                                                                             |
|                                         | .2 | Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Departmental Representative and local authority having jurisdiction over installation.           |
|                                         | .3 | Perform tests before energizing electrical system.                                                                                                                                                             |
| 3.4 CLEANING                            | .1 | Progress Cleaning: clean in accordance with Section 01 74 11.<br>.1 Leave Work area clean at end of each day.                                                                                                  |
|                                         | .2 | Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11.                                                                                    |
|                                         | .3 | Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 11.<br>.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility. |



## PART 1 - GENERAL

- |                                                  |    |                                                                                                                                                                                             |
|--------------------------------------------------|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>1.1 WASTE<br/>MANAGEMENT AND<br/>DISPOSAL</u> | .1 | Separate and recycle waste materials in accordance with Section 01 74 11.                                                                                                                   |
|                                                  | .2 | Remove from site and dispose of all packaging materials at appropriate recycling facilities.                                                                                                |
|                                                  | .3 | Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan. |
|                                                  | .4 | Divert unused metal materials from landfill to metal recycling facility as approved by Departmental Representative.                                                                         |
|                                                  | .5 | Fold up metal banding, flatten and place in designated area for recycling.                                                                                                                  |

## PART 2 - PRODUCTS

- |                                 |    |                                                                       |
|---------------------------------|----|-----------------------------------------------------------------------|
| <u>2.1 SUPPORT<br/>CHANNELS</u> | .1 | U shape, size 41 x 41 mm, 2.5 mm thick, surface mounted or suspended. |
|---------------------------------|----|-----------------------------------------------------------------------|

## PART 3 - EXECUTION

- |                         |    |                                                                                                                                                                                                |
|-------------------------|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>3.1 INSTALLATION</u> | .1 | Secure equipment to masonry, tile and plaster surfaces with lead anchors.                                                                                                                      |
|                         | .2 | Secure equipment to poured concrete with expandable inserts.                                                                                                                                   |
|                         | .3 | Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.                                                                                                              |
|                         | .4 | Secure surface mounted equipment with twist clip fasteners to inverted T bar ceilings. Ensure that T bars are adequately supported to carry weight of equipment specified before installation. |
-

3.1 INSTALLATION  
(Cont'd)

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- .5 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .6 Fasten exposed conduit or cables to building construction or support system using straps.
  - .1 One-hole malleable iron steel straps to secure surface conduits and cables 50 mm and smaller.
  - .2 Two-hole steel straps for conduits and cables larger than 50 mm.
  - .3 Beam clamps to secure conduit to exposed steel work.
- .7 Suspended support systems.
  - .1 Support individual cable or conduit runs with 6 mm dia threaded rods and spring clips.
  - .2 Support 2 or more cables or conduits on channels supported by 6 mm dia threaded rod hangers where direct fastening to building construction is impractical.
- .8 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .9 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .10 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .11 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Departmental Representative.
- .12 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

## PART 1 - GENERAL

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|---------------------------------------------------|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>1.1 REFERENCES</u>                             | .1 | Canadian Standards Association<br>(CSA International)<br>.1 CSA C22.1-2015, Canadian Electrical Code,<br>Part 1.                                                                                               |
| <u>1.2 SUBMITTALS</u>                             | .1 | Provide submittals in accordance with<br>Section 01 11 00.                                                                                                                                                     |
|                                                   | .2 | Product Data:<br>.1 Provide manufacturer's printed product<br>literature, specifications and datasheet and<br>include product characteristics, performance<br>criteria, physical size, finish and limitations. |
| <u>1.3 DELIVERY,<br/>STORAGE AND<br/>HANDLING</u> | .1 | Waste Management and Disposal:<br>.1 Separate waste materials for reuse and<br>recycling in accordance with Section 01 11 00<br>and Section 01 74 11.                                                          |

## PART 2 - PRODUCTS

- |                                        |    |                                                              |
|----------------------------------------|----|--------------------------------------------------------------|
| <u>2.1 JUNCTION AND<br/>PULL BOXES</u> | .1 | Construction: welded steel enclosure.                        |
|                                        | .2 | Covers Flush Mounted: 25 mm minimum extension<br>all around. |
|                                        | .3 | Covers Surface Mounted: screw-on flat edge<br>covers.        |

## PART 3 - EXECUTION

- |                                      |    |                                                                                            |
|--------------------------------------|----|--------------------------------------------------------------------------------------------|
| <u>3.1 SPLITTER<br/>INSTALLATION</u> | .1 | Mount plumb, true and square to building lines.                                            |
|                                      | .2 | Extend splitters full length of equipment<br>arrangement except where indicated otherwise. |
-

3.2 JUNCTION, PULL  
BOXES AND CABINETS  
INSTALLATION

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

3.3 IDENTIFICATION

- .1 Equipment Identification: to Section 26 05 01.
- .2 Identification Labels: Size 2 nameplate.

## PART 1 - GENERAL

- |                                                   |    |                                                                                                                                |
|---------------------------------------------------|----|--------------------------------------------------------------------------------------------------------------------------------|
| <u>1.1 REFERENCES</u>                             | .1 | Canadian Standards Association<br>(CSA International)<br>.1 CSA C22.1-2012, Canadian Electrical Code,<br>Part 1, 22nd Edition. |
| <u>1.2 SUBMITTALS</u>                             | .1 | Provide submittals in accordance with<br>Section 01 11 00.                                                                     |
|                                                   | .2 | Submit samples for floor box in accordance with<br>Section 01 11 00.                                                           |
| <u>1.3 DELIVERY,<br/>STORAGE AND<br/>HANDLING</u> | .1 | Deliver, store and handle materials in<br>accordance with Section 01 11 00.                                                    |
|                                                   | .2 | Waste Management and Disposal:<br>.1 Separate waste materials for reuse and<br>recycling in accordance with Section 01 74 11.  |

## PART 2 - PRODUCTS

- |                                                     |    |                                                                                        |
|-----------------------------------------------------|----|----------------------------------------------------------------------------------------|
| <u>2.1 OUTLET AND<br/>CONDUIT BOXES<br/>GENERAL</u> | .1 | Size boxes in accordance with CSA C22.1.                                               |
|                                                     | .2 | 102 mm square or larger outlet boxes as<br>required.                                   |
|                                                     | .3 | Gang boxes where wiring devices are grouped.                                           |
|                                                     | .4 | Blank cover plates for boxes without wiring<br>devices.                                |
|                                                     | .5 | Combination boxes with barriers where outlets<br>for more than one system are grouped. |
| <u>2.2 GALVANIZED<br/>STEEL OUTLET BOXES</u>        | .1 | One-piece electro-galvanized construction.                                             |
-

- |                                                  |    |                                                                                                                                                                                                                                    |
|--------------------------------------------------|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2.2 GALVANIZED<br>STEEL OUTLET BOXES<br>(Cont'd) | .2 | Single and multi gang flush device boxes for flush installation, minimum size 76 x 50 x 38 mm or as indicated. 102 mm square outlet boxes when more than one conduit enters one side with extension and plaster rings as required. |
|                                                  | .3 | Utility boxes for outlets connected to surface-mounted EMT conduit, minimum size 102 x 54 x 48 mm.                                                                                                                                 |
|                                                  | .4 | 102 mm square or octagonal outlet boxes for lighting fixture outlets.                                                                                                                                                              |
|                                                  | .5 | Extension and plaster rings for flush mounting devices in finished walls.                                                                                                                                                          |

- |                   |    |                                                                                                 |
|-------------------|----|-------------------------------------------------------------------------------------------------|
| 2.3 CONDUIT BOXES | .1 | Cast FS or FD boxes with factory-threaded hubs and mounting feet for surface wiring of devices. |
|-------------------|----|-------------------------------------------------------------------------------------------------|

- |                           |    |                                                                                   |
|---------------------------|----|-----------------------------------------------------------------------------------|
| 2.4 FITTINGS -<br>GENERAL | .1 | Bushing and connectors with nylon insulated throats.                              |
|                           | .2 | Knock-out fillers to prevent entry of debris.                                     |
|                           | .3 | Conduit outlet bodies for conduit up to 35 mm and pull boxes for larger conduits. |
|                           | .4 | Double locknuts and insulated bushings on sheet metal boxes.                      |

### PART 3 - EXECUTION

- |                  |    |                                                                                                                                                     |
|------------------|----|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| 3.1 INSTALLATION | .1 | Support boxes independently of connecting conduits.                                                                                                 |
|                  | .2 | Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work. |
|                  | .3 | For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.            |

3.1 INSTALLATION  
(Cont'd)

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

## PART 1 - GENERAL

- |                                          |    |                                                                                                                       |
|------------------------------------------|----|-----------------------------------------------------------------------------------------------------------------------|
| <u>1.1 REFERENCES</u>                    | .1 | Adhere to the latest Canadian Standards Association (CSA International)                                               |
|                                          | .1 | CAN/CSA-C22.2 No. 18, Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware, A National Standard of Canada.   |
|                                          | .2 | CAN/CSA-C22.2 NO. 18.1, Metallic Outlet Boxes.                                                                        |
|                                          | .3 | CAN/CSA-C22.2 No. 18.3, Conduit, Tubing, and Cable Fittings (Tri-National standard, with ANCE NMX-J-017 and UL 514B). |
|                                          | .4 | CSA C22.2 No. 56, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.                                     |
|                                          | .5 | CSA C22.2 No. 83, Electrical Metallic Tubing.                                                                         |
| <u>1.2 SUBMITTALS</u>                    | .1 | Provide submittals in accordance with Section 01 33 00.                                                               |
|                                          | .2 | Product data: submit manufacturer's printed product literature, specifications and datasheets.                        |
|                                          | .1 | Submit cable manufacturing data.                                                                                      |
|                                          | .3 | Quality assurance submittals:                                                                                         |
|                                          | .1 | Test reports: submit certified test reports.                                                                          |
|                                          | .2 | Instructions: submit manufacturer's installation instructions.                                                        |
| <u>1.3 WASTE MANAGEMENT AND DISPOSAL</u> | .1 | Separate waste materials for reuse and recycling in accordance with Section 01 74 11.                                 |
|                                          | .2 | Place materials defined as hazardous or toxic waste in designated containers.                                         |
|                                          | .3 | Ensure emptied containers are sealed and stored safely for disposal away from children.                               |



## PART 2 - PRODUCTS

|                                                 |    |                                                                                                                                 |
|-------------------------------------------------|----|---------------------------------------------------------------------------------------------------------------------------------|
| <u>2.1 CONDUITS</u>                             | .1 | Electrical metallic tubing (EMT): to CSA C22.2 No. 83, with couplings.                                                          |
|                                                 | .2 | Flexible metal conduit: to CSA C22.2 No. 56, liquid-tight flexible metal.                                                       |
| <u>2.2 CONDUIT FASTENINGS</u>                   | .1 | One hole steel straps to secure surface conduits 50 mm and smaller.<br>.1 Two hole steel straps for conduits larger than 53 mm. |
|                                                 | .2 | Beam clamps to secure conduits to exposed steel work.                                                                           |
|                                                 | .3 | Channel type supports for two or more conduits at 3 m on centre.                                                                |
|                                                 | .4 | Threaded rods, 6 mm diameter, to support suspended channels.                                                                    |
| <u>2.3 CONDUIT FITTINGS</u>                     | .1 | Fittings: to CAN/CSA C22.2 No. 18, manufactured for use with conduit specified. Coating: same as conduit.                       |
|                                                 | .2 | Ensure factory "ells" where 90 degrees bends for 25 mm and larger conduits.                                                     |
|                                                 | .3 | Watertight connectors and couplings for EMT.<br>.1 Set-screws are not acceptable.                                               |
| <u>2.4 EXPANSION FITTINGS FOR RIGID CONDUIT</u> | .1 | Weatherproof expansion fittings with internal bonding assembly suitable for 200 mm linear expansion.                            |
|                                                 | .2 | Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection.                  |
|                                                 | .3 | Weatherproof expansion fittings for linear expansion at entry to panel.                                                         |

2.5 FISH CORD .1 Polypropylene.

### PART 3 - EXECUTION

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

3.2 INSTALLATION

- .1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .2 Conceal conduits except in mechanical and electrical service rooms and in unfinished areas.
- .3 Surface mount conduits on existing concrete wall and columns.
- .4 Use rigid galvanized steel threaded conduit except where specified otherwise.
- .5 Use electrical metallic tubing (EMT) above 2.4 m not subject to mechanical injury.
- .6 Use flexible metal conduit for connection to motors in dry areas connection to recessed fixtures without prewired outlet box connection to recessed fluorescent fixtures, work in movable metal partitions.
- .7 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations.
- .8 Install conduit sealing fittings in hazardous areas.
  - .1 Fill with compound.
- .9 Minimum conduit size for lighting and power circuits: 19 mm.
- .10 Bend conduit cold:
  - .1 Replace conduit if kinked or flattened more than 1/10th of its original diameter.

3.2 INSTALLATION  
(Cont'd)

- .11 Mechanically bend steel conduit over 19 mm diameter.
- .12 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .13 Install fish cord in empty conduits.
- .14 Run 2-25 mm spare conduits up to ceiling space and 2-25 mm spare conduits down to ceiling space from each flush panel.
  - .1 Terminate these conduits in 152 x 152 x 102 mm junction boxes in ceiling space or in case of an exposed concrete slab, terminate each conduit in surface type box.
- .15 Remove and replace blocked conduit sections.
  - .1 Do not use liquids to clean out conduits.
- .16 Dry conduits out before installing wire.

3.3 SURFACE  
CONDUITS

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

3.4 CONCEALED  
CONDUITS

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

|                     |                        |                  |
|---------------------|------------------------|------------------|
| PWGSC Ontario       | CONDUITS, CONDUIT      | Section 26 05 34 |
| Region Project      | FASTENINGS AND CONDUIT | Page 5           |
| Number R.064667.004 | FITTINGS               | 2016-01-26       |

- 3.5 CLEANING
- .1 Proceed in accordance with Section 01 74 11.
  - .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

## PART 1 - GENERAL

- |                                          |    |                                                                                                                                                               |
|------------------------------------------|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>1.1 REFERENCES</u>                    | .1 | Adhere to the latest Canadian Standards Association (CSA)                                                                                                     |
| <u>1.2 PRODUCT DATA</u>                  | .1 | Submit product data in accordance with Section 01 33 00.                                                                                                      |
|                                          | .2 | Submit WHMIS MSDS - Material Safety Data Sheets. WHMIS acceptable to Labour Canada, and Health and Welfare Canada.                                            |
|                                          | .3 | Submit product data sheets for motors. Include product characteristics, performance criteria, physical size, horsepower, watt rating, limitations and finish. |
| <u>1.3 SHOP DRAWINGS</u>                 | .1 | Submit shop drawings in accordance with Section 01 33 00.                                                                                                     |
|                                          | .2 | Indicate dimensions, recommended installation procedure, wiring diagrams, sizes and location of mounting bolt holes and recommended support method.           |
| <u>1.4 CLOSEOUT SUBMITTALS</u>           | .1 | Provide maintenance data for fractional horsepower motors for incorporation into manual specified in Section 01 78 00.                                        |
| <u>1.5 WASTE MANAGEMENT AND DISPOSAL</u> | .1 | Separate and recycle waste materials in accordance with Section 01 74 11.                                                                                     |
|                                          | .2 | Place materials defined as hazardous or toxic waste in designated containers.                                                                                 |
|                                          | .3 | Ensure emptied containers are sealed and stored safely for disposal away from children.                                                                       |
|                                          | .4 | Collect and separate plastic, paper packaging and corrugated cardboard in accordance with the Waste Management Plan.                                          |
-

1.5 WASTE  
MANAGEMENT AND  
DISPOSAL

(Cont'd)

- .5 Fold up metal banding, flatten and place in designated area for recycling.
- .6 Collect, package and store expired motors for either recycling or rebuilding and return to recycler or rebuilder.

PART 2 - PRODUCTS

2.1 FRACTIONAL  
HORSEPOWER MOTOR

- .1 Non-hazardous locations: to CSA C22.2 No. 100.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Install wiring, flexible connections and grounding.
- .2 Check rotation before coupling to driven equipment.

## PART 1 - GENERAL

- |                                                |    |                                                                                                                                                                                                     |
|------------------------------------------------|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>1.1 REFERENCES</u>                          | .1 | CSA International                                                                                                                                                                                   |
|                                                | .1 | CSA C22.2 No.42 - (10), General Use Receptacles, Attachment Plugs and Similar Devices.                                                                                                              |
|                                                | .2 | CAN/CSA-C22.2 No.42.1 - 00 (R2009), Cover Plates for Flush-Mounted Wiring Devices (Bi-national standard, with UL 514D).                                                                             |
|                                                | .3 | CSA C22.2 No.55 - M1986 (2008), Special Use Switches.                                                                                                                                               |
| <u>1.2 ACTION AND INFORMATIONAL SUBMITTALS</u> | .1 | Submit in accordance with Section 01 33 00.                                                                                                                                                         |
|                                                | .2 | Product Data:                                                                                                                                                                                       |
|                                                | .1 | Submit manufacturer's instructions, printed product literature and data sheets for wiring devices and include product characteristics, performance criteria, physical size, finish and limitations. |
| <u>1.3 CLOSEOUT SUBMITTALS</u>                 | .1 | Submit in accordance with Section 01 78 00.                                                                                                                                                         |
|                                                | .2 | Operation and Maintenance Data: submit operation and maintenance data for wiring devices for incorporation into manual.                                                                             |
| <u>1.4 DELIVERY, STORAGE AND HANDLING</u>      | .1 | Deliver, store and handle materials in accordance with Section 01 61 00 and with manufacturer's written instructions.                                                                               |
|                                                | .2 | Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.                                                       |
|                                                | .3 | Storage and Handling Requirements:                                                                                                                                                                  |
|                                                | .1 | Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.                                                                          |
|                                                | .2 | Store and protect wiring devices from nicks, scratches, and blemishes.                                                                                                                              |
|                                                | .3 | Replace defective or damaged materials with new.                                                                                                                                                    |
-

## PART 2 - PRODUCTS

- 2.1 SWITCHES
- .1 15A, 120V, single pole, double pole, three-way, switches to: CSA C22.2 No.55 and CSA C22.2 No.111.
  - .2 Manually-operated general purpose AC switches with following features:
    - .1 Terminal holes approved for No. 10 AWG wire.
    - .2 Silver alloy contacts.
    - .3 Urea or melamine moulding for parts subject to carbon tracking.
    - .4 Suitable for back and side wiring.
    - .5 Ivory on drywall and Brown on existing concrete walls toggle.
  - .3 Toggle operated fully rated for tungsten filament, LED, and fluorescent lamps, and up to 80% of rated capacity of motor loads.
  - .4 Switches of one manufacturer throughout project.
- 2.2 RECEPTACLES
- .1 Duplex receptacles, CSA type 5-15 R, 125 V, 15 A, U ground, to: CSA C22.2 No.42 with following features:
    - .1 Ivory urea moulded housing.
    - .2 Suitable for No. 10 AWG for back and side wiring.
    - .3 Break-off links for use as split receptacles.
    - .4 Eight back wired entrances, four side wiring screws.
    - .5 Triple wipe contacts and rivetted grounding contacts.
  - .2 Single receptacles CSA type 5-15 R, 125 V, 15 A, U ground with following features:
    - .1 Ivory in drywalls and Brown in concrete walls urea moulded housing.
    - .2 Suitable for No. 10 AWG for back and side wiring.
    - .3 Four back wired entrances, 2 side wiring screws.
  - .3 Other receptacles with ampacity and voltage as indicated.
-



|                                     |    |                                                     |
|-------------------------------------|----|-----------------------------------------------------|
| <u>2.2 RECEPTACLES<br/>(Cont'd)</u> | .4 | Receptacles of one manufacturer throughout project. |
|-------------------------------------|----|-----------------------------------------------------|

|                         |    |                                                                                                                      |
|-------------------------|----|----------------------------------------------------------------------------------------------------------------------|
| <u>2.3 COVER PLATES</u> | .1 | Cover plates for wiring devices to: CSA C22.2 No.42.1.                                                               |
|                         | .2 | Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.                         |
|                         | .3 | Stainless steel, vertically brushed, 1 mm thick cover plates for wiring devices mounted in flush-mounted outlet box. |
|                         | .4 | Sheet metal cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.                  |

|                                   |    |                                                        |
|-----------------------------------|----|--------------------------------------------------------|
| <u>2.4 SOURCE QUALITY CONTROL</u> | .1 | Cover plates from one manufacturer throughout project. |
|-----------------------------------|----|--------------------------------------------------------|

### PART 3 - EXECUTION

|                        |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|------------------------|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>3.1 EXAMINATION</u> | .1 | Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for wiring devices installation in accordance with manufacturer's written instructions.<br>.1 Visually inspect substrate in presence of Departmental Representative.<br>.2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.<br>.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative. |
|------------------------|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

|                         |    |                                                                                                                                                                                                      |
|-------------------------|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>3.2 INSTALLATION</u> | .1 | Switches:<br>.1 Install single throw switches with handle in "UP" position when switch closed.<br>.2 Install switches in gang type outlet box when more than one switch is required in one location. |
|-------------------------|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

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- 3.2 INSTALLATION  
(Cont'd)
- .1 (Cont'd)
    - .3 Mount toggle switches at height in accordance with Section 26 05 01.
  - .2 Receptacles:
    - .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
    - .2 Mount receptacles at height in accordance with Section 26 05 01.
    - .3 Where split receptacle has one portion switched, mount vertically and switch upper portion.
    - .4 Install GFI type receptacles as indicated.
  - .3 Cover plates:
    - .1 Install suitable common cover plates where wiring devices are grouped.
    - .2 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

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

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

## PART 1 - GENERAL

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| <u>1.1 REFERENCES</u>                          | .1 | CSA International (CSA)                                                                                                                                                                               |
|                                                | .1 | CSA C22.2 No. 5-(13), Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, and NMX-J-266-ANCE-2010).                                 |
| <u>1.2 ACTION AND INFORMATIONAL SUBMITTALS</u> | .1 | Submit in accordance with Section 01 33 00.                                                                                                                                                           |
|                                                | .2 | Product Data:                                                                                                                                                                                         |
|                                                | .1 | Submit manufacturer's instructions, printed product literature and data sheets for circuit breakers and include product characteristics, performance criteria, physical size, finish and limitations. |
| <u>1.3 DELIVERY, STORAGE AND HANDLING</u>      | .1 | Deliver, store and handle materials in accordance with Section 01 61 00 and with manufacturer's written instructions.                                                                                 |
|                                                | .2 | Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.                                                         |
|                                                | .3 | Storage and Handling Requirements:                                                                                                                                                                    |
|                                                | .1 | Store circuit breakers in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.                                                                     |
|                                                | .2 | Store and protect circuit breakers.                                                                                                                                                                   |
|                                                | .3 | Replace defective or damaged materials with new.                                                                                                                                                      |

## PART 2 - PRODUCTS

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| <u>2.1 BREAKERS GENERAL</u> | .1 | Moulded-case circuit breakers, and ground-fault circuit-interrupters: to CSA C22.2 No. 5.                                                                      |
|                             | .2 | Bolt-on moulded case circuit breaker: quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient. |
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| <u>2.2 THERMAL<br/>MAGNETIC BREAKERS<br/>DESIGN A</u> | .1 | Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection. |
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| <u>2.3 ENCLOSURE</u> | .1 | Sprinkler-proof: NEMA 1R. |
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### PART 3 - EXECUTION

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| <u>3.1 EXAMINATION</u> | .1 | Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for installation in accordance with manufacturer's written instructions.<br>.1 Visually inspect substrate in presence of Departmental Representative.<br>.2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.<br>.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative. |
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| <u>3.2 INSTALLATION</u> | .1 | Install circuit breakers as required. |
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| <u>3.3 CLEANING</u> | .1 | Progress Cleaning: clean in accordance with Section 01 74 11.<br>.1 Leave Work area clean at end of each day.                                                                                                  |
|                     | .2 | Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11.                                                                                    |
|                     | .3 | Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 11.<br>.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility. |

## PART 1 - GENERAL

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| <u>1.1 REFERENCES</u>                     | .1 | CSA International<br>.1 CAN/CSA-C22.2 No.144-2015, Ground Fault Circuit Interrupters.                                                                                                                                                      |
|                                           | .2 | National Electrical Manufacturers Association (NEMA)<br>.1 NEMA PG 2.2, Application Guide for Ground Fault Protection Devices for Equipment.                                                                                               |
| <u>1.2 ACTION AND INFORMATIONAL</u>       | .1 | Submit in accordance with Section 01 33 00.                                                                                                                                                                                                |
| <u>SUBMITTALS</u>                         | .2 | Product Data:<br>.1 Submit manufacturer's instructions, printed product literature and data sheets for ground fault circuit interrupters and include product characteristics, performance criteria, physical size, finish and limitations. |
|                                           | .3 | Shop Drawings:<br>.1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.                                                                                                    |
|                                           | .4 | Test and Evaluation Reports: submit test report for field testing of ground fault equipment to Departmental Representative and certificate that system as installed meets criteria specified.                                              |
| <u>1.3 CLOSEOUT SUBMITTALS</u>            | .1 | Submit in accordance with Section 01 78 00.                                                                                                                                                                                                |
|                                           | .2 | Operation and Maintenance Data: submit operation and maintenance data for ground fault circuit interrupters for incorporation into manual.                                                                                                 |
| <u>1.4 DELIVERY, STORAGE AND HANDLING</u> | .1 | Deliver, store and handle materials in accordance with Section 01 61 00 and with manufacturer's written instructions.                                                                                                                      |
|                                           | .2 | Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.                                                                                              |
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| <u>1.4 DELIVERY,<br/>STORAGE AND<br/>HANDLING<br/>(Cont'd)</u> | .3 | Storage and Handling Requirements:<br>.1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.<br>.2 Store and protect ground fault circuit interrupters.<br>.3 Replace defective or damaged materials with new. |
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## PART 2 - PRODUCTS

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| <u>2.1 MATERIALS</u>                                     | .1 | Equipment and components for ground fault circuit interrupters (GFCI): to CAN/CSA-C22.2 No.144.                              |
|                                                          | .2 | Components comprising ground fault protective system to be of same manufacturer.                                             |
| <u>2.2 BREAKER TYPE<br/>GROUND FAULT<br/>INTERRUPTER</u> | .1 | Single or Two pole ground fault circuit interrupter for 15 or 20A, 120V, single-phase circuit c/w test and reset facilities. |

## PART 3 - EXECUTION

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| <u>3.1 EXAMINATION</u> | .1 | Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for ground fault circuit interrupters installation in accordance with manufacturer's written instructions.<br>.1 Visually inspect substrate in presence of Departmental Representative.<br>.2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.<br>.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative. |
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- 3.2 FIELD QUALITY CONTROL
- .1 Perform tests in accordance with Section 26 05 01 and co-ordinate with Section 01 45 00 if required.
  - .2 Arrange for field testing of ground fault equipment by ground fault equipment manufacturer before commissioning service.
  - .3 Demonstrate simulated ground fault tests.
- 3.3 CLEANING
- .1 Progress Cleaning: clean in accordance with Section 01 74 11.
    - .1 Leave Work area clean at end of each day.
  - .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11.
  - .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 11.
    - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

## PART 1 - GENERAL

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| <u>1.1 PRODUCT DATA</u> | .1 | Submit product data in accordance with Section 01 33 00. |
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| <u>1.2 WASTE<br/>MANAGEMENT AND<br/>DISPOSAL</u> | .1 | Separate and recycle waste materials in accordance with Section 01 74 11. |
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## PART 2 - PRODUCTS

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| <u>2.1 DISCONNECT<br/>SWITCHES</u> | .1 | Non-fusible, disconnect switch in CSA Enclosure 1R, size as indicated.       |
|                                    | .2 | Provision for padlocking in off switch position by locks.                    |
|                                    | .3 | Mechanically interlocked door to prevent opening when handle in ON position. |
|                                    | .4 | ON-OFF switch position indication on switch enclosure cover.                 |

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| <u>2.2 EQUIPMENT<br/>IDENTIFICATION</u> | .1 | Provide equipment identification in accordance with Section 26 05 01. |
|                                         | .2 | Indicate name of load controlled on Size 4 nameplate.                 |

## PART 3 - EXECUTION

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| <u>3.1 INSTALLATION</u> | .1 | Install disconnect switches complete with fuses if applicable. |
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## PART 1 - GENERAL

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| <u>1.1 REFERENCES</u>                          | .1 | CSA International                                                                                                                                                                               |
|                                                | .1 | CSA C22.2 No.14-(10), Industrial Control Equipment.                                                                                                                                             |
|                                                | .2 | National Electrical Manufacturers Association (NEMA)                                                                                                                                            |
|                                                | .1 | NEMA ICS 2-2000 (R2005), Controllers, Contactors and Overload Relays Rated 600 V.                                                                                                               |
| <u>1.2 ACTION AND INFORMATIONAL SUBMITTALS</u> | .1 | Submit in accordance with Section 01 33 00.                                                                                                                                                     |
|                                                | .2 | Product Data:                                                                                                                                                                                   |
|                                                | .1 | Submit manufacturer's instructions, printed product literature and data sheets for contactors and include product characteristics, performance criteria, physical size, finish and limitations. |
| <u>1.3 CLOSEOUT SUBMITTALS</u>                 | .1 | Submit in accordance with Section 01 78 00.                                                                                                                                                     |
|                                                | .2 | Operation and Maintenance Data: submit operation and maintenance data for contactors for incorporation into manual.                                                                             |
|                                                | .3 | Include operating information required for start-up, synchronizing and shut-down of generating units.                                                                                           |
| <u>1.4 DELIVERY, STORAGE AND HANDLING</u>      | .1 | Deliver, store and handle materials in accordance with Section 01 61 00 and with manufacturer's written instructions.                                                                           |
|                                                | .2 | Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.                                                   |
|                                                | .3 | Storage and Handling Requirements:                                                                                                                                                              |
|                                                | .1 | Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.                                                                      |
|                                                | .2 | Store and protect contactors from nicks, scratches, and blemishes.                                                                                                                              |
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| 1.4 DELIVERY,<br>STORAGE AND<br>HANDLING<br>(Cont'd) | .3 (Cont'd)<br>.3 Replace defective or damaged materials with<br>new. |
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## PART 2 - PRODUCTS

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| <u>2.1 CONTACTORS</u> | .1 Contactors: to CSA C22.2 No.14.                                                                                                                                          |
|                       | .2 Electrically held controlled by pilot devices as indicated and rated for type of load controlled. Half size contactors not accepted.                                     |
|                       | .3 Complete with 2 normally open and 2 normally closed auxiliary contacts unless indicated otherwise.                                                                       |
|                       | .4 Mount in NEMA Enclosure 1R unless otherwise indicated.                                                                                                                   |
|                       | .5 Include following options in cover:<br>.1 Red and Green indicating lamp.<br>.2 Stop-Start pushbutton.<br>.3 Hand-Off-Auto selector switch.<br>.4 On-Off selector switch. |
|                       | .6 Control transformer: in accordance with control devices, factory wired and installed in contactor enclosure.                                                             |

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| <u>2.2 EQUIPMENT IDENTIFICATION</u> | .1 Identify equipment in accordance with Section 26 05 01. |
|                                     | .2 Size 4 nameplate indicating name of load controlled.    |

## PART 3 - EXECUTION

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| <u>3.1 INSTALLATION</u> | .1 Install contactors and connect power wires and auxiliary control devices.          |
|                         | .2 Identify contactors with nameplates or labels indicating panel and circuit number. |

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| <u>3.1 INSTALLATION</u><br>(Cont'd) | .3 Test contactors in accordance with 26 05 00.                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <u>3.2 CLEANING</u>                 | .1 Progress Cleaning: clean in accordance with Section 01 74 11.<br>.1 Leave Work area clean at end of each day.<br><br>.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11.<br><br>.3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 20.<br>.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility. |
| <u>3.3 PROTECTION</u>               | .1 Protect installed products and components from damage during construction.<br><br>.2 Repair damage to adjacent materials caused by contactor installation.                                                                                                                                                                                                                                                                                                                   |

## PART 1 - GENERAL

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|------------------------------------------------|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>1.1 REFERENCES</u>                          | .1 | International Electrotechnical Commission (IEC)<br>.1 IEC 60947-4-1:2012, Low-voltage switchgear and controlgear - Part 4-1: Contactors and motor-starters - Electromechanical contactors and motor-starters.                                                                                                                                                                                                                                            |
| <u>1.2 ACTION AND INFORMATIONAL SUBMITTALS</u> | .1 | Provide submittals in accordance with Section 01 33 00.                                                                                                                                                                                                                                                                                                                                                                                                  |
|                                                | .2 | Product Data:<br>.1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.                                                                                                                                                                                                                                                    |
|                                                | .3 | Shop Drawings:<br>.1 Provide shop drawings: in accordance with Section 01 33 00.<br>.1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.<br>.2 Provide shop drawings for each type of starter to indicate:<br>.1 Mounting method and dimensions.<br>.2 Starter size and type.<br>.3 Layout and components.<br>.4 Enclosure types.<br>.5 Wiring diagram.<br>.6 Interconnection diagrams. |
| <u>1.3 CLOSEOUT SUBMITTALS</u>                 | .1 | Provide maintenance materials in accordance with Section 01 78 00.                                                                                                                                                                                                                                                                                                                                                                                       |
|                                                | .2 | Submit operation and maintenance data for each type and style of motorstarter for incorporation into maintenance manual.                                                                                                                                                                                                                                                                                                                                 |
|                                                | .3 | Extra Materials:<br>.1 Provide listed spare parts for each different size and type of starter.<br>.1 3 contacts, stationary.<br>.2 3 contacts, movable.<br>.3 1 contacts, auxiliary.<br>.4 1 control transformers.                                                                                                                                                                                                                                       |
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| 1.3 CLOSEOUT<br>SUBMITTALS<br>(Cont'd) | .3 | (Cont'd)                         |
|                                        | .1 | (Cont'd)                         |
|                                        | .5 | 1 operating coil.                |
|                                        | .6 | 2 fuses.                         |
|                                        | .7 | 10 % indicating lamp bulbs used. |
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| 1.4 DELIVERY,<br>STORAGE AND<br>HANDLING | .1 | Deliver, store and handle in accordance with<br>Section 01 61 00.                                                                                                       |
|                                          | .2 | Deliver materials to site in original factory<br>packaging, labelled with manufacturer's name,<br>address.                                                              |
|                                          | .3 | Packaging Waste Management: remove for reuse and<br>return by manufacturer of pallets crates<br>padding and packaging materials in accordance<br>with Section 01 74 11. |

## PART 2 - PRODUCTS

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|---------------|----|--------------------------------------------------------------|
| 2.1 MATERIALS | .1 | Starters: to IEC 60947-4-1 with AC4 utilization<br>category. |
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| 2.2 FULL VOLTAGE<br>MAGNETIC STARTERS | .1 | Magnetic and combination magnetic starters of<br>size, type, rating and enclosure type as<br>indicated with components as follows: <ul style="list-style-type: none"> <li>.1 Contactor solenoid operated, rapid action<br/>type.</li> <li>.2 Motor overload protective device in each<br/>phase, manually reset from outside enclosure.</li> <li>.3 Wiring and schematic diagram inside starter<br/>enclosure in visible location.</li> <li>.4 Identify each wire and terminal for<br/>external connections, within starter, with<br/>permanent number marking identical to diagram.</li> </ul> |
|                                       | .2 | Combination type starters to include fused<br>disconnect switch motor circuit interrupter<br>circuit breaker with operating lever on outside<br>of enclosure to control disconnect motor circuit<br>interrupter circuit breaker, and provision for: <ul style="list-style-type: none"> <li>.1 Locking in "OFF" position with up to<br/>3 padlocks.</li> <li>.2 Independent locking of enclosure door.</li> </ul>                                                                                                                                                                                |
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| <u>2.2 FULL VOLTAGE<br/>MAGNETIC STARTERS<br/>(Cont'd)</u> | .2     | (Cont'd)                                                                                                                                                                    |
|                                                            | .3     | Provision for preventing switching to "ON" position while enclosure door open.                                                                                              |
|                                                            | .3     | Accessories:                                                                                                                                                                |
|                                                            | .1     | Pushbuttons Selector switches: standard heavy duty oil tight labelled as indicated.                                                                                         |
|                                                            | .2     | Indicating lights: standard heavy duty oil tight type and color as indicated.                                                                                               |
|                                                            | .3     | 1-N/O and 1-N/C spare auxiliary contacts unless otherwise indicated.                                                                                                        |
| <br><u>2.3 CONTROL<br/>TRANSFORMER</u>                     | <br>.1 | <br>Single phase, dry type, control transformer with primary voltage as indicated and 120V secondary, complete with secondary fuse, installed in with starter as indicated. |
|                                                            | .2     | Size control transformer for control circuit load plus 20% spare capacity.                                                                                                  |
| <br><u>2.4 ACCESSORIES</u>                                 | <br>.1 | <br>Pushbutton: heavy duty, oil tight as required.                                                                                                                          |
|                                                            | .2     | Selector switches: heavy duty, oil tight as required.                                                                                                                       |
|                                                            | .3     | Indicating lights: heavy duty, oil tight, type and colour as indicated.                                                                                                     |
| <br><u>2.5 FINISHES</u>                                    | <br>.1 | <br>Apply finishes to enclosure in accordance with Section 26 05 01.                                                                                                        |
| <br><u>2.6 EQUIPMENT<br/>IDENTIFICATION</u>                | <br>.1 | <br>Provide equipment identification in accordance with Section 26 05 01.                                                                                                   |
|                                                            | .2     | Magnetic starter designation label, white plate, black letters, size as required engraved as indicated.                                                                     |
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### PART 3 - EXECUTION

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| <u>3.1 INSTALLATION</u>          | .1 | Install starters and control devices in accordance with manufacturer's instructions.                                               |
|                                  | .2 | Install and wire starters and controls as indicated.                                                                               |
|                                  | .3 | Ensure correct fuses installed.                                                                                                    |
|                                  | .4 | Confirm motor nameplate and adjust overload device to suit.                                                                        |
| <u>3.2 FIELD QUALITY CONTROL</u> | .1 | Perform tests in accordance with Section 26 05 01 and manufacturer's instructions.                                                 |
|                                  | .2 | Operate switches and contactors to verify correct functioning.                                                                     |
|                                  | .3 | Perform starting and stopping sequences of contactors and relays.                                                                  |
|                                  | .4 | Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated. |
| <u>3.3 CLEANING</u>              | .1 | Clean in accordance with Section 01 74 11.<br>.1 Remove surplus materials, excess materials, rubbish, tools and equipment.         |
|                                  | .2 | Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 11.                            |