

**Government of Canada
Existing Building Renovation
Issued for Tender**

144202775.215

Edmonton, Alberta

Appendix No. 4 Specifications

June 8, 2016

DIVISION 02 EXISTING CONDITIONS

Section 02 41 16	Selective Demolition	5
Section 02 83 33	Lead Abatement and Removal.....	9
Section 02 83 33.01	Initial Lead Surface Contamination Assessment	10

DIVISION 03 CONCRETE

Section 03 10 00	Concrete Forming and Accessories	10
Section 03 20 00	Concrete Reinforcing.....	7
Section 03 30 00	Cast-in Place Concrete.....	15

DIVISION 04 MASONRY

Section 04 05 00	Common Work Results for Masonry	8
Section 04 05 12	Masonry Mortar	5
Section 04 05 19	Masonry Anchorage and Reinforcing.....	5
Section 04 22 00	Concrete Unit Masonry.....	6

DIVISION 05 METALS

Section 05 50 00	Metal Fabrications	9
Section 05 72 00	Stainless Steel Fabrications	5

DIVISION 06 WOOD, PLASTICS AND COMPOSITES

Section 06 10 00	Rough Carpentry.....	5
Section 06 40 00	Architectural Woodwork	10

DIVISION 07 THERMAL AND MOISTURE PROTECTION

Section 07 21 16	Acoustic Insulation	3
Section 07 84 00	Fire Stopping	6
Section 07 92 00	Joint Sealing	6

DIVISION 08 OPENINGS

Section 08 34 73	Acoustic Doors & Frames.....	8
Section 08 56 73	Sound Control Windows.....	6
Section 08 70 05	Cabinet and Miscellaneous Hardware	4
Section 08 71 00	Door Hardware	7
Section 08 81 00.01	Door Hardware Schedule.....	1

DIVISION 09 FINISHES

Section 09 21 16	Gypsum Board Assemblies.....	12
Section 09 51 13	Acoustic Ceilings.....	7
Section 09 65 16	Resilient Flooring	9
Section 09 67 10	Epoxy Flooring	8
Section 09 91 23	Interior Painting	12

Section 09 91 23.01	Interior Re-Painting	11
---------------------	----------------------------	----

DIVISION 11 EQUIPMENT

Section 11 67 23	Shooting Range Equipment	6
------------------	--------------------------------	---

DIVISION 21 FIRE PROTECTION

Section 21 05 00	Common Work Results for Fire Suppression	2
Section 21 05 23	General Duty Valves for Water Based Fire Suppression Piping	2
Section 21 05 29	Hangers and Supports for Fire Suppression Piping and Equipment.....	2
Section 21 05 53	Identification for Fire Suppression Piping and Equipment	2
Section 21 13 13	Wet Pipe Fire Suppression Sprinkler Systems	7
Section 21 13 19	Preaction Sprinkler Systems	9

DIVISION 22 PLUMBING

Section 22 01 10.51	Plumbing Piping Cleaning	3
Section 22 05 00	Common Work Results for Plumbing	2
Section 22 05 19	Meters and Gauges for Plumbing Piping	1
Section 22 05 23	General Duty Valves for Plumbing Piping	6
Section 22 05 29	Hangers and Supports for Plumbing Piping and Equipment	2
Section 22 05 53	Identification for Plumbing Piping and Equipment	2
Section 22 07 00	Plumbing Insulation	2
Section 22 11 16	Domestic Water Piping	6
Section 22 11 19	Domestic Water Piping Specialties.....	3
Section 22 13 16	Sanitary Waste and Vent Piping	5
Section 22 13 19	Sanitary Waste Piping Specialties	3
Section 22 15 13	General Service Compressed Air Piping	2
Section 22 15 16	General Service Compressed Air Valves.....	2
Section 22 15 19	General Service Packaged Air Compressors and Receivers	2
Section 22 45 00	Emergency Plumbing Fixtures.....	2

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

Section 23 01 30.51	HVAC Air Distribution System Cleaning	4
Section 23 05 00	Common Work Results for HVAC.....	34
Section 23 05 13	Common Motor Requirements for HVAC Equipment	8
Section 23 05 14	Variable Frequency Drives for HVAC Equipment.....	27
Section 23 05 19	Meters and Gauges for HVAC Systems	5
Section 23 05 29	Hangers and Supports for HVAC Piping and Equipment	14
Section 23 05 48	Vibration and Seismic Controls for HVAC	15
Section 23 05 53	Identification for HVAC Piping and Equipment	11
Section 23 05 93	Testing, Adjusting and Balancing for HVAC Systems	13
Section 23 07 00	HVAC Insulation	13
Section 23 09 00	Instrumentation and Control for HVAC	15
Section 23 09 13	Instrumentation and Control Devices for HVAC	5
Section 23 09 23.6	Direct Digital Control Systems for HVAC –	

	Input/Output Devices.....	5
Section 23 09 93.1	Sequence of Operations for HVAC Control	2
Section 23 09 93.2	Point Schedules.....	1
Section 23 31 13	Metal Ducts.....	10
Section 23 33 00	Air Duct Accessories	8
Section 23 34 00	HVAC Fans	4
Section 23 37 00	Air Outlets and Inlets	3
Section 23 37 26	Laminar Airflow Airwall System	10
Section 23 72 23	Packaged Air to Air Energy Recovery Units.....	5
Section 23 82 16	Air Coils	3

DIVISION 26 ELECTRICAL

Section 26 05 00 11	Electrical General Requirements	15
Section 26 05 19 00	Wires and Cables 0 - 1000 V	5
Section 26 05 19 10	Wire and Box Connectors 0 - 1000 V	2
Section 26 05 19 11	Wiring Devices	2
Section 26 05 29 00	Fastenings and Supports	4
Section 26 05 31 00	Splitters, Junction Boxes, Pull Boxes and Cabinets	3
Section 26 05 32 00	Outlet Boxes, Conduit Boxes and Fittings.....	4
Section 26 05 34 00	Conduits, Conduit Fastenings and Conduit Fittings	6
Section 26 05 43 00	Direct Buried Underground Cable Ducts.....	3
Section 26 05 43 10	Installation of cables in Trenches and in Ducts	2
Section 26 08 00 10	Starting of Electrical Equipment and System	2
Section 26 08 00 11	Testing, Adjusting and Balancing of Electrical Equipment and Systems	4
Section 26 24 02 10	Disconnect Switches Fused and Non-Fused up to 600 V - Primary	2
Section 26 24 16 00	Panelboard – Breaker Type	3
Section 26 24 16 01	Panelboards.....	4
Section 26 24 16 10	Molded Case Circuit Breakers.....	2
Section 26 24 19 22	Motor Starts to 600V	5
Section 26 24 19 23	Connections to Mechanical Equipment	2
Section 26 50 00 00	Lighting Equipment.....	8
Section 26 53 00 00	Exit Lights	1

DIVISION 27 COMMUNICATIONS

Section 27 10 05 00	Structured Cabling	11
Section 27 10 05 10	Telecommunications Raceway System.....	1

DIVISION 28 ELECTRONIC SAFETY AND SECURITY

Section 28 31 02	Addressable Fire Alarm System	10
------------------	-------------------------------------	----

END OF SPECIFICATION INDEX

1 General

1.1 RELATED SECTIONS

- .1 Section 02 83 33 - Lead Abatement & Removal.

1.2 REFERENCES

- .1 Definitions:
 - .1 Hazardous Materials: dangerous substances, dangerous goods, hazardous commodities and hazardous products, include but not limited to: poisons, corrosive agents, flammable substances, ammunition, explosives, radioactive substances, or materials that endanger human health or environment if handled improperly.
- .2 Reference Standards:
 - .1 CSA International
 - .1 CSA S350-M1980(R2003), Code of Practice for Safety in Demolition of Structures.
 - .2 Department of Justice Canada (Jus)
 - .1 Canadian Environmental Assessment Act (CEAA), 1995, c. 37.
 - .2 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
 - .1 SOR/2003-2, On-Road Vehicle and Engine Emission Regulations.
 - .2 SOR/2006-268, Regulations Amending the On-Road Vehicle and Engine Emission Regulations.
 - .3 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-Installation Meetings:
 - .1 Convene pre-installation meeting one week prior to beginning work of this Section, with Contractor's Representative, Departmental Representative in accordance with Section 01 31 19 - Project Meetings to:
 - .1 Verify project requirements.
 - .2 Verify existing site conditions adjacent to demolition work.
 - .3 Co-ordination with other construction subtrades.
 - .2 Hold project meetings every month.
 - .3 Ensure key personnel, site supervisor, project manager, subcontractor representatives attend.
 - .4 Departmental Representative will provide written notification of change to meeting schedule established upon contract award 24 hours prior to scheduled meeting.

- .2 Scheduling:
 - .1 Employ necessary means to meet project time lines without compromising specified minimum rates of material diversion.
 - .1 In event of unforeseen delay notify Departmental Representative in writing.
- .3 For demolition and range cleaning work, submit copies of Contractor's qualifications as follows:
 - .1 Respiratory Protection Program endorsed by a Certified Industrial Hygienist.
 - .2 Medical Surveillance Program.
 - .3 Evidence of medical examinations for all workers, including a physician's statement indicating the employee is fit to conduct this type of work.
 - .4 Certificates of worker training
 - .5 Reference list demonstrating at least 10 previous projects of similar scope and a minimum of five years' experience in this type of work.

1.4 QUALITY ASSURANCE

- .1 Regulatory Requirements: Ensure Work is performed in compliance with applicable Provincial and Municipal regulations.
- .2 Comply with all applicable hygienic regulations governing shooting range cleaning.

1.5 SITE CONDITIONS

- .1 Environmental protection:
 - .1 Ensure Work is done in accordance with Section 01 35 43 - Environmental Procedures.
 - .2 Ensure Work does not adversely affect adjacent watercourses, groundwater and wildlife, or contribute to excess air and noise pollution.
 - .3 Fires and burning of waste or materials is not permitted on site.
 - .4 Do not bury rubbish waste materials.
 - .5 Do not dispose of waste or volatile materials including but not limited to: mineral spirits, oil, petroleum based lubricants, or toxic cleaning solutions into watercourses, storm or sanitary sewers.
 - .1 Ensure proper disposal procedures are maintained throughout project.
 - .6 Do not pump water containing suspended materials into watercourses, storm or sanitary sewers, or onto adjacent properties.
 - .7 Control disposal or runoff of water containing suspended materials or other harmful substances in accordance with authorities having jurisdiction and as directed by Departmental Representative.
 - .8 Protect trees, plants and foliage on site and adjacent properties where indicated.
 - .9 Prevent extraneous materials from contaminating air beyond application area, by providing temporary enclosures during demolition work.
 - .10 Cover or wet down dry materials and waste to prevent blowing dust and debris. Control dust on all temporary roads.

- .2 Where exterior demolition occurs, such as removal of roof top units and the like, take into consideration, prevailing weather conditions and weather forecasts. Do not proceed with demolition work when weather conditions constitute a hazard to the workers and site.

1.6 EXISTING CONDITIONS

- .1 If material resembling spray or trowel applied asbestos or other substance listed as hazardous be encountered in course of demolition, stop work, take preventative measures, and notify Departmental Representative immediately. Proceed only after receipt of written instructions have been received from Departmental Representative.
- .2 Structures to be demolished are based on their condition at time of examination prior to tendering.
 - .1 Remove, protect and store salvaged items as directed by Departmental Representative. Salvage items as identified by Departmental Representative. Deliver to Departmental Representative as directed.

2 Products

2.1 EQUIPMENT

- .1 Leave machinery running only while in use, except where extreme temperatures prohibit shutting machinery down.

2.2 SALVAGED MATERIALS

- .1 In addition to the items noted as being salvaged for turn over to the Departmental Representative or salvaged for reuse in this project, all existing items which are to be removed or demolished, are to be inspected by the Departmental Representative. If the Departmental Representative wants the demolished or removed items, turn them over to the Departmental Representative. If the Departmental Representative does not want the demolished or removed items, then they become the property of the Contractor and are to be immediately removed from site.
- .2 Notify the Departmental Representative prior to removal and obtain approval regarding method of removal.
- .3 Carefully remove without damage, items to be retained by the Departmental Representative, or to be retained for reincorporation in the Work, and if required to ensure reinstallation in the correct location, tag them to identify location of origin.
- .4 Deliver and store where directed by the Departmental Representative, on site.

3 Execution

3.1 PREPARATION

- .1 Protection of in-place conditions:
 - .1 Work in accordance with Section 01 35 43 - Environmental Procedures.
 - .2 Prevent movement, settlement or damage of adjacent structures, services, and parts of existing building to remain.
 - .1 Provide bracing, shoring and underpinning as required.
 - .2 Repair damage caused by demolition as directed by Departmental Representative.
 - .3 Support affected structures and, if safety of structure being demolished adjacent structures, services or parts of existing building to remain appears to be endangered, take preventative measures, stop Work and immediately notify Departmental Representative.
 - .4 Prevent debris from blocking surface drainage system, mechanical and electrical systems which must remain in operation.
- .2 Surface Preparation:
 - .1 Disconnect and re-route electrical and telephone service lines as required to accommodate work.
 - .1 Post warning signs on electrical lines and equipment which must remain energized to serve other properties during period of demolition.
 - .2 Disconnect and cap designated mechanical services.
 - .1 Natural gas supply lines: remove in accordance with gas company requirements.
 - .2 Sewer and water lines: remove in accordance with authority having jurisdiction and as directed by Departmental Representative.
 - .3 Other underground services: remove and dispose of as indicated.
 - .3 Do not disrupt active or energized utilities designated to remain undisturbed.

3.2 DEMOLITION

- .1 Do demolition work in accordance with Section 01 56 00 - Temporary Barriers and Enclosures.
- .2 Blasting operations not permitted during demolition.
- .3 Remove contaminated or dangerous materials as defined by authorities having jurisdiction, relating to environmental protection, from site and dispose of in safe manner to minimize danger at site or during disposal.
- .4 Demolish parts of existing building as required to accommodate new construction.
- .5 Crush concrete generated due to demolition of foundations to size suitable for recycling.

- .6 Remove existing equipment, services, and obstacles where required for refinishing or making good of existing surfaces, and replace as work progresses.
- .7 At end of each day's work, leave Work in safe and stable condition.
 - .1 Protect interiors of parts not to be demolished from exterior elements at all times.
- .8 Demolish to minimize dusting. Keep materials wetted as directed by Departmental Representative.
- .9 Contain fibrous materials to minimize release of airborne fibres while being transported within facility.
- .10 Remove and dispose of demolished materials except where noted otherwise and in accordance with authorities having jurisdiction.
- .11 Immediately as demolition progresses, repair any resulting damage to existing parts intended to remain.
- .12 Use natural lighting to do Work where possible.
 - .1 Shut off lighting except those required for security purposes at end of each day.

3.3 CLEANING

- .1 Designate appropriate security resources / measures to prevent vandalism, damage and theft.
- .2 Locate stockpiled materials convenient for use in new construction. Eliminate double handling wherever possible.
- .3 Remove demolition debris which is not otherwise to be salvaged, from site and dispose of in a legal manner.

END OF SECTION

1 General

1.1 SUMMARY

- .1 Comply with requirements of this Section when performing following Work:
 - .1 Removal/cleaning of lead-containing dust from all surfaces throughout rooms and areas to be impacted by HVAC upgrade project

1.2 RELATED REQUIREMENTS

- .1 Section 01 14 00 - Work Restrictions.
- .2 Section 01 35 29.06 - Health and Safety Requirements

1.3 REFERENCES

- .1 All applicable national building codes, Canadian electrical codes and standards, fire and construction safety codes, shall be in effect during all aspects of this lead remediation project. In any situation where there are discrepancies between these specifications and others, the more stringent standard shall always apply. The following list has been included as a guide only; others may apply:
 - .1 Canadian Environmental Protection Act, 1999 (CEPA 1999)
 - .1 Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations (SOR/2005-149).
 - .2 Department of Justice Canada (Jus)
 - .1 Transportation of Dangerous Goods Act, 1992 (TDG Act) [1992], (c. 34).
 - .2 Transportation of Dangerous Goods Regulations (T-19.01-SOR/2001-286).
 - .3 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
 - .4 National Research Council Canada Institute for Research in Construction (NRC-IRC)
 - .1 National Fire Code of Canada-[2005].
 - .5 Alberta Government
 - .1 Alberta Occupational Health and Safety Act, Regulations and Code (AB OH&S Reg., including amendments to date of work)
 - .2 "Alberta User Guide for Waste Managers", current version
 - .3 Dangerous Goods Transportation and Handling Act
 - .6 The Federal Transportation of Dangerous Goods Regulation

1.4 RESTRICTIONS

- .1 HEPA vacuum: High Efficiency Particulate Air filtered vacuum equipment with filter system capable of collecting and retaining fibres greater than 0.3 microns in any direction at 99.97% efficiency.
- .2 Authorized Visitors: Departmental Representative or designated representative[s] and representatives of regulatory agencies.
- .3 Occupied Area: areas of building or work site that is outside Work Area.

- .4 Sprayer: garden reservoir type sprayer or airless spray equipment capable of producing mist or fine spray. Must be appropriate capacity for scope of work.
- .5 Airlock: ingress or egress system, without permitting air movement between contaminated area and uncontaminated area. Consisting of two curtained doorways at least 2 m apart.
- .6 Curtained doorway: arrangement of closures to allow ingress and egress from one room to another. Typically constructed as follows:
 - .1 Place two overlapping polyethylene sheets over existing or temporarily framed doorway, securing each along top of doorway, securing vertical edge of one sheet along one vertical side of doorway, and secure other sheet along opposite vertical side of doorway.
 - .2 Reinforce free edges of polyethylene with duct tape and add weight to bottom edge to ensure proper closing.
 - .3 Overlap each polyethylene sheet at openings 1.5 m on each side.
- .7 Action level: employee exposure, without regard to usage of respirators, to an airborne concentration of lead of 50% of the 8 hour time-weighted average (TWA) occupational exposure limit (OEL). TWA OEL for lead in Alberta is 0.05 milligrams per cubic meter of air. Intermediate precautions for lead abatement are based on expected airborne lead concentrations greater than 50% of the OEL (> 0.025 milligrams per cubic meter of air) within Work Area.
- .8 Competent person: individuals capable of identifying existing lead hazards in workplace and taking corrective measures to eliminate them.
- .9 Lead in Dust: wipe sampling on vertical and/or horizontal surfaces, dust and debris is considered to be lead contaminated if it contains lead in concentrations greater than those indicated below.

Surface	Clearance Criteria	
	µg/100 cm ²	µg/ft ²
Exterior concrete and rough surfaces	86.1	800
Interior concrete, window troughs, rough surfaces	43	400
Interior window sills	26.9	250
Firing ranges and work places where lead is used	21.5	200
Floors and other surfaces: Non-Residential	21.5	200
Floors and other surfaces: Residential	4.3	40
Child care facilities, primary schools, food preparation, food processing, pediatrics, labour and delivery, and maternity areas of hospitals (all surfaces routinely accessible by occupants or used in food processing).	4.3	40

1.5 SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Provide proof satisfactory to Departmental Representative that suitable arrangements have been made to dispose of lead waste in accordance with requirements of authority having jurisdiction.

-
- .3 Provide Provincial requirements for Notice of Project Form, and provide a copy to the Departmental Representative.
 - .4 Provide proof of Contractor's General and Environmental Liability Insurance.
 - .5 Quality Control:
 - .1 Provide Departmental Representative copies of necessary permits for transportation and disposal of lead waste and proof that it has been received and properly disposed.
 - .2 Provide proof satisfactory to Departmental Representative that employees have had instruction on hazards of lead exposure, respirator use, dress, entry and exit from Work Area, and aspects of work procedures and protective measures. Minimum of one supervisor for every ten workers.
 - .3 Provide proof (certificates) that all equipment equipped with HEPA filters have been DOP tested on-site.
 - .6 Product data:
 - .1 Provide documentation including Material Safety Data Sheets (MSDS) for chemicals or materials that the contractor wishes to use on-site, including, but not limited to:
 - .1 Encapsulants.
 - .2 Amended water.
 - .3 Slow drying sealer.

1.6 QUALITY ASSURANCE

- .1 Regulatory Requirements: comply with Federal, Provincial/Territorial and local requirements pertaining to lead paint, in case of conflict among those requirements or with these specifications more stringent requirement applies. Comply with regulations in effect at time work is performed.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.
 - .2 Safety Requirements: worker and visitor protection.
 - .1 Protective equipment and clothing to be worn by workers and visitors in Work Area includes:
 - .1 Properly fitted NIOSH approved respirator equipped with HEPA or P-100 filter cartridges with minimum assigned protection factor of 10 (half-mask or greater protection), acceptable to Authority having jurisdiction. Suitable for type of lead and level of lead dust exposure in Lead Work Area. Provide sufficient filters so workers can install new filters following disposal of used filters and before re-entering contaminated areas.
 - .2 Disposable type protective clothing that does not readily retain or permit skin contamination, consisting of full body covering including head covering with snug fitting cuffs at wrists, ankles, and neck.
 - .3 Steel Toe safety boots (CSA approved)
 - .2 Requirements for workers:
 - .1 Remove street clothes in clean change room and put on respirator with new filters or reusable filters, clean coveralls and head covers before entering Equipment and Access Rooms or Work Area. Store street

-
- clothes, uncontaminated footwear, towels, and similar uncontaminated articles in clean change room.
- .2 Remove gross contamination from clothing before leaving work area. Place contaminated work suits in receptacles for disposal with other lead - contaminated materials. Leave reusable items except respirator in Equipment and Access Room. When not in use in Work Area, store work footwear in Equipment and Access Room. Upon completion of lead abatement, dispose of footwear as contaminated waste or clean thoroughly inside and out using soap and water before removing from Work Area or from Equipment and Access Room.
 - .3 Enter unloading room from outside dressed in clean coveralls to remove waste containers and equipment from Holding Room of Container and Equipment Decontamination Enclosure system. Workers not to use this system as means to leave or enter work area.
 - .3 Eating, drinking, chewing, and smoking are not permitted in Work Area.
 - .4 Ensure workers are fully protected with respirators and protective clothing during preparation of system of enclosures prior to commencing actual lead abatement.
 - .5 Ensure workers wash hands and face when leaving Work Area.
 - .6 Provide and post in Clean Change Room and in Equipment and Access Room the procedures described in this Section, in both official languages.
 - .7 Ensure no person required to enter Work Area has facial hair that affects seal between respirator and face.
 - .8 Visitor Protection:
 - .1 Provide protective clothing and approved respirators to Authorized Visitors to Work Areas.
 - .2 Instruct Authorized Visitors in use of protective clothing, respirators and procedures.
 - .3 Instruct Authorized Visitors in proper procedures to be followed in entering into and exiting from Work Area.

1.7 WASTE AND MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with local municipal bylaws.
- .2 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional and Municipal regulations.
- .3 Disposal of lead waste generated by removal activities must comply with Federal, Provincial and Municipal regulations. Dispose of lead waste in sealed double thickness 6 mil bags or leak proof drums, or as required by the accepting facility/transportation regulations. Label containers with appropriate warning labels.
- .4 Provide manifests describing and listing waste created. Transport containers by approved means to licensed accepting facility.

1.8 EXISTING CONDITIONS

- .1 Reports and information pertaining to assessment findings related to lead contamination (and other hazardous building materials in the work area, where applicable) that is to be

removed, or otherwise disturbed and disposed of during this Project are attached to this specification package in Appendix X.

- .2 Notify Departmental Representative of lead contamination or other potential hazardous building materials discovered during Work and not apparent from drawings, specifications, or report pertaining to Work. Do not disturb such material until instructed by Departmental Representative.

1.1 SCHEDULING

- .1 Not later than two days before beginning Work on this Project notify the following in writing, where appropriate:
 - .1 Provincial Ministry of Labour.
 - .2 Disposal Authority.
- .2 Inform sub trades of presence of lead-containing materials identified in Existing Conditions.
- .3 Provide Departmental Representative with copies of notifications prior to start of Work.
- .4 Hours of Work: perform work involving lead abatement during normal working hours.

2 Products

2.1 MATERIALS

- .1 Polyethylene: 6 mil unless otherwise specified; in sheet size to minimize joints.
- .2 FR polyethylene: 10 mil woven fibre reinforced fabric bonded both sides with polyethylene.
- .3 Tape: fibreglass - reinforced duct tape suitable for sealing polyethylene under dry conditions and wet conditions using amended water.
- .4 Slow - drying sealer: non-staining, clear, water - dispersible type that remains tacky on surface for at least 8 hours and designed for trapping residual lead paint residue.
- .5 Lead waste containers: All lead waste is to be placed in small means of containment which meet the requirements for transporting leachable toxic waste, in accordance with government regulations. All packaged waste is to be appropriately labeled and handled in accordance with government regulations.
- .6 Label containers with pre-printed bilingual cautionary labels indicating "Warning Lead" clearly visible when ready for removal to disposal site.

3 Execution

3.1 SUPERVISION

- .1 Approved Supervisor must remain within Lead Work Area during disturbance, removal, or other handling of lead contamination.

3.1 PREPARATION

- .1 Remove and wrap items to be salvaged or reused, and transport and store in area specified by Departmental Representative.
- .2 Work Area:

-
- .1 Shut off and isolate HVAC system to prevent dust dispersal into other building areas. Conduct smoke tests to ensure duct work is airtight.
 - .2 Pre-clean fixed casework, and equipment within work areas, using HEPA vacuum and cover with polyethylene sheeting sealed with tape.
 - .3 Clean work areas using HEPA vacuum. If not practicable, use wet cleaning method. Do not use methods that raise dust, such as dry sweeping, or vacuuming using other than HEPA vacuum.
 - .4 Seal off openings, corridors, doorways, windows, skylights, ducts, grilles, and diffusers, with polyethylene sheeting sealed with tape.
 - .5 Prevent the spread of dust from the Contact Work Area using measures appropriate to the work to be done and which are consistent with the requirements for a lead abatement operation. Erect a polyethylene enclosure around the Contract Work Area.
 - .6 Establish negative pressure in polyethylene enclosure as follows:
 - .1 Install and maintain HEPA filtered Negative Air Unit(s) sufficient to allow one complete air change every 15 minutes; and,
 - .2 Operate Negative Air Unit(s) continuously from time of Departmental Representative's authorization to proceed until acceptable clearance results have been achieved and have been verified in writing by the Departmental Representative.
 - .7 At point of access to work areas install warning signs in both official languages in upper case "Helvetica Medium" letters reading as follows where number in parentheses indicates font size to be used:
 - .1 CAUTION LEAD HAZARD AREA (25 mm).
 - .2 NO UNAUTHORIZED ENTRY (19 mm).
 - .3 WEAR ASSIGNED PROTECTIVE EQUIPMENT AND RESPIRATOR (19 mm).
 - .4 BREATHING LEAD CONTAMINATED DUST CAUSES SERIOUS BODILY HARM (7 mm).
 - .8 Maintain emergency and fire exits from work areas, or establish alternative exits satisfactory to Authority having jurisdiction.
 - .9 Where water application is required for wetting lead containing materials, provide temporary water supply by use of appropriately sized hoses for application of water as required.
 - .10 Provide electrical power and shut off for operation of powered tools and equipment. Provide 24 volt safety lighting and ground fault interrupter circuits on power source for electrical tools, in accordance with applicable CSA Standard. Ensure safe installation of electrical lines and equipment.
- .3 Worker Decontamination Enclosure System:
- .1 Worker Decontamination Enclosure System includes Equipment and Access Room and Clean Room, as follows:
 - .1 Equipment and Access Room: construct between exit and work areas, with two curtained doorways, one to the rest of suite, and one to work area. Install waste receptor and storage facilities for workers' shoes and protective clothing to be re-worn in work areas. Build large enough to accommodate specified facilities, equipment needed, and at least one worker allowing sufficient space to change comfortably.

-
- .2 Clean Room: construct with curtained doorway to outside of enclosures. Provide lockers or hangers and hooks for workers' street clothes and personal belongings. Provide storage for clean protective clothing and respiratory equipment. Install mirror to permit workers to fit respiratory equipment properly.
 - .4 Construction of Decontamination Enclosures:
 - .1 Construct framing for enclosures or use existing rooms. Line enclosure with polyethylene sheeting and seal with tape, apply two layers of FR polyethylene on floor.
 - .2 Construct curtain doorways between enclosures so when people move through or waste containers and equipment are moved through doorway, one of two closures comprising doorway always remains closed.
 - .3 In the wash Station, install a wash sink with hot and cold water. Also provide disposable towels, a mirror and disposal containers for contaminated and non-contaminated waste.
 - .5 Separation of Work Areas from Occupied Areas
 - .1 Barriers between Work Area and occupied area to be constructed as follows:
 - .1 Construct floor to ceiling with appropriate stud framing, cover with polyethylene sheeting and seal with duct tape. Apply plywood over polyethylene sheeting, if necessary. Seal plywood joints and between adjacent materials with surface film forming sealer, to create airtight barrier.
 - .2 Where plywood is used, cover plywood with polyethylene sheeting and sealed with duct tape.
 - .6 Maintenance of Enclosures:
 - .1 Maintain enclosures in clean condition.
 - .2 Ensure barriers and polyethylene linings are effectively sealed and taped. Repair damaged barriers and remedy defects immediately.
 - .3 Visually inspect enclosures at beginning of each work day.
 - .4 Use smoke test method to test effectiveness of barriers and negative pressure as directed by Departmental Representative.

3.2 LEAD ABATEMENT

- .1 Before beginning lead dust abatement work, remove visible dust from surfaces in the Contract Work Area where dust is likely to be disturbed during the course of the work. Use HEPA vacuum or damp cloths where damp cleaning does not create a hazard and is otherwise appropriate. Do not use compressed air to clean up or remove dust from any surface.
- .2 The cleanup of the lead contamination is to be executed in a systematic and orderly manner. The abatement workers will first vacuum and then wet wipe the surfaces to be cleaned. Used rags will be placed into a clear disposal bag and sealed with duct tape. The disposal bags will then be taken to a designated transfer area for appropriate disposal.
- .3 Visually inspect the Contract Work Area at least once per day and on days when there are no shifts to ensure integrity of enclosures and barriers and functionality of negative air units.
- .4 Seal filled containers. Clean external surfaces thoroughly by wet sponging. Remove from immediate working area to Staging Area. Clean external surfaces thoroughly again by wet

- sponging before moving containers to decontamination Washroom. Wash containers thoroughly in decontamination Washroom, and store in Holding Room pending removal to Unloading Room and outside. Ensure containers are removed from Holding Room by workers who have entered from uncontaminated areas dressed in clean coveralls.
- .5 Wet clean work area including equipment and access room, and equipment used in process. After inspection by Departmental Representative, apply continuous coat of slow drying sealer to surfaces. Do not disturb work for 8 hours with no entry, activity, ventilation or disturbance during this period.
- .6 After encapsulating lead painted surfaces, wet clean work area and equipment and access room. During settling period no entry, activity, or ventilation will be permitted.

3.3 INSPECTION

- .1 Perform inspections to confirm compliance with specifications and governing authority requirements. Deviations from these requirements not approved in writing by Departmental Representative will result in work stoppage, at no cost to Owner.
- .2 Departmental Representative will inspect work for:
- .1 Adherence to specific procedures and materials.
 - .2 Final cleanliness and completion.
 - .3 No additional costs will be allowed by Contractor for additional labour or materials required to provide specified performance level.
- .3 When lead dust leakage from Work Area occurs, Departmental Representative may order Work shutdown.
- .4 No additional costs will be allowed by Contractor for additional labour or materials required to provide specified performance level.

3.4 LEAD AIR SAMPLING – WORK AREAS

- .1 Departmental Representative will conduct periodic air sampling for lead, at their discretion, and as follows:
- .1 At locations or on workers within the work area enclosure (occupational air samples), to assess whether the airborne lead concentrations to which workers are exposed and to evaluate whether appropriate levels of respiratory protection are being used.
 - .2 At locations outside of the work area enclosure (ambient air samples), to assess whether enclosure structures and entry/egress/decontamination procedures are effective in maintaining airborne lead concentrations within applicable limits outside of the enclosure.
 - .3 At locations inside of the work area, to assess airborne lead concentrations subsequent to work completion (clearance air samples)
- .2 Contractor is to make personnel available to wear occupational air sample pumps and media, as requested by Departmental Representative.
- .3 Airborne lead concentrations shall not exceed the action level of 0.025 milligrams per cubic meter (TWA), when respiratory protection factors are considered, either within or adjacent to enclosure structures.
- .1 If airborne lead concentrations are found to exceed applicable action levels or OEL through occupational, ambient or clearance air samples, the contractor will re-clean areas, upgrade dust control, upgrade respiratory protection or otherwise

address the issue such that subsequent sampling will show acceptable airborne concentrations, all at no additional cost to the Owner.

3.5 LEAD SURFACE SAMPLING – WORK AREAS

- .1 Departmental Representative will conduct final lead surface sampling as follows:
 - .1 After Work Area has passed a visual inspection for cleanliness approved by Departmental Representative and acceptable coat of lock-down agent has been applied to surfaces within enclosure, and appropriate setting period of 8 hours has passed.
 - .2 Departmental Representative will perform lead wipe sampling in Work Area.
 - .1 Final lead wipe sampling results from horizontal and vertical surfaces where lead contamination has been removed must show lead levels of less than the criteria indicated in paragraph 1.4.9 of this specification.
 - .2 If wipe sampling results show levels of lead in excess applicable criteria, Contractor is to re-clean work area at contractor's expense and apply another acceptable coat of lock-down agent to surfaces.
 - .3 Repeat as necessary until clearance criteria are met.

3.6 FINAL CLEANUP

- .1 Following specified cleaning procedures, and when lead wipe sampling is below acceptable concentrations proceed with final cleanup.
- .2 Remove polyethylene sheet by rolling it away from walls to centre of work area. Vacuum visible lead containing particles observed during cleanup, immediately, using HEPA vacuum equipment.
- .3 Place polyethylene seals, tape, cleaning material, clothing, and other contaminated waste in plastic bags and sealed labelled waste containers for transport.
- .4 Clean-up Work Areas, Equipment and Access Room, and other contaminated enclosures.
- .5 Clean-up sealed waste containers and equipment used in Work and remove from work areas, via Container and Equipment Decontamination Enclosure System, at appropriate time in cleaning sequence.
- .6 Conduct final check to ensure no dust or debris remains on surfaces as result of dismantling operations.

END OF SECTION



Stantec Consulting Ltd.
200 – 325 25th Street SE
Calgary, AB T2A 7H8

April 20, 2016
File: 144202775.215

Attention: Mr. Chuck Koch
Government of Canada

Dear Mr. Koch,

**Reference: Government of Canada Existing Building Renovation
Initial Lead Surface Dust Contamination Assessment
Edmonton, AB**

As part of a systems upgrade project, Stantec Consulting Limited (Stantec) was retained by the Government of Canada to provide consulting services related to lead abatement within an area of their Facility (subject area) located in Edmonton, AB.

The purpose of this Initial Lead Surface Dust Contamination was to gather information regarding the concentrations of lead in dust on various surfaces throughout the subject area that may be impacted by planned upgrade/renovation work. The information obtained through this assessment will be utilized in the preparation of technical specification documents pertaining lead abatement required to facilitate the systems upgrade project within the subject area, in accordance with applicable occupational health and safety guidelines and regulations.

The site work for this assessment was conducted by Mr. David Siemens of Stantec on June 2, 2015.

1 SCOPE OF WORK

The scope of work for this Initial Lead Surface Dust Assessment involved the following:

- A review of existing information, including site drawings, previous assessment documentation and discussions with site personnel, where available.
- The collection of twelve (12) lead surface wipe samples (plus one (1) blank sample for laboratory and sampling media QA/QC) to evaluate lead dust concentrations.
- Submission of samples collected to an independent laboratory for analysis.
- Evaluation and interpretation of field findings and laboratory analytical results.

2 SAMPLING METHODOLOGY

Site work was carried out in general compliance with the requirements of Alberta Occupational Health and Safety Codes and Regulations and Stantec's Safe Work Practices.

The methodologies used for analysis of samples collected during the Initial Lead Surface Dust Assessment are provided in the following sections.



**Reference: Government of Canada Existing Building Renovation
Initial Lead Surface Dust Contamination Assessment
Edmonton, AB**

2.1 SAMPLING METHODOLOGY

In the absence of specific guidelines published in Alberta with respect to acceptable lead dust concentrations With respect to "acceptable" concentrations of lead in surface dust, various agencies have published "clearance criteria", or standards to which surfaces should be cleaned during lead abatement. For example, the US Environmental Protection Agency (EPA) has published the following criteria for maximum lead dust concentrations (in micrograms per square foot [$\mu\text{g}/\text{ft}^2$]) that can remain on surfaces after remediation:

- Floors: 40 $\mu\text{g}/\text{ft}^2$ (or 4.3 μg per 100 square centimetres ($\mu\text{g}/100\text{cm}^2$))
- Interior windowsills: 250 $\mu\text{g}/\text{ft}^2$ (or 27 $\mu\text{g}/100\text{cm}^2$)
- Window troughs: 400 $\mu\text{g}/\text{ft}^2$ (or 43 $\mu\text{g}/100\text{cm}^2$)

The above-noted criteria are referenced and/or utilized by other agencies for reference – including Worksafe Alberta (through their 2013 document entitled "Lead at the Work Site"), and WorkSafe BC through their 2011 document entitled "Lead-Containing Paints and Coatings – Preventing Exposure in the Construction Industry" (BC Lead Guideline). It should be noted, however, that the BC Lead Guideline also indicates that:

"These levels were originally intended for residential settings, public housing, and locations frequented by children. Many jurisdictions in the U.S. and Canada have adopted these values (or derivatives of them) to protect the health of workers (including pregnant workers) and the general public, as well as children. However, some commercial and industrial buildings may have little or no association with children, so clearance criteria could take this into account."

Further to the above, the BC Lead Guideline provides recommended lead clearance criteria for surfaces equivalent to the above for residences, schools, daycare centres, and other public, but as follows for commercial buildings, including retail stores, offices (administrative), and laboratories (other than lead assay laboratories):

- Floors: 200 $\mu\text{g}/\text{ft}^2$ (or 22 $\mu\text{g}/100\text{cm}^2$)
- Sill/ledge: 500 $\mu\text{g}/\text{ft}^2$ (or 54 $\mu\text{g}/100\text{cm}^2$)
- Troughs: 800 $\mu\text{g}/\text{ft}^2$ (or 86 $\mu\text{g}/100\text{cm}^2$)

In addition to the above, the Environmental Abatement Council of Ontario (EACO) has recently (October 2014) published "Lead Guideline For Construction, Renovation, Maintenance or Repair" (EACO Lead Guideline), which provides additional criteria for "clearance" samples collected subsequent to abatement work. According to the EACO Lead Guideline, lead concentrations for clearance wipe samples, when at or below the clearance criteria listed below, provide analytical confirmation that an area has been adequately cleaned.



**Reference: Government of Canada Existing Building Renovation
Initial Lead Surface Dust Contamination Assessment
Edmonton, AB**

Area or Surface to be Tested	Clearance Criteria	
	$\mu\text{g}/100\text{ cm}^2$	$\mu\text{g}/\text{ft}^2$
Exterior concrete and rough surfaces	86.1	800
Interior concrete, window troughs, rough surfaces	43	400
Interior window sills	26.9	250
Firing ranges and work places where lead is used	21.5	200
Floors and other surfaces: Non-Residential	21.5	200
Floors and other surfaces: Residential	4.3	40
Child care facilities, primary schools, food preparation, food processing, pediatrics, labour and delivery, and maternity areas of hospitals (all surfaces routinely accessible by occupants or used in food processing).	4.3	40

In order to obtain data to compare with the above-referenced criteria, dust samples were collected from various surfaces throughout the subject area. The surfaces were sampled using Ghost Wipe™ sampling media to wipe an area of 100 square centimeters (cm^2) in discrete locations on each selected surface type. Each used Ghost Wipe was then placed into a clean plastic container, which was labelled and sealed appropriately for transport to the laboratory.

This process was repeated for each discrete area and/or surface sampled using a separate (new) Ghost Wipe, and new clean nitrile gloves.

2.2 LABORATORY ANALYSIS

The samples were submitted to EMSL Canada. (EMSL) located in Mississauga, Ontario for lead in dust analysis by Flame Atomic Absorption Spectrophotometry (SW 846 3050B/7000B).

EMSL's analytical laboratory is accredited by the National Voluntary Laboratory Accreditation Program (NVLAP).

3 ASSESSMENT LIMITATIONS

In preparation of this report, Stantec used professional judgment based on experience. The work was conducted in accordance with generally accepted professional standards. Stantec relied on information gathered during the site investigation and laboratory analytical reports.

This report reflects the observations made within accessible and accessed portions of the subject area, and the results of analyses performed on the specific material sampled during the assessment. Analytical results reflect the sampled materials at the specific sample locations.



Reference: Government of Canada Existing Building Renovation
Initial Lead Surface Dust Contamination Assessment
Edmonton, AB

Sampling and assessment associated with this report were limited surfaces within the primary assessment area and associated areas (for lead dust), within the subject area.

This report has been prepared for the exclusive use of the Government of Canada for the purpose of assessing general conditions in the subject area as they pertain to lead dust. Any use that a third party makes of this report, or reliance on, or decisions to be made on it, are the responsibility of such third parties. Stantec accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

4 ASSESSMENT RESULTS

The following table summarizes the sampled surfaces (materials), locations, lead dust concentrations detected by the laboratory and applicable reference standards. A copy of the EMSL Laboratory Report for the samples collected is provided in **Appendix A**.

Sample Number	Sampled Surface/Location	Surface Lead Dust Concentration ($\mu\text{g}/100\text{ cm}^2$)	Reference Standards ($\mu\text{g}/100\text{ cm}^2$)
LW-Blank	Field Blank	13 $\mu\text{g}/\text{wipe}$	N/A
LW-01	East end of primary assessment area (floor)	7,300	US EPA: 4.3 BC Lead Guideline: 22 EACO Lead Guideline: 21.5
LW-02	North wall of primary assessment area (wall)	340	US EPA: 4.3 BC Lead Guideline: 22 EACO Lead Guideline: 21.5
LW-03	West end of primary assessment area (floor)	800	US EPA: 4.3 BC Lead Guideline: 22 EACO Lead Guideline: 21.5
LW-04	west end of primary assessment area (wall)	190	US EPA: 4.3 BC Lead Guideline: 22 EACO Lead Guideline: 21.5
LW-05	center of primary assessment area (on top of ductwork)	6,400	US EPA: 4.3 BC Lead Guideline: 22 EACO Lead Guideline: 21.5
LW-06	observation area (floor)	120	US EPA: 4.3 BC Lead Guideline: 22 EACO Lead Guideline: 21.5



Reference: Government of Canada Existing Building Renovation
Initial Lead Surface Dust Contamination Assessment
Edmonton, AB

Sample Number	Sampled Surface/Location	Surface Lead Dust Concentration ($\mu\text{g}/100\text{ cm}^2$)	Reference Standards ($\mu\text{g}/100\text{ cm}^2$)
LW-07	observation area (floor)	58	US EPA: 4.3 BC Lead Guideline: 22 EACO Lead Guideline: 21.5
LW-08	corridor outside of observation area (floor)	36	US EPA: 4.3 BC Lead Guideline: 22 EACO Lead Guideline: 21.5
LW-09	room west of observation area (floor)	240	US EPA: 4.3 BC Lead Guideline: 22 EACO Lead Guideline: 21.5
LW-10	exhaust vent upstream of HEPA filter	1.228×10^6	US EPA: 4.3 BC Lead Guideline: 22 EACO Lead Guideline: 21.5
LW-11	exhaust vent downstream of HEPA filter	18,000	US EPA: 4.3 BC Lead Guideline: 22 EACO Lead Guideline: 21.5
LW-12	east end of primary assessment area (wall baffle)	61,000	US EPA: 4.3 BC Lead Guideline: 22 EACO Lead Guideline: 21.5

Table notes:

1. Bold text and highlighting indicates samples with lead concentrations exceeding one or more of the applicable criteria for clearance.
2. As samples are for background/initial contamination assessment purposes, they have not been blank-corrected.

The surface dust lead concentrations for the wipe sampling undertaken at the sampling locations noted above ranged between $36\text{ }\mu\text{g}/100\text{ cm}^2$ and $1.228 \times 10^6\text{ }\mu\text{g}/100\text{ cm}^2$.

The lead dust levels were found to be greater than all of the applicable reference criteria listed in in all locations tested.

These results would indicate that the above-noted areas should be included for cleaning under lead abatement precautions, as part of the systems upgrade project.



April 20, 2016
Mr. Chuck Koch
Page 6

**Reference: Government of Canada Existing Building Renovation
Initial Lead Surface Dust Contamination Assessment
Edmonton, AB**

5 RECOMMENDATIONS

As concentrations of lead in dust in excess of accepted "clearance" criteria were identified, lead dust should be abated (removed) from surfaces prior to disturbances that will be required as part of the planned systems upgrade project.

Lead dust abatement should be conducted by appropriately trained professionals (typically, abatement contractor personnel), in accordance with accepted standards and practices for such work.

6 CLOSURE

This report has been prepared for the sole benefit of the Government of Canada. Any use which a third party makes of this report, or any reliance on decisions based on it, is the responsibility of such third parties. Stantec Consulting Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

The information and conclusions contained in this report are based upon work undertaken by trained professionals and technical staff in accordance with generally accepted engineering, scientific and occupational health and safety practices current at the time the work was performed. Conclusions presented in this report should not be construed as legal advice.

The conclusions presented in this report represent the best technical judgment of Stantec Consulting Ltd. based on the data obtained from the work.

The conclusions are based on the site conditions encountered by Stantec Consulting Ltd. at the time the work was performed at the specific assessment and/or sampling locations, and can only be extrapolated to an undefined limited area around these locations. The extent of the limited area depends on building construction and conditions, weather, building usage and other factors. Due to the nature of the investigation and the limited data available, Stantec Consulting Ltd. cannot warrant against undiscovered environmental or health and safety liabilities.

If any conditions become apparent that differ significantly from our understanding of conditions as presented in this report, we request that we be notified immediately to reassess the conclusions provided herein.



April 20, 2016
Mr. Chuck Koch
Page 7

**Reference: Government of Canada Existing Building Renovation
Initial Lead Surface Dust Contamination Assessment
Edmonton, AB**

We trust that the above is satisfactory for your purposes at this time. Should you have any questions or concerns, or require additional information, please do not hesitate to contact the Stantec Project Manager at your convenience.

Regards,

STANTEC CONSULTING LTD.

Lovy Mangat, B.Sc.
Report Author
Phone: (403) 716-1422
Fax: (403) 716-8049
Lovy.Mangat@stantec.com

Sean Brigden, B.Sc., P.B.Dipl., CRSP
Associate
Tel: (306) 667-2495
Fax: (306) 667-2500
Sean.Brigden@stantec.com

Rob Robinson, P.Eng.
Principal
Phone: (905) 817-2070
Fax: (905) 858-4426
Rob.Robinson@stantec.com

LM/SB/RR/bv

Attachment: Appendix A – Laboratory Analytical Report –Flame Atomic Absorption
Spectrophotometer Analysis

\\cd1002-f04\shared_projects\144202775\hazmat\reports\revised\215 - edmonton\rpt_144202775_215_rcmp_lead_initial_assessment_revised_20160420_fnl.docx



APPENDIX A

Laboratory Analytical Reports – Flame Atomic Absorption Spectrophotometer Analysis

**EMSL Canada Inc.**

2756 Slough Street, Mississauga, ON L9T 5N4

Phone/Fax: 289-997-4602 / (289) 997-4607

<http://www.EMSL.com>torontolab@emsl.com

EMSL Canada Or 551506248
CustomerID: 55JACQ30Z
CustomerPO: 144202775
ProjectID:

Attn: **David Siemens**
Stantec Consulting, Ltd.
200-325 25th Street SE
Calgary, AB T2A 7H8

Phone: (403) 781-4143
Fax: (403) 716-8049
Received: 06/11/15 11:05 AM
Collected:

Project: **144202775.215.05****Test Report: Lead in Dust by Flame AAS (SW 846 3050B/7000B)***

<i>Client Sample Description</i>	<i>Lab ID</i>	<i>Collected</i>	<i>Analyzed</i>	<i>Area (cm²)</i>	<i>Lead Concentration</i>
LW-BLANK	551506248-0001	6/16/2015	n/a		13 µg/wipe
Site: BLANK Desc: WIPE SAMPLE FOR LEAD					
LW-01	551506248-0002	6/16/2015	100 cm ²		7300 µg/100 cm ²
Site: EAST END OF PRIMARY ASSESSMENT AREA Desc: WIPE SAMPLE FOR LEAD FLOOR					
LW-02	551506248-0003	6/16/2015	100 cm ²		340 µg/100 cm ²
Site: NORTH WALL OF PRIMARY ASSESSMENT AREA Desc: WIPE SAMPLE FOR LEAD WALL					
LW-03	551506248-0004	6/16/2015	100 cm ²		800 µg/100 cm ²
Site: WEST END OF PRIMARY ASSESSMENT AREA Desc: WIPE SAMPLE FOR LEAD FLOOR					
LW-04	551506248-0005	6/16/2015	100 cm ²		190 µg/100 cm ²
Site: WEST END OF PRIMARY ASSESSMENT AREA Desc: WIPE SAMPLE FOR LEAD WALL					
LW-05	551506248-0006	6/16/2015	100 cm ²		6400 µg/100 cm ²
Site: CENTER OF PRIMARY ASSESSMENT AREA Desc: WIPE SAMPLE FOR LEAD ON TOP OF DUCT WORK					
LW-06	551506248-0007	6/16/2015	100 cm ²		120 µg/100 cm ²
Site: OBSERVATION AREA - FLOOR Desc: WIPE SAMPLE FOR LEAD					
LW-07	551506248-0008	6/16/2015	100 cm ²		58 µg/100 cm ²
Site: OBSERVATION AREA - WALL Desc: WIPE SAMPLE FOR LEAD					
LW-08	551506248-0009	6/16/2015	100 cm ²		36 µg/100 cm ²
Site: CORRIDOR OUTSIDE OF OBSERVATION AREA - FLOOR Desc: WIPE SAMPLE FOR LEAD					
LW-09	551506248-0010	6/16/2015	100 cm ²		240 µg/100 cm ²
Site: ROOM WEST OF OBSERVATION AREA - FLOOR Desc: WIPE SAMPLE FOR LEAD					
LW-10	551506248-0011	6/16/2015	100 cm ²		1.228e+006 µg/100 cm ²
Site: EXHAUST VENT UPSTREAM OF HEPA FILTER Desc: WIPE SAMPLE FOR LEAD					

Shiraz Saloojee
or other approved signatory

*Analysis following Lead in Dust by EMSL SOP/ Determination of Environmental Lead by FLAA. Reporting limit is 10 ug/wipe. ug/wipe = ug/ft² x area sampled in ft². Unless noted, results in this report are not blank corrected. This report relates only to the samples reported above and may not be reproduced, except in full, without written approval by EMSL. EMSL bears no responsibility for sample collection activities (such as volume sampled) or analytical method limitations. Samples received in good condition unless otherwise noted. The lab is not responsible for data reported in µg/ft² which is dependant on the area provided by non-lab personnel. The test results contained within this report meet the requirements of NELAC unless otherwise noted. "<" (less than) results signifies that the analyte was not detected at or above the reporting limit. Measurement of uncertainty is available upon request. The QC data associated with the sample results included in this report meet the recovery and precision requirements unless specifically indicated otherwise.

Samples analyzed by EMSL Canada Inc. Mississauga, ON A2LA Accredited Environmental Testing Cert #2845.08

Report Amended: 04/14/2016 15:22:34 Replaces Report Amended: 06/25/2015 17:04:30. Reason Code: Client-Change to Location

**EMSL Canada Inc.**

2756 Slough Street, Mississauga, ON L9T 5N4

Phone/Fax: 289-997-4602 / (289) 997-4607

<http://www.EMSL.com>torontolab@emsl.com

EMSL Canada Or 551506248
CustomerID: 55JACQ30Z
CustomerPO: 144202775
ProjectID:

Attn: **David Siemens**
Stantec Consulting, Ltd.
200-325 25th Street SE
Calgary, AB T2A 7H8

Phone: (403) 781-4143
Fax: (403) 716-8049
Received: 06/11/15 11:05 AM
Collected:

Project: **144202775.215.05****Test Report: Lead in Dust by Flame AAS (SW 846 3050B/7000B)***

<i>Client Sample Description</i>	<i>Lab ID</i>	<i>Collected</i>	<i>Analyzed</i>	<i>Area (cm²)</i>	<i>Lead Concentration</i>
LW-11	551506248-0012	6/16/2015		100 cm ²	18000 µg/100 cm ²
Site: EXHAUST VENT DOWNSTREAM OF HEPA FILTER Desc: WIPE SAMPLE FOR LEAD					
LW-12	551506248-0013	6/16/2015		100 cm ²	61000 µg/100 cm ²
Site: EAST END OF PRIMARY ASSESSMENT AREA - WALL BAFFLE Desc: WIPE SAMPLE FOR LEAD					

Shiraz Saloojee
or other approved signatory

*Analysis following Lead in Dust by EMSL SOP/ Determination of Environmental Lead by FLAA. Reporting limit is 10 ug/wipe. ug/wipe = ug/ft² x area sampled in ft². Unless noted, results in this report are not blank corrected. This report relates only to the samples reported above and may not be reproduced, except in full, without written approval by EMSL. EMSL bears no responsibility for sample collection activities (such as volume sampled) or analytical method limitations. Samples received in good condition unless otherwise noted. The lab is not responsible for data reported in µg/ft² which is dependant on the area provided by non-lab personnel. The test results contained within this report meet the requirements of NELAC unless otherwise noted. "<" (less than) results signifies that the analyte was not detected at or above the reporting limit. Measurement of uncertainty is available upon request. The QC data associated with the sample results included in this report meet the recovery and precision requirements unless specifically indicated otherwise.

Samples analyzed by EMSL Canada Inc. Mississauga, ON A2LA Accredited Environmental Testing Cert #2845.08

Report Amended: 04/14/2016 15:22:34 Replaces Report Amended: 06/25/2015 17:04:30. Reason Code: Client-Change to Location

Part 1 General

1.1 RELATED SECTIONS

- | | | |
|----|------------------------|------------------|
| .1 | Concrete Reinforcing | Section 03 20 00 |
| .2 | Cast-in-Place Concrete | Section 03 30 00 |
| .3 | Rough Carpentry | Section 06 10 00 |

1.2 WORK INSTALLED BUT SUPPLIED UNDER OTHER SECTIONS

- .1 Install materials specified to be supplied under other sections of these project specifications. Materials include but are not limited to:
 - .1 Fabricated components, anchor bolts, bearing plates, sleeves and other inserts to be built into concrete.
- .2 Ensure installation is to the satisfaction of trades concerned and of the Engineer prior to placing concrete.

1.3 REFERENCE STANDARDS

- .1 Perform all work in accordance with the following standards, except where specified otherwise. All standards to be latest issue at time of tender.
 - .1 NBC 2010, "National Building Code".
 - .2 Canadian Standards Association (CSA International)
 - .1 CSA-A23.1-10/CSA-A23.2-10, "Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete".
 - .2 CSA-A23.3-10, "Design of Concrete Structures".
 - .3 CSA B111-1974 (R2003), "Wire Nails, Spikes and Staples".
 - .4 CAN/CSA-O86-09, "Engineering Design in Wood (Limit States Design)".
 - .5 CSA-O121-08(R2013), "Douglas Fir Plywood".
 - .6 CAN/CSA-O141-05(R2014), "Softwood Lumber".
 - .7 CSA-O151-09(R2014), "Canadian Softwood Plywood".

- .8 CSA-O153-M1980 (R2008), "Poplar Plywood".
- .9 CSA-O325-07(R2012), "Construction Sheathing".
- .10 CSA-O437 Series-93 (R2011), "Standards on OSB and Waferboard".
- .11 CSA-S269.1-2016, "Falsework & Formwork".
- .3 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S701-11, "Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering".
- .4 Provincial safety standards where applicable.
- .5 Conform to applicable safety regulations for erection, maintenance and removal of formwork.

1.4 REGULATIONS

- .1 Abide by the current bylaws and regulations of the province and/or municipality in which the work is located, and abide by the current laws and regulations with regard to public safety.
- .2 The regulations of the Minister of Labour, Occupational Health and Safety Act, the Workers' Compensation Board and other applicable acts administered by the authority having jurisdiction of the province apply to the work of this section.

1.5 SAFETY

- .1 Carry out work in accordance with the current Occupational Health and Safety Act and construction safety regulations.

1.6 QUALIFICATIONS

- .1 Engage a professional structural engineer registered in the Province of Alberta, fully qualified and experienced in the design of formwork and shoring, to be responsible for the design of formwork, scaffolding, shoring, re-shoring and all other components required for formwork erection.

1.7 SUBMITTALS

- .1 Indicate method and schedule of construction, shoring, stripping, and re-shoring procedures, materials, grades, dimensions, arrangement of joints, special architectural exposed finishes, ties, liners, and locations of temporary embedded parts. Comply with CSA-S269.1 for falsework & formwork drawings.

- .2 Indicate formwork design data: permissible rate of concrete placement, stripping requirement, and temperature of concrete in forms.
- .3 Indicate sequence of erection and removal of formwork/falsework as directed by Consultant.
- .4 Submit all proposed joint details, locations and construction procedures. Include waterstop, crack inducer, reglet, sealant and joint filler products as required.
- .5 Review of the shop drawings by the Engineer is intended to assist the Contractor and does not relieve the Contractor of responsibility for the completeness and accuracy of the work and its conformance with the contract drawings and specifications.
- .6 Fabrication that commences prior to shop drawing review by the Engineer is at the risk of the Contractor.

1.8 DELIVERY, STORAGE AND HANDLING

- .1 Deliver all materials to the site in bundles easily identified and properly marked.
- .2 Store and handle all material on site in a manner to prevent damage and contamination.

1.9 QUALITY CONTROL

- .1 The Contractor's professional engineer responsible for the design of formwork is to inspect the fabrication and erection of formwork.
- .2 The Contractor is not to assign the responsibility of coordination of forming, placing reinforcing steel, placing other required material and placing concrete. Ensure a full-time qualified superintendent representing the Contractor is in attendance to inspect and check all phases of this work.

Part 2 Products

2.1 FORMWORK MATERIALS

- .1 Plywood:
 - .1 Douglas fir conforming to CSA-O121 or softwood conforming to CSA-O151 or CSA-O153 as required to resist design loads imposed upon the forming system. Regular grade select tight face. Sound, undamaged sheets with clean, true finish.
- .2 Lumber: SPF species, No. 2 Grade or better, conforming to CSA-O141 and to the design requirements of CAN/CSA-O86.1 to resist applied loads required of the forming system.

-
- .3 Anchorage devices (including nails, bolts, spikes and lag screws): Sized to ensure all formwork loadings are adequately resisted. Nails, spikes and staples conforming to CSA-B111 galvanized or phosphatized.
 - .4 Steel forms: Minimum 1.6 mm well matched, tight fitting and adequately stiffened to support weight of concrete without deflection.
 - .5 Form ties for all concrete below grade or exposed to weather:
 - .1 Snap off metal ties with 40 mm length cone to resist all forces.
 - .2 Removable ties to resist all forces that will permit a recessed or flush finish.
 - .6 Form tie hole sealant: One-component polymeric sealant. Cementitious Non-Shrink Grout. Natural grey or colour to match concrete.
 - .7 Form release agent: Ecologo certified under the Environmental Choice Program (ECP) or, if not Ecologo certified, the Contractor shall:
 - .1 provide a product that conforms to the requirements for concrete release agents in accordance with ECP Certification Criteria Document (CCD) 143 governing Asphalt and Concrete Release Agents, excluding the provisions under Conditions for Ecologo Use and,
 - .2 if requested, provide the Engineer with the same rights as the ECP under CCD 143 with regard to verification of product compliance.
 - .8 Fillets for chamfered corners: Minimum 12 mm x 12 mm wood.
 - .9 Void form: Closed celled expanded polystyrene complete with void spaces specifically designed to allow frost heave and swelling of soil under concrete without inducing uplift on the concrete. Structurally sufficient to support weight of wet concrete 100mm thick.
 - .10 Void forms: Moisture-resistant treated paper faces, biodegradable, structurally sufficient to support weight of wet concrete until initial set, 100mm thick. Use wax mat with minimum compressive strength of 0.12 MPa.
 - .11 Grade beam void form: Expanded polystyrene (EPS) configured to support a maximum load of 25 kPa. Use Geospan by Plastifab or approved alternate.
 - .12 Grade beam and wall void form protection: Provide polyethylene protection under biodegradable void form as required to protect the void form from moisture and premature failure prior to placing concrete

- .13 Structural slab on grade void form protection: Provide plywood or hard board as required over void form to protect the form from crushing under construction activities and reinforcement chairing.
- .14 Void protection: Wood preserved pressure treated plywood, 12 mm thick by 250 mm high each side of biodegradable void form to ensure void space.
 - .1 Wood cement composites:
 - .2 Rigid insulation board: to CAN/ULC-S701
- .15 Form stripping agent: colourless mineral oil, non-toxic, biodegradable, low VOC, free of kerosene, with viscosity between 70 and 110s Saybolt Universal 15 to 24 mm²/s at 40 degrees C, flashpoint minimum 150 degrees C, open cup.
- .16 Falsework materials: to CSA-S269.1.

Part 3 Execution

3.1 FABRICATION AND ERECTION

- .1 Fabricate and erect falsework in accordance with CSA S269.1
- .2 Refer to architectural drawings for concrete members requiring architectural exposed finishes.
- .3 Verify lines, levels and centres before proceeding with formwork. Ensure that dimensions agree with drawings.
- .4 Do not place shores and mud sills on frozen ground.
- .5 Provide site drainage to prevent washout of soil supporting mud sills and shores.
- .6 Fabricate and erect formwork in accordance with CAN/CSA-S269.1 to produce finished concrete conforming to shape, dimensions, locations and levels indicated within tolerances required by CSA-A23.1/A23.2.
- .7 Ensure that supplied equipment, hardware, and items to be cast-in will fit concrete dimensions.
- .8 Construct formwork, shoring and bracing accurately to meet design and code requirements so that resultant finished concrete conforms to shapes, lines, levels and dimensions indicated on drawings.
- .9 Provide bracing to ensure stability of formwork as a whole. Prop or strengthen all previously constructed elements liable to be overstressed by construction loads.

-
- .10 Arrange and assemble formwork so as to permit easy dismantling and stripping so that concrete is not damaged during its removal.
 - .11 Align joints and make watertight to prevent leakage of mortar and disfigured appearance of concrete. Keep form joints to a minimum. Obtain approval of Engineer for location of form joints in exposed work.
 - .12 Chamfer external corners and edges of beams and walls 12 mm when exposed or as noted.
 - .13 Provide 12 mm fillets at interior corners and joints unless specified otherwise.
 - .14 Construct formwork to maintain concrete tolerances in accordance with CSA-A23.1, Clause 10.
 - .15 Construct formwork to maintain the following minimum tolerances:
 - .1 Variation for cross sections and offsets:
 - .1 Up to 0.3 m ± 8 mm.
 - .2 Up to 1.0 m ± 12 mm.
 - .3 Maximum ± 20 mm.
 - .2 Vertical alignment to be within 1:400 with a maximum 40 mm.
 - .3 Horizontal alignment to be within 1:400 with a maximum of 40 mm.
 - .16 Camber beams: 0.2% of span unless otherwise noted.
 - .17 Apply form release agent on formwork in accordance with manufacturer's recommendations. Apply prior to placing reinforcing steel, anchoring devices and embedded parts.
 - .18 Do not apply form release agent where concrete surfaces are to receive special finishes or applied coverings which are affected by agent. Soak inside surfaces of untreated forms with clean water and keep moist prior to placing concrete.
 - .19 Do not re-use formwork with surface defects that will impair the appearance of finished concrete. Do not patch formwork. Meet the requirements of Part 2 of this section when re-using formwork.
 - .20 Verify top of pile elevations. Cut down piles or increase lengths as required to the proper elevations. Ensure piles project into grade beams and pile caps as indicated on drawings.

- .21 Remove all loose concrete from tops of piles. Ensure tops of piles are clean and of sound concrete.
- .22 Provide sufficient space below grade beams and walls for void form and void protection. Place void form prior to reinforcement to ensure specified concrete cover.
- .23 Prepare structural slab on grade subgrade to prevent moisture degradation of void form. Do not use polyethylene protection.
- .24 Form construction joints in accordance with CSA-A23.1 at locations indicated on the drawings or with the written approval of the Engineer as follows:
 - .1 At centre of span of suspended slabs.
 - .2 In grade beams at midspan.
 - .3 In walls immediately above and below floor construction joints.
- .25 Construction joints in walls and grade beams maximum 12 m or as detailed.
- .26 Construction joints in slabs on grade maximum 24 m or as detailed.
- .27 Proposed construction joint locations and details to be approved by the Engineer.

3.2 CLEANING FORMS

- .1 Clean formwork in accordance with CSA-A23.1/A23.2, before placing concrete.
- .2 Clean forms as erection proceeds to remove foreign matter. Remove cuttings, shavings and debris from within forms. Flush completely with water or compressed air to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean-out ports. Do not use water to clean forms where hydrophylic type water stops are specified.
- .3 During cold weather, remove ice and snow from within forms. Do not use de-icing salts. Do not use water to clean out completed forms unless formwork and concrete construction proceed within a heated enclosure. Use compressed air or other means to remove foreign matter.
- .4 Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain. Close temporary ports or openings with tight-fitting panels, flush with inside of forms, neatly fitted so that joints will not be apparent in exposed concrete surfaces.

3.3 INSERTS/EMBEDDED PARTS/OPENINGS

- .1 Provide formed openings/chases or slots where required for pipes, conduits, sleeves and other work to be embedded in and passing through concrete members.
- .2 Refer to architectural, mechanical and electrical drawings for sleeves and openings required through structural components. These are not to reduce the structural capacity. Locations and sizes not shown on the structural drawings are to be approved in writing by the Engineer.
- .3 Maximum size of electrical conduit in structural slabs is 1/5 of solid portion of the slab thickness, and where more than two are adjacent to each other, they are to be spaced 100 mm apart. Conduit is to be placed in the middle third of the slab.
- .4 Provide recesses in top of foundation walls at all doors and openings to allow slab to bear on walls.
- .5 Accurately locate and set in place all items that are to be cast directly in concrete.
- .6 Coordinate work of other sections and cooperate with the trade involved in forming and/or setting openings, slots, recesses, chases, sleeves, bolts, anchors and other inserts. Do not perform work unless specifically indicated on drawings or approved prior to installation.
- .7 Do not place anchor bolts, sleeves and inserts into freshly placed concrete. Tie firmly into place prior to placing concrete.
- .8 Ensure that anchors and inserts will not protrude beyond surfaces designated to receive applied finishes, including paint.
- .9 Install all concrete accessories in accordance with drawings and manufacturer's recommendations, straight, level and plumb. Ensure adequate support to prevent movement during concrete placement.

3.4 FORM REMOVAL AND RESHORING

- .1 Comply with CSA-S269.1 for dismantling all falsework.
- .2 Leave formwork in place for following minimum periods of time after placing concrete.
 - .1 3 days for walls.
- .3 Space reshoring in each principal direction at not more than 3000mm apart.
- .4 Re-use formwork and falsework subject to requirements of CSA-A23.1/A23.2.

- .5 Do not remove forms, shores and bracing until concrete has gained sufficient strength to carry its own weight, construction loads and the design loads that are liable to be imposed upon it. Verify strength of concrete by compression tests to the satisfaction of the Engineer.
- .6 Remove forms not directly supporting weight of concrete as soon as stripping operations will not damage concrete but not before a minimum of three days from final concrete placement to prevent rapid loss of moisture from concrete.
- .7 Arrange forms to allow removal without removal of principal shores where these are required to remain in place.
- .8 Retain shores and forms under structural members for a minimum of 14 days or until the concrete has attained 75% of the required 28 day strength, whichever occurs later.
- .9 Beams, slabs and joists are to remain shored, or re-shoring sequence is to be controlled, to prevent excessive dead load deflections.
- .10 Verify strength by field cylinders or insert type tests in accordance with ASTM C900-T.
- .11 Remove formwork progressively and in accordance with code requirements so that no shock loads or unbalanced loads are imposed on structure.
- .12 Loosen forms carefully. Do not damage concrete by wedging pry bars, hammers or tools against concrete surfaces.
- .13 Re-shore structural members as required for design or construction conditions. Construction is to be re-shored to carry all future anticipated construction loading unless otherwise approved in writing by the Engineer.

3.5 VOID FORM

- .1 Ensure void form is in place and not damaged prior to placing concrete (top protection may be required – by contractor).
- .2 Install void space protection prior to backfilling walls and grade beams (required for biodegradable void form only).
- .3 Install void form top protection for structural slabs on grade.

3.6 CERTIFICATION

- .1 At the completion of formwork and shoring, the Contractor's professional engineer shall certify all formwork components fabricated and erected by the Contractor is in accordance with his design drawings.

- .2 Certify that all formwork, shoring and components are capable of supporting all the construction loads and forces required to complete the cast-in-place concrete work.

END OF SECTION

Part 1 General

1.1 RELATED WORK SPECIFIED IN OTHER SECTIONS

- | | | |
|----|----------------------------------|------------------|
| .1 | Concrete Forming and Accessories | Section 03 10 00 |
| .2 | Cast-in-Place Concrete | Section 03 30 00 |
| .3 | Concrete Finishing | Section 03 35 00 |

1.2 REFERENCE STANDARDS

- .1 Perform all work in accordance with the following standards, except where specified otherwise. All standards to be latest issue at time of tender.
 - .1 NBC 2010, "National Building Code".
 - .2 American Concrete Institute (ACI)
 - .1 SP-66-04, ACI Detailing Manual 2004
 - .1 ACI 315-99, "Details and Detailing of Concrete Reinforcement".
 - .2 ACI 315R-04, "Manual of Structural and Placing Drawings for Reinforced Concrete Structures".
 - .3 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A143/A143M-07, "Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement".
 - .2 ASTM A1064 / A1064M - 14, "Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete".
 - .3 ASTM A123/A123M-15 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - .4 Canadian Standards Association (CSA International)
 - .1 CSA-A23.1-10/CSA-A23.2-10, "Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete".
 - .2 CSA-A23.3-10, "Design of Concrete Structures"
 - .3 CAN/CSA-G30.18-09 (R2014), "Billet-Steel Bars for Concrete Reinforcement, A National Standard of Canada".

- .4 CAN/CSA-G40.20-13/CAN/CSA-G40.21-13, "General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel".
- .5 CSA-W186-M1990 (R2012), "Welding of Reinforcing Bards in Reinforced Concrete Construction".
- .5 Reinforcing Steel Institute of Canada (RSIC)
 - .1 RSIC 2004, "Reinforcing Steel Manual of Standard Practice".
- .6 Concrete Reinforcing Steel Institute (CRSI) where noted.

1.3 REGULATIONS

- .1 Abide by the current bylaws and regulations of the province and/or municipality in which the work is located, and abide by the current laws and regulations with regard to crossing and public safety.
- .2 The regulations of the Minister of Labour, Occupational Health and Safety Act, the Workers' Compensation Board and other applicable acts administered by the authority having jurisdiction of the province apply to the work of this section.

1.4 SAFETY

- .1 Carry out cast-in-place concrete work in accordance with the current Occupational Health and Safety Act and construction safety regulations.

1.5 SUBMITTALS

- .1 Prepare and submit reinforcement drawings in accordance with RSIC Manual of Standard Practice.
- .2 Quality Assurance:
 - .1 Mill Test Report: upon request provide Engineer with certified copy of mill test report of reinforcing steel, minimum 4 weeks prior to beginning reinforcing work.
 - .2 Upon request submit in writing to Engineer proposed source of reinforcement material to be supplied.
- .3 Submit results of ladle analysis of all reinforcement to be spliced by welding, and submit manufacturer's information and test reports for mechanical splices of all reinforcement to be mechanically spliced.
- .4 Submit responses to all site review reports stating that all reported defects and deficiency items were corrected or stating what action was taken.

1.6 SHOP DRAWINGS

- .1 Submit shop drawings including placing of reinforcement and indicate:
 - .1 Bar bending details.

-
- .2 Lists.
 - .3 Quantities of reinforcement.
 - .4 Sizes, spacings, locations of reinforcement and mechanical splices if approved by Engineer.
 - .5 Indicate sizes, spacings and locations of chairs, spacers and hangers.
 - .2 Detail lap lengths and bar development lengths to CSA-A23.3, unless otherwise indicated.
 - .1 Provide Type B tension lap splices, where indicated unless otherwise indicated.
 - .3 Use large scale details for areas of congested reinforcement.
 - .4 Review of the shop drawings by the Engineer is intended to assist the Contractor and does not relieve the Contractor of responsibility for the completeness and accuracy of the work and its conformance with the contract drawings and specifications.
 - .5 Fabrication that commences prior to shop drawing review by the Engineer is at the risk of the Contractor.

1.7 DELIVERY, STORAGE AND HANDLING

- .1 Store and manage hazardous materials in accordance with Section 01 47 15 – Sustainable Requirements: Construction.
- .2 Deliver all materials to the site in bundles easily identified and properly marked.
- .3 Store and handle all material on site in a manner to prevent damage and contamination.
- .4 Do not straighten or re-bend any reinforcement.
- .5 Do not use any reinforcement that has been kinked or bent on site.

1.8 PAYMENT

- .1 Payment for the work of this section shall be on a lump sum basis as tendered which shall be full compensation for all labour, materials, and equipment necessary to complete the work, including all subsidiary and incidental items thereto for which separate payment is not elsewhere provided.

Part 2 Products

2.1 MATERIALS

- .1 Substitute different size bars only if permitted in writing by Engineer.
- .2 Reinforcing steel for straight reinforcing bars only: To CAN/CSA-G30.18, 400MPa yield grade deformed billet steel bars.

-
- .3 Reinforcing steel for welded and bent reinforcing bars: To CAN/CSA-G30.18, 400W MPa yield grade special low alloy deformed billet steel. The equivalent carbon content is not to exceed 0.5.
 - .4 Welded steel wire fabric: To CSA-G30.5, hot dip galvanized to CAN/CSA-G164 flat sheets.
 - .5 Welded deformed steel wire fabric: To CSA-G30.15, hot dip galvanized, to CAN/CSA-G164 flat sheets.
 - .6 Chairs, bolsters, bar supports, spacers to meet requirements of CSA-A23.1/A23.2: Adequate for strength and support of reinforcing. Where concrete is exposed to view, exposed to elements or where rust is possible; use plastic or non-corrosive material, or precast concrete made from concrete of equal strength and durability of concrete to be placed. Chairs used are not to result in voids or unacceptable appearance in exposed concrete surfaces.
 - .7 Slab on grade chairs and bar supports: Precast concrete, plastic chairs, or subject to approval concrete masonry block or brick of correct height. Metal pipe, stone or wood are not acceptable. Chairs shall be compatible with void form where applicable.
 - .8 Tie wire: Minimum 1.6 mm type or patented system approved by the Engineer.
 - .9 Galvanizing of non-prestressed reinforcement: to CAN/CSA-G164, minimum zinc coating 600 g/m².
 - .1 Protect galvanized reinforcing steel with chromate treatment to prevent reaction with Portland cement paste.
 - .2 If chromate treatment is carried out immediately after galvanizing, soak steel in aqueous solution containing minimum 0.2% by weight sodium dichromate or 0.2% chromic acid.
 - .1 Temperature of solution equal to or greater than 32 degrees and galvanized steels immersed for minimum 20 seconds.
 - .3 If galvanized steels are at ambient temperature, add sulphuric acid as bonding agent at concentration of 0.5% to 1%.
 - .1 In this case, no restriction applies to temperature of solution.
 - .4 Chromate solution sold for this purpose may replace solution described above, provided it is of equivalent effectiveness.
 - .1 Provide product description as described in Part 1 – SUBMITTALS.
 - .10 Plain round bars: to CAN/CSA-G40.20/CAN/CSA-G40.21.

2.2 FABRICATION

- .1 Fabricate reinforcement hooks, bends, laps and similar details to CSA-A23.1, ACI Detailing Manual 315 and Metric Supplement of the Reinforcing Steel Institute of Canada (RISC) Manual of Standard Practice and in accordance with the drawings and specifications and the reviewed shop drawings.

-
- .2 Verify dimensions of existing work prior to commencing fabrication.
 - .3 Verify all drawing dimensions and conditions prior to commencing fabrication.
 - .4 Bend all reinforcement cold unless otherwise approved by the Engineer.
 - .5 Provide wall dowels from foundations using same reinforcing as in walls unless noted otherwise on the drawings.
 - .6 Provide horizontal, L-shaped corner bars with legs minimum 600 mm of same cross section and spacing as horizontal bars to a maximum size of 20M or welded wire fabric around wall and grade beam corners unless otherwise detailed on the drawings.
 - .7 Provide all additional support bars as required to support all main reinforcement indicated.
 - .8 Provide stirrup support bars sized to match stirrup size in hooks or corners of beam stirrups unless noted otherwise on drawings.
 - .9 Provide 10M “U” spacers at 3 m on centre horizontally and 1.5 m on centre vertically to hold wall reinforcing mats in position.
 - .10 Locate reinforcing splices not indicated on drawings at points of minimum stress. Location of splices is to be approved by the Engineer.
 - .11 Refer to structural drawings for minimum splices. Splices to be Type B unless noted otherwise.
 - .12 Provide minimum reinforcing to slabs on grade unless otherwise noted: 100 mm slabs 305 x 305 x MW66.7 x MW66.7 “step through” mesh. An alternative using tied reinforcing steel providing the equivalent reinforcing value will be considered if approved in writing by the Engineer.
 - .13 Lap adjacent sheets of welded steel wire fabric to provide an overlap of at least one cross wire spacing plus 50 mm.
 - .14 Obtain Engineer’s approval for locations of reinforcement splices other than those shown on placing drawings.
 - .15 Ship bundles of bar reinforcement, clearly identified in accordance with bar bending details and lists.

Part 3 Execution

3.1 PREPARATION

- .1 Galvanizing to include chromate treatment.
 - .1 Duration of treatment to be 1 hour per 25 mm of bar diameter.

-
- .2 Conduct bending tests to verify galvanized bar ductility is in accordance with ASTM A143/A143M.

3.2 FIELD BENDING

- .1 Do not field bend weld reinforcement except where indicated or authorized by Engineer.
- .2 When field bending is authorized, bend without heat, applying slow and steady pressure.
- .3 Replace bars, which develop cracks or splits.

3.3 PLACING REINFORCEMENT

- .1 Place reinforcing steel in accordance with CSA-A23.1/A23.2.
- .2 Place reinforcement within a tolerance of ± 6 mm for slab steel and ± 12 mm for other steel. Bends and end of bars to be within 50 mm of specified location. Adequately support and secure reinforcement to prevent movement within the allowable tolerances before and during placing of concrete.
- .3 Place and secure all reinforcement in its correct position prior to placing any concrete. Do not adjust or place reinforcement in freshly placed concrete.
- .4 Reinforce around openings as noted on structural drawings.
- .5 Supply and place all necessary support accessories, whether specifically detailed or not, to ensure proper placement of reinforcing steel.
- .6 Use non-corrosive or non-stain supports for reinforcing when concrete is exposed.
- .7 Support slab on grade, structural slab and pile cap reinforcement at 900 mm maximum on centre.
- .8 Supply bar support chairs for top reinforcing bars in sufficient quantity to not exceed 900 mm average spacing in each direction.
- .9 Supply chairs to support temperature reinforcing or mesh to maintain minimum covers specified.
- .10 Ensure supports are such that they are not forced into the supporting formwork, void form or soil and do not break or collapse from the weight of reinforcement and other construction loads.
- .11 Supply horizontal reinforcing spacers in walls to ensure reinforcing does not move during placement.
- .12 Support reinforcement laterally in pairs on opposite faces of walls, columns and beams.
- .13 Provide minimum concrete cover to reinforcing steel in accordance with CSA-A23.1, except where indicated on the drawings.

-
- .14 Where a structural concrete member is required to have a fire-resistance rating as identified on the drawings or in the specifications, provide minimum concrete cover to reinforcing steel in accordance with the Supplement to the National Building Code, "Fire Performance Ratings".
 - .15 Ensure reinforcing is clean, free of loose scale, dirt, oil, rust and other foreign coatings.
 - .16 Place reinforcement for interior and exterior slabs on grade as indicated on drawings. Place and support uniformly above centre line of the slab, and have a minimum concrete top cover of 40 mm interior, 50 mm exterior.
 - .17 Place reinforcing for slab on grade on precast concrete chairs or other approved supports at correct height.
 - .18 Obtain written approval from the Engineer prior to cutting of reinforcing to accommodate openings, or embedded items or to accommodate timber connections. Allow for additional splice material which may be required to reinforce these cut bars as directed by the Engineer.
 - .19 Prior to placing concrete, obtain Engineer's approval of reinforcing material and placement.

3.4 FIELD TOUCH-UP

- .1 Touch up damaged and cut ends of galvanized reinforcing steel with compatible finish to provide continuous coating.

END OF SECTION

Part 1 General

1.1 RELATED WORK SPECIFIED IN OTHER SECTIONS

- | | | |
|----|----------------------------------|------------------|
| .1 | Concrete Forming and Accessories | Section 03 10 00 |
| .2 | Concrete Reinforcing | Section 03 20 00 |
| .3 | Concrete Finishing | Section 03 35 00 |

1.2 REFERENCE STANDARDS

- .1 Perform cast-in-place concrete work in accordance with the following standards, except where specified otherwise. All standards to be latest issue at time of tender. Provide one copy on site of the first four standards listed below.
 - .1 NBC 2010, "National Building Code".
 - .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM C260-10a, "Standard Specification for Air-Entraining Admixtures for Concrete".
 - .2 ASTM C309-11, "Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete".
 - .3 ASTM C330-14, "Standard Specification for Lightweight Aggregates for Structural Concrete".
 - .4 ASTM C494/C494M-13, "Standard Specification for Chemical Aggregates for Concrete".
 - .5 ASTM C1017/C1017M-13, "Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete".
 - .6 ASTM D412-06a(2013), "Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers- Tension".
 - .7 ASTM D624-00 (2012), "Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomer".
 - .8 ASTM D1751-04(2013), "Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)".
 - .9 ASTM D1752-04a(2013), "Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction".
 - .3 Canadian General Standards Board (CGSB)

-
- .1 CAN/CGSB-37.2-M88, “Emulsified Asphalt, Mineral Colloid-Type, Unfilled, for Dampproofing and Waterproofing and for Roof Coatings”.
 - .2 CAN/CGSB-51.34-M86 (R1988), “Vapour Barrier, Polyethylene Sheet for Use in Building Construction”.
 - .4 Canadian Standards Association (CSA International)
 - .1 CSA-A23.1-09/CSA-A23.2-09, “Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete”.
 - .2 CSA-A23.3-09, “Design of Concrete Structures”.
 - .3 CAN3-A438-00(R2004), “Concrete Construction for Housing and Small Buildings”.
 - .4 CSA-A23.4-09, “Precast Concrete – Materials and Construction”.
 - .5 CSA-A371-04(R2014), “Masonry Construction for Buildings”.
 - .6 CSA-A283-06(R2011), “Qualification Code for Concrete Testing Laboratories”.
 - .7 CAN/CSA-A3000-13, “Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005)”.
 - .8 CAN/CSA-A3001-13, “Cementitious Materials or Use in Concrete”.

1.3 ACRONYMS AND TYPES

- .1 Cement: hydraulic cement or blended hydraulic cement (XXb – where b denotes blended).
 - .1 Type GU or GUb – General use cement.
 - .2 Type MS or MSb – Moderate sulphate-resistant cement.
 - .3 Type MH or MHb – Moderate heat of hydration cement.
 - .4 Type HE or HEb – High early-strength cement.
 - .5 Type LH or LHb – Low heat of hydration cement.
 - .6 Type HS or HSb – High sulphate-resistant cement.
- .2 Fly Ash:
 - .1 Type F – with CaO content less than 8%.
 - .2 Type CI – with CaO content ranging from 8 to 20%.
 - .3 Type CH – with CaO greater than 20%.
- .3 GGBFS – Ground, granulated blast-furnace slag.

1.4 REGULATIONS

- .1 Abide by the current bylaws and regulations of the province and/or municipality in which the work is located, and abide by the current laws and regulations with regard to public safety.
- .2 The regulations of the Minister of Labour, Occupational Health and Safety Act, the Workers' Compensation Board and other applicable acts administered by the authority having jurisdiction of the province apply to the work of this section.

1.5 SAFETY

- .1 Carry out cast-in-place concrete work in accordance with the current Occupational Health and Safety Act construction safety regulations.

1.6 CONCRETE MIX DESIGN REQUIREMENTS

- .1 Performance: in accordance with CSA-A23.1/A23.2, and as described in Mixes of Part 2 – PRODUCTS.

1.7 SUBMITTALS

- .1 Submit the proposed mix design for all concrete and grout mix types to the Engineer for approval two weeks prior to their initial use.
- .2 Submit data sheets for all proposed pre-mixed grouts to the Engineer for review.
- .3 Submit samples of fine and coarse aggregate and all admixtures proposed for concrete mixes to the testing firm's laboratory, if requested by the Engineer.
- .4 Prior to conducting trial mixes, submit data on all specified or proposed concrete admixtures with the mix design to the Engineer for approval. Data is to confirm the compatibility of the water reducing admixture, the superplasticizer, the air entraining agent, the cement, the fly ash and the silica fume where used.
- .5 Submit copies of mill certificate test reports of cement, silica fume and fly ash, if requested by the Engineer.
- .6 Submit data on all concrete accessories specified or proposed.
- .7 Submit responses to all site review reports stating that all reported defects and deficiency items were corrected or stating what action was taken.
- .8 Submit testing, inspection, results and reports for review by Engineer and do not proceed without written approval when deviations from mix design or parameters are found.
- .9 Submit proposed quality control procedures.
- .10 Concrete pours: submit accurate records of poured concrete items indicating date and location of pour, quality, air temperature and test samples taken.

- .11 Concrete hauling time: submit for review by Engineer deviations exceeding maximum allowable time of 2 hours for concrete to be delivered to site of Work and discharged after batching.

1.8 QUALITY ASSURANCE

- .1 Quality Assurance: in accordance with Section 01 45 00 – Quality Control.
- .2 Submit to Engineer, minimum 4 weeks prior to starting concrete work, valid and recognized certificate from plant delivering concrete.
 - .1 When plant does not hold valid certification, provide test data and certification by qualified independent inspection and testing laboratory that materials based in concrete mixture will meet specified requirements.
- .3 Minimum 4 weeks prior to starting concrete work, submit proposed quality control procedures for review by Engineer on following items:
 - .1 Falsework erection.
 - .2 Hot weather concrete (air temperature above 25°C).
 - .3 Cold weather concrete (air temperature below 5°C).
 - .4 Curing.
 - .5 Finishes.
 - .6 Formwork removal.
 - .7 Floor topping.

1.9 INSPECTION AND TESTING OF CONCRETE

- .1 Test all concrete by a testing firm certified in accordance with CSA-A283, retained and paid for by the Contractor and approved by the Engineer.
- .2 Provide casual labour to the testing firm's field personnel for the purpose of obtaining, handling, and storing sample materials. Provide free access to all portions of the work, and cooperate with the testing firm.
- .3 Advise testing firm 48 hours in advance of concrete placement.
- .4 The Contractor is to provide properly designed temperature-controlled storage boxes for test cylinders, as specified in CSA-A23.2, for a period of at least 48 hours and further protection from adverse weather and mishandling until removed from the site. The Contractor is to provide a max-min thermometer for each storage box. Storage in a portable building that will be used by the Contractor's personnel or the Engineer during the first 24 hour storage period will not be permitted. Storage facilities are to be provided, installed, checked and approved before any concrete may be placed.
- .5 Secure sufficient 3 and 7-day test cylinders for testing of concrete to ensure quality control and sufficient strength for application of construction loads and formwork stripping. Cost for these additional tests to be borne by the Contractor.

-
- .6 Testing firm to conduct all tests in accordance with CSA-A23.2.
 - .7 Samples of concrete to be taken as close to the point of final deposit in the form as possible, at end of pipe when pumping is used.
 - .8 Testing firm to take a minimum of three (3) test cylinders for a strength test and not less than one strength test for each 50 m³ of concrete, or portion thereof, for each type of concrete placed and not less than one (1) test for each type of concrete placed in any one day.
 - .9 Testing firm to moist cure and test one (1) cylinder in 7 days and to moist cure and test the remaining two (2) cylinders in 28 days or (1) in 7 days, (1) in 28 days and (2) in 56 days.
 - .10 Testing firm is to take one additional test cylinder during cold weather concreting and cure on job site under same conditions as the concrete it represents.
 - .11 Testing firm is to take at least one slump test and one entrained air test for each set of test cylinders taken.
 - .12 Testing firm is to report results of tests immediately to the Contractor. The Contractor is responsible for ensuring that the concrete meets the requirements of the specifications. Report adverse test results to the Engineer immediately.
 - .13 Testing firm is not authorized to revoke, relax, enlarge or release any requirements of the specification, nor to approve or disapprove any portion of the work.
 - .14 Testing firm is to advise placing crews to halt placing of adverse concrete immediately, and thereafter notify Contractor to reject the concrete. The execution, or lack of execution, of this request is to be recorded.
 - .15 Testing firm is to submit to the Engineer and Contractor certified copies of test results. Include the following information with the results:
 - .1 Name of the project.
 - .2 Date of sampling.
 - .3 Mix design, specified strength, slump and air content.
 - .4 Name of supplier, truck and ticket number.
 - .5 Time batched and time placed.
 - .6 Identification of sampling and testing technician.
 - .7 Cement type and admixtures used.
 - .8 Exact location in the structure of the concrete sampled, including floor, elevation, and grids where applicable.
 - .9 Ambient air and concrete temperatures.
 - .10 Nominal aggregate size.
 - .11 Water added and personnel authorizing additional water.

.12 Concrete density.

.16 Testing firm to certify, in writing, that all concrete meets the specified requirements.

.17 Reject and do not place concrete with slumps greater than maximum specified, air content lower than minimum specified and concrete over 2 hours from batch time.

1.10 INSPECTION AND TESTING OF UNIT MASONRY CORE FILL

.1 All clauses pertaining to inspection and testing of concrete contained in this specification are to apply to unit masonry grout unless noted otherwise.

.2 Testing firm to take a minimum of three (3) test cylinders, one slump test and one entrained air test for each 20 m³ placed or portion thereof for a project having more than 20 m³ of grout and for each 10 m³ placed or portion thereof for a project having less than 20 m³ and not less than one (1) test in any one day of grout placed.

.3 Reject and do not place job site-mixed grout over 1.5 hours from mixing time.

1.11 INSPECTION AND TESTING OF GROUT

.1 Test all grout by a testing firm certified in accordance with CSA-A283, retained and paid for by the Contractor and approved by the Engineer in accordance with Section 01400 of these specifications.

.2 In accordance with ASTM C109, provide at least two (2) cube tests on all types of non-shrink grout used. Provide at least 5 tests of cement grout but maximum one (1) test per day.

1.12 INSPECTION AND TESTING OF GUNITE

.1 Take a minimum of three cores for each day's operation or 200 m³ of material placed, and test in accordance with ASTM C42.

1.13 PAYMENT

.1 Payment for the work of this section shall be on a lump sum basis as tendered which shall be full compensation for all labour, materials, and equipment necessary to complete the work, including all subsidiary and incidental items thereto for which separate payment is not elsewhere provided.

1.14 PAY ADJUSTMENTS

.1 When the air content is tested with the prescribed procedure and falls outside the specified limits, concrete will not be accepted for payment at contract prices but will be subject to the following penalties:

.1 Concrete having an air content up to 0.2% beyond the specified limits will be subject to a contract deduction of \$5/m³.

.2 Concrete having an air content greater than 0.2% up to 0.5% beyond the specified limits will be subject to a contract deduction of \$25/m³.

-
- .3 Concrete having an air content greater than 0.5% and up to 1.0% beyond the specified limits will be subject to a contract deduction of \$100/m³.
 - .4 Concrete having an air content greater than 1.0% beyond the specified limit is to be removed and replaced at no additional cost to the contract.
 - .5 The volume of concrete used to adjust the contract amount will be based on the volume of concrete for which the defaulting test is representative, but in no case will the volume be less than one day's placement of 40 m³, which is the specified testing frequency. Testing at a lesser frequency will result in larger volumes, calculated by direct ratios.
- .2 When structural considerations do not govern and the results of strength test do not conform to CSA-A23.1 for the specified strength, the Engineer will review the durability and strength requirements and may require one or more of the following:
 - .1 For durability only, apply a protective surface treatment to the concrete in question at no additional cost to the contract.
 - .2 Removal and replacement of the concrete at no additional cost to the contract.
 - .3 Accept the concrete subject to a contract deduction of \$100/m³.
 - .4 The volume of concrete used to adjust the contract amount will be based on the volume of concrete for which the defaulting test is representative, but in no case will the volume be less than one day's placement or 40 m³, which is the specified testing frequency. Testing at a lesser frequency will result in larger volumes, calculated by direct ratios.

Part 2 Products

2.1 CEMENTING MATERIALS

- .1 Portland silica fume blended cement: Type GUSF to CAN/CSA A3000. Cement and silica fume to meet the requirements identified in clause 2.2 of A362.

2.2 SUPPLEMENTARY CEMENTING MATERIAL

- .1 Silica fume used in the work is to meet all the requirements for a Type U supplementary cementing material as specified in CSA-A3000, with a minimum SiO₂ content of at least 85%, a maximum ignition loss of 6% and a maximum SO₃ content of 1%.

2.3 AGGREGATES

- .1 For all concrete mix types, the fine aggregate is to conform to the requirements identified in CSA-A23.1 for the specified exposure class.
- .2 For all concrete mix types, the coarse aggregate is to conform to the requirements identified in CSA-A23.1 for the specified exposure class. The aggregate is to meet the Group 1 gradation requirements listed in Table II of CSA-A23.1.

.3 Aggregates are not to react with alkalis in the cement to an extent that results in excessive expansion of concrete.

.4 The source of the aggregate and the method of manufacture or production, including the type of equipment used, is not to be altered for the duration of the project following the acceptance of the aggregate.

2.4 WATER

.1 Water for use in concrete production and curing is to be clean and free from injurious amounts of oil, acid, alkali, soluble chlorides, organic matter, sediment or any other deleterious substances as per CSA-A23.1.

2.5 ADMIXTURES

.1 Air-entraining admixtures are to conform to the requirements of ASTM C260. The admixture is to be of uniform consistency and quality within each container and from shipment to shipment.

.2 Water-reducing admixtures are to conform to the requirements of ASTM C494, Type A or D. The admixture is to be of uniform consistency and quality within each container and from shipment to shipment.

2.6 CONCRETE ACCESSORIES

.1 Liquid membrane-forming curing compound: To ASTM C309. Must be compatible with dustproofing and hardening agents, floor hardeners and flooring adhesives and any

.2 Drilled anchors:

.1 Use epoxy grout for embedding all rebar. Use standard embedment depths per manufacturer's specifications throughout. Epoxy grout system must be submitted for engineer's approval prior to use.

.3 Precast concrete plugs: To fit cone holes formed by compatible form ties. Class of concrete, colour and texture to match surrounding concrete.

2.7 GUNITE

.1 Portland cement: To CAN/CSA-A3000, Normal, Type GU.

.2 Water and aggregates: To ACI 506.2.

2.8 MISCELLANEOUS MATERIALS

.1 Dampproof membrane:

.1 Kraft/polyethylene membrane:

.1 Plain: .05 mm thick polyethylene film bonded to asphalt treated creped kraft.

- .2 Reinforced: two .05mm thick polyethylene films bonded each side of asphalt treated creped kraft paper, reinforced with 13 x 13 mm fibreglass scrim.
- .3 Membrane adhesive: as recommended by membrane manufacturer.
- .2 Dampproofing:
- .1 Emulsified asphalt, mineral colloid type, unfilled: to CAN/CGSB-37.2, and to Section 07 11 13 – Bituminous Dampproofing.

2.9 CONCRETE MIXES

Location	Exp. Class	Min. Spec. Strength (MPa)	Max. w/cm Ratio	Air Cont. Cat.	% Air Content At the Point of Discharge Aggregate Size			% Fly Ash Cont.	Cement Type
					28 to 40mm	14 to 20mm	10mm		
<u>Piles</u>									
Freezing & Thawing (with sulphate attack)									
F-S (moderate) - wet	F-1/S-3	30@28 days	0.50	1	4 to 7	5 to 8	6 to 9	40	HS
<u>Slab-on-Grade</u>									
No Exposure (no sulphate attack)									
Interior	N	25@28 days	0.55	N/A	<3	<3	<3	40	GU
<u>Structural</u>									
No Exposure									
Interior	N	25@28 days	0.55	N/A	<3	<3	<3	40	GU GU
Freezing & Thawing									
F – dry	F-2	25@28 days	0.55	2	3 to 6	4 to 7	5 to 8	40	GU
F – wet	F-1	30@28 days	0.50	1	4 to 7	5 to 8	6 to 9	40	GU
<u>Pavements, Sidewalks, Curb & Gutter</u>									
Freezing & Thawing with Chlorides									
F-C – wet	C-2	32@28 days	0.45	1	4 to 7	5 to 8	6 to 9	25	GU or HS
<u>Masonry Core Fill</u>									
No Exposure									
Interior	-	15@28 days	-	1	12mm	<4		25	GU
Freezing & Thawing									
	F-2	15@28 days	-	1	12mm	5 to 8			

Spec Note: For slumps, see table below:

<i>Component</i>	<i>Slump (mm)</i>
<i>Piles</i>	80 – 125
<i>S.O.G.</i>	50 – 90
<i>Architectural</i>	50 – 90
<i>Pavements, Parking Decks and Toppings</i>	20 – 60
<i>Masonry Grout</i>	200 - 250

- .1 The Contractor is to design all concrete mixes and is to pay for all costs associated with the development of the mix designs.
- .2 The Contractor is to supply concrete in accordance with CSA-A23.1, except that the additional requirements of this specification are also to apply.
- .3 Only such materials or blends of materials that will result in a uniform colour of exposed surfaces are to be used.
- .4 Concrete mixes that will be placed by concrete pump are to be designed for pumping.
- .5 In the event that slump and/or air content are outside the specified tolerance range as determined by the inspection and testing firm appointed by the Contractor, the Engineer may, at his sole discretion, accept a proposal for one adjustment of the deficient condition as an alternate to rejection.
- .6 The maximum placement temperature of 18°C is specified to ensure that concrete temperatures do not exceed 60°C during curing, that temperature gradients do not exceed 20°C total and temperature rise or drop do not exceed a maximum heating and cooling rate of 2°C/hour. The maximum placement temperature may be increased to 25°C provided the above temperature requirements are met.
- .7 Supply “Controlled Concrete” in accordance with CSA-A23.1 with properties as noted on the drawings in the following table:
- .8 Water-soluble chloride ion content in exposure class C-XL and C-1 concrete before exposure is not to exceed 0.06% by mass of cementing material.
- .9 Aggregate size specified is maximum nominal allowance. Contractor may use smaller nominal size to ease placing. Air content may have to be increased for smaller aggregate to meet exposure class requirements.
- .10 Minimum cement content:
 - .1 380 kg/m³ (total cementitious material) for Type A.
- .11 Maximum fly ash content as a percentage of the total cementitious material:
 - .1 Concrete with exposure classes C-XL, C-1 and C-2: Maximum 15% fly ash.
 - .2 Concrete with exposure classes C-3, C-4 and F-1: Maximum 25% fly ash.
 - .3 Concrete with exposure classes F-2 and N: Maximum 40% fly ash.

-
- .12 Slump: No slumps outside the range of maximum or minimum will be permitted without written permission of the Engineer. Supply slumps at 20 mm below maximum.
 - .13 Air Content: All mix types with exposure classifications to be air-entrained in accordance with the above table and CSA-A23.1.
 - .14 Use a water-reducing agent in all concrete.
 - .15 Use accelerating admixtures in cold weather only when approved by the Engineer. If approved, the use of admixtures will not relax cold weather placement requirements.
 - .16 Do not use calcium chloride or admixtures containing calcium chloride.
 - .17 Use set-retarding admixtures during hot weather with written approval of the Engineer
 - .18 Use all admixtures in strict accordance with the manufacturer's recommendations.
 - .19 Do not use non-specified admixtures unless approved in writing by the Engineer. Where superplasticizers are thus approved, ensure mix designs are correctly adjusted for placement, strength, durability and air content requirements.
 - .20 Documentation indicating the compatibility of the water reducing admixture, the air entraining admixture, the superplasticizing admixture (if any), the cement, the silica fume (if any) and the fly ash (if any) is to be submitted upon request with the mix design for review by the Engineer.

2.10 GROUT MIXES

- .1 Epoxy grout: Non-shrink, high strength compound consisting of epoxy resins, hardeners and non-metallic aggregate for exterior use. Use for Pre-mixed in strict accordance with the manufacturer's instructions to obtain a minimum compressive strength of 50 MPa in 28 days.
- .2 Dry pack grout: Non-shrink compound consisting of non-metallic aggregate and water. Mixed with sufficient water for the mixture to make a sound, solid pack and capable of developing compressive strength of 50 MPa at 28 days.
- .3 Non-shrink grout: Pre-mixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents. Pre-mixed in strict accordance with manufacturer's instructions to obtain a minimum compressive strength of 16 MPa in 24 hours and 50 MPa in 28 days. Acceptable non-shrink grouts:
 - .1 Masterflow 713 Grout.
 - .2 Master Builders Set Non-Shrink Grout.
 - .3 Sika Grout 212.
 - .4 Sternson M-Bed Standard Grout.
 - .5 CPD Non-Shrink Grout.
 - .6 SonogROUT.

Part 3 Execution

3.1 GENERAL

- .1 Perform cast-in-place concrete work in accordance with requirements of CSA-A23.1 unless indicated otherwise on the drawings.
- .2 Verify top of pile elevations. Cut down piles or increase lengths as required to the proper elevations. Ensure piles project into grade beams and pile caps as indicated on drawings.
- .3 Remove all loose concrete from tops of piles. Ensure tops of piles are clean and of sound concrete.

3.2 PLACING CONCRETE

- .1 Notify Engineer and testing firm a minimum of 48 hours prior to commencement of any concrete placement. Allow time for corrective work for areas of unusual formwork and congested reinforcement.
- .2 Notify geotechnical engineer to inspect and verify all soil conditions and bearing pressures of all foundations prior to placing concrete for mudslabs or foundations.
- .3 Do not place concrete against frozen ground, frozen concrete or frosted forms.
- .4 In locations where new concrete is doweled to existing work, drill holes in existing concrete, insert steel dowels and set solidly with non-shrink grout or as specified on the drawings. The holes for the inserts are to be thoroughly cleaned.
- .5 Ensure all hardware and all other items to be cast into concrete are placed securely and will not cause undue hardship in placing concrete.
- .6 Ensure reinforcement, inserts, embedded parts, formed expansion and contraction joints and other critical items are not disturbed during concrete placement.
- .7 Revise, re-seat and correct improperly positioned reinforcing hardware and other embedded items immediately before concrete placement.
- .8 Ensure specified concrete cover around reinforcing is maintained.
- .9 Place concrete reinforcing in accordance with Section 03 20 00 – Concrete Reinforcing.
- .10 During concrete operations:
 - .1 Development of cold joints not allowed.
 - .2 Ensure concrete delivery and handling facilities placing with minimum of rehandling, and without damage to existing structure or Work.
- .11 Prior to placing of concrete, obtain Engineer's approval of proposed method for protection of concrete during placing and curing.

- .12 Protect previous Work from staining.
- .13 Clean and remove stains prior to application for concrete finishes.

3.3 CONSTRUCTION

- .1 Do not place concrete older than 2 hours from batch time.
- .2 Do not add water after batching unless in strict accordance with CSA-A23.1, and such that concrete conforms with the specified mix design parameters.
- .3 Place concrete and screed in accordance with the lines and levels indicated on the drawings.
- .4 Place concrete in approximate horizontal layers such that each lift can be vibrated into the previous lift.
- .5 Maximum vertical free fall of concrete is not to exceed 1200 mm in unexposed work or 800 mm in exposed work. Confine concrete with a suitable vertical drop pipe to prevent segregation.
- .6 Place concrete directly into its final position in forms. Do not spread concrete with vibrators.
- .7 Compact concrete thoroughly by mechanical vibrators. Ensure concrete is worked around reinforcement, embedded items and into all areas and corners of forms.
- .8 Use internal vibrators in all sections that are sufficiently large, and supplement with external type in the event that satisfactory surfaces can not be obtained.
- .9 Check and re-adjust formwork to required lines and levels during placement of concrete.
- .10 Place concrete as a continuous operation, stopping only at construction joints.
- .11 Allow a minimum of three days between adjacent concrete placements.
- .12 Use cold weather concreting methods in accordance with CSA-A23.1 when the mean daily temperature falls below 5°C, and use hot weather methods when the mean temperature rises above 25°C.
- .13 Maintain accurate records of concrete placement. Record date, location of placement, quantity, air temperature and test samples taken.
- .14 Sleeves and inserts:
 - .1 Do not permit penetrations, sleeves, ducts, pipes or other openings to pass through joists, beams, column capitals or columns, except where indicated or approved by Engineer.
 - .2 Where approved by Engineer set sleeves, ties, pipe hangers and other inserts and openings as indicated or specified elsewhere.
 - .3 Sleeves and openings greater than 100 x 100 mm not indicated, must be reviewed by Engineer.

-
- .4 Do not eliminate or displace reinforcement to accommodate hardware. If inserts cannot be located as specified, obtain approval of modifications from Engineer before placing of concrete.
 - .5 Check locations and sizes of sleeves and openings shown on drawings.
 - .6 Set special inserts for strength testing as indicated and as required by non-destructive method of testing concrete. Anchor bolts:
 - .7 Set anchor bolts to templates under supervision of appropriate trade prior to placing concrete.
 - .8 Protect anchor bolt holes from water accumulations, snow and ice build-ups.
 - .9 Set bolts and fill holes with epoxy grout.
 - .10 Locate anchor bolts used in connection with expansion shoes, rollers and rockers with due regard to ambient temperature at time of erection.

3.4 PLACING OF EXPOSED CONCRETE

- .1 Do not place concrete from one end for full height of placement.
- .2 Use sufficient vibration equipment and methods to ensure dense, smooth concrete lines and surfaces free from bugholes, honeycombs and cold joints.
- .3 Ensure vibrator penetrates each layer of fresh concrete to prevent stratification.
- .4 In hot weather, use set retarding agents to prevent cold joints with permission of the Engineer.

3.5 FINISHING FLATWORK

- .1 Refer to Section 03 35 00 for concrete floor finishes.

3.6 DEFECTIVE CONCRETE

- .1 Immediately after removing forms, all concrete surfaces are to be inspected, and any imperfect joints, voids, stone pockets or other defective areas as specified are to be reported to the Engineer at once and repaired before the concrete is thoroughly dry. Defective areas are to be chipped away to a depth of not less than 25 mm with the edges perpendicular to the surface. The area to be repaired and a space at least 150 mm wide entirely surrounding it are to be wetted to a saturated surface dry condition to prevent absorption of water from the repair material.
- .2 The repair is to be made of the same material and of the same proportions as used for the concrete, except that the coarse aggregate is to be omitted and cement added to match the colour of the surrounding concrete. The amount of mixing water is to be as little as consistent with the requirements for handling and placing. The mortar is to be re-tempered without the addition of water by allowing it to stand for a period of one hour, during which time it is to be mixed with a trowel to prevent setting.

-
- .3 The repair material is to be thoroughly compacted into place and screeded off to leave the repair slightly higher than the surrounding surface. It is then to be left undisturbed for a period of one to two hours to permit initial shrinkage before being finally finished. The repair is then to be finished to match the adjoining surface and cured to the requirements noted in this specification.
 - .4 Watertight structures with honeycombing or embedded debris are not acceptable. Remove and replace concrete between construction joints.
 - .5 Report any shapes and lines outside the specified tolerances and repair or correct as directed by the Engineer.

3.7 EXTERNAL FASTENING AND CORING

- .1 Do not core concrete without prior written approval of the Engineer.
- .2 Do not drill inserts or drive power actuated fasteners into structural concrete without prior written approval of the Engineer.

3.8 CARBON MONOXIDE EQUIPMENT

- .1 Do not place concrete for floor slabs if carbon monoxide producing equipment has been in operation in the building or temporary enclosure during the 12 hours preceding the start of concreting.
- .2 Provide positive ventilation during the 12 hours preceding the start of concreting.
- .3 Unless directly used for the concrete placing, do not operate carbon monoxide producing equipment in the building or temporary enclosure during or within 24 hours after completing the finishing of any floor slab section.

3.9 JOINT FILLERS

- .1 Furnish filler for each joint in single piece for depth and width required for joint, unless otherwise authorized by Engineer.

3.10 CLEANING

- .1 Repair, remove and clean all drips and smears resulting from the work of this section on exposed, finished surfaces or surfaces to be subsequently finished.
- .2 Hose down sandblasted surfaces. Brush thoroughly with a stiff broom to remove all dust and loose particles.

END OF SECTION

1 General

1.1 RELATED REQUIREMENTS

- .1 Section 04 05 12 - Masonry Mortar.
- .2 Section 04 05 19 - Masonry Anchorage and Reinforcing.
- .3 Section 04 22 00 - Concrete Unit Masonry.

1.2 REFERENCES

- .1 CSA Group
 - .1 CAN/CSA-A23.1-14/A23.2-14, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.
 - .2 CSA A165 Series-14, CSA Standards on Concrete Masonry Units (Consists of A165.1, A165.2 and A165.3).
 - .3 CSA A179-14, Mortar and Grout for Unit Masonry.
 - .4 CSA-A370-14, Connectors for Masonry.
 - .5 CSA-A371-14, Masonry Construction for Buildings.
 - .6 CSA-A3000-13, Cementitious Materials Compendium.
 - .7 CSA S304-14, Design of Masonry Structures.
 - .8 CSA S304.1-04(R2010), Design of Masonry Structures.
 - .9 CAN/CSA-G30.18-09, Billet-Steel Bars for Concrete Reinforcement.
- .2 International Masonry Industry All-Weather Council (IMIAC)
 - .1 Recommended Practices and Guide Specification for Cold Weather Masonry Construction.

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-installation meetings: comply with Section 01 31 19 - Project Meetings. Conduct pre-installation meeting one week prior to commencing work of this Section to:
 - .1 Verify project requirements, including mock-up requirements.
 - .2 Verify substrate conditions.
 - .3 Co-ordinate products, installation methods and techniques.
 - .4 Sequence work of related sections.
 - .5 Co-ordinate with other building subtrades.
 - .6 Review manufacturer's installation instructions.
 - .7 Review masonry cutting operations, methods and tools and determine worker safety and protection from dust during cutting operations.
 - .8 Review warranty requirements.
 - .9 Review cutting, patching and alterations to existing masonry and tie ins to existing masonry.

- .2 Sequencing: sequence with other work in accordance with Section 01 32 16.06 - Construction Progress Schedule - Critical Path Method (CPM). Comply with manufacturer's written recommendations for sequencing construction operations.
- .3 Scheduling: schedule with other work in accordance with Section 01 32 16.06 - Construction Progress Schedule - Critical Path Method (CPM).

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for masonry and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit 2 copies of WHMIS MSDS in accordance with Section 01 35 29.06 - Health and Safety Requirements.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Alberta, Canada.
 - .2 Submit shop drawings detailing temporary bracing required, designed to resist wind pressure and lateral forces during installation.
- .4 Certificates: submit manufacturer's product certificates certifying materials comply with specified requirements.
- .5 Test and Evaluation Reports:
 - .1 Submit certified test reports in accordance with Section 01 29 83 - Payment Procedures for Testing Laboratory Services.
 - .2 Test reports to certify compliance of masonry units and mortar ingredients with specified performance characteristics and physical properties.
 - .3 Submit data for masonry units, in addition to requirements set out in referenced CSA and ASTM Standards, indicating initial rates of absorption.
- .6 Installer Instructions: provide manufacturer's installation instructions, including storage, handling, safety and cleaning.
- .7 Manufacturer's Reports: provide written reports prepared by manufacturer's on-site personnel to include:
 - .1 Verification of compliance of work with Contract.
 - .2 Site visit reports providing detailed review of installation of work, and installed work.

1.5 CLOSEOUT SUBMITTALS

-
- .1 Submit manufacturer's instructions for care, cleaning and maintenance of prefaced masonry units for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.6 EXTRA MATERIALS

- .1 Submit manufacturer's instructions in accordance with Section 01 78 00 - Closeout Submittals covering maintenance requirements and parts catalogue, with cuts and identifying numbers.

1.7 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect material from nicks, scratches, and blemishes.
 - .3 Keep materials dry until use.
 - .4 Store under waterproof cover on pallets or plank platforms held off ground by means of plank or timber skids.
 - .5 Replace defective or damaged materials with new.

1.8 SITE CONDITIONS

- .1 Ambient Conditions: assemble and erect components when temperatures are above 4 degrees C.
- .2 Weather Requirements: to CAN/CSA-A371 and to IMIAC - Recommended Practices and Guide Specifications for Cold Weather Masonry Construction.
- .3 Cold weather requirements:
 - .1 To CAN/CSA-A371 with following requirements.
 - .1 Maintain temperature of mortar between 5 degrees C and 50 degrees C until batch is used or becomes stable.
 - .2 Maintain ambient temperature of masonry work and it's constituent materials between 5 degrees C and 50 degrees C and protect site from windchill.
 - .3 Maintain temperature of masonry above 0 degrees C for minimum of 3 days, after mortar is installed.
 - .4 Preheat unheated wall sections in enclosure for minimum 72 hours above 10 degrees C, before applying mortar.
 - .2 Hot weather requirements:

- .1 Protect freshly laid masonry from drying too rapidly, by means of waterproof, non-staining coverings.
- .2 Keep masonry dry using waterproof, non-staining coverings that extend over walls and down sides sufficient to protect walls from wind driven rain, until masonry work is completed and protected by flashings or other permanent construction.
- .3 Spray mortar surface at intervals and keep moist for maximum of 3 days after installation.

1.9 WARRANTY

- .1 For Work in this Section, 12 months warranty period is extended to 24 months.

2 Products

2.1 MATERIALS

- .1 Masonry materials are specified elsewhere in related Sections:
 - .1 Section 04 05 12 - Masonry Mortar.
 - .2 Section 04 05 19 - Masonry Anchorage and Reinforcing.
 - .3 Section 04 22 00 - Concrete Unit Masonry.

3 Execution

3.1 INSTALLERS

- .1 Experienced and qualified masons to carry out erection, assembly and installation of masonry work.

3.2 EXAMINATION

- .1 Examine conditions, substrates and work to receive work of this Section.
 - .1 Co-ordinate with Section 01 71 00 - Examination and Preparation.
- .2 Examine openings to receive masonry units. Verify opening size, location, and that opening is square and plumb, and ready to receive work of this Section.
 - .1 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .2 Proceed with installation after unacceptable conditions have been remedied and after receipt of written approval from Departmental Representative.
- .3 Verification of Conditions:
 - .1 Verify that:
 - .1 Substrate conditions which have been previously installed under other sections or contracts, are acceptable for product installation in accordance with manufacturer's instructions prior to installation of concrete block.
 - .2 Field conditions are acceptable and are ready to receive work.

.3 Built-in items are in proper location, and ready for roughing into masonry work.

.2 Commencing installation means acceptance of existing substrates.

3.3 PREPARATION

.1 Surface Preparation: prepare surface in accordance with manufacturer's written recommendations and co-ordinate with Section 01 71 00 - Examination and Preparation.

.2 Establish and protect lines, levels, and coursing.

.3 Protect adjacent materials from damage and disfiguration.

3.4 INSTALLATION

.1 Do masonry work in accordance with CAN/CSA-A371 except where specified otherwise.

.2 Build masonry plumb, level, and true to line, with vertical joints in alignment, respecting construction tolerances permitted by CAN/CSA-A371.

.3 Layout coursing and bond to achieve correct coursing heights, and continuity of bond above and below openings, with minimum of cutting.

3.5 CONSTRUCTION

.1 Exposed masonry:

.1 Remove chipped, cracked, and otherwise damaged units, in accordance with CAN/CSA-A165, in exposed masonry and replace with undamaged units.

.2 Jointing:

.1 Allow joints to set just enough to remove excess water, then tool with round jointer to provide smooth, joints true to line, compressed, uniformly concave joints where concave joints are indicated.

.2 Allow joints to set just enough to remove excess water, then rake joints uniformly to 6 mm depth and compress with square tool to provide smooth, compressed, raked joints of uniform depth where raked joints are indicated.

.3 Strike flush joints concealed in walls and joints in walls to receive plaster, tile, insulation, or other applied material except paint or similar thin finish coating.

.4 Where new masonry ties into adjacent masonry, ensure joints in new masonry align with joints in existing masonry. Tooth new masonry into existing masonry to maintain continuity of the bond.

.3 Cutting:

.1 Cut out for electrical switches, outlet boxes, and other recessed or built-in objects.

.2 Make cuts straight, clean, and free from uneven edges.

- .4 Building-In:
 - .1 Build in items required to be built into masonry.
 - .2 Prevent displacement of built-in items during construction. Check plumb, location and alignment frequently, as work progresses.
 - .3 Brace door jambs to maintain plumb. Fill spaces between jambs and masonry with mortar.
- .5 Support of loads:
 - .1 Use 20 MPa concrete to Section 03 30 00 - Cast-in-Place Concrete, where concrete fill is used in lieu of solid units and to locations where concrete core fills are indicated.
 - .2 Use concrete core fills to CAN/CSA-A179 where concrete core fills are used in lieu of solid units.
 - .3 Install building paper below voids to be filled with concrete; keep paper 25 mm back from faces of units.
- .6 Provision for movement:
 - .1 Leave 6 mm space between top of non-load bearing walls and partitions and structural elements. Do not use wedges.
 - .2 Built masonry to tie in with stabilizers, with provision for vertical movement.
- .7 Loose steel lintels:
 - .1 Install loose steel lintels. Center over opening width.
- .8 Control joints:
 - .1 Construct continuous control joints as indicated or as otherwise directed by the Departmental Representative.
- .9 Movement joints:
 - .1 Build-in continuous movement joints as indicated.
- .10 Interface with other work:
 - .1 Cut openings in existing work as indicated.
 - .2 Openings in walls: reviewed and accepted by Departmental Representative.
 - .3 Make good existing work. Use materials to match existing.

3.6 SITE TOLERANCES

- .1 Tolerances in notes to CAN/CSA-A371 apply.

3.7 EXISTING WORK ALTERATIONS

- .1 Provide for making good and patching of work in existing building including cutting and patching for Mechanical and Electrical trades, whenever required, in accordance with good workmanship. Use materials to match existing.

-
- .2 Infill existing openings and install new lintels, doors and the like, in existing masonry construction as indicated. Neatly and accurately saw cut existing masonry to accommodate new construction.
 - .3 Patch and make good existing masonry where required to accommodate new construction, and where damaged or disturbed due to work of this contract.
 - .4 Install new block jambs and lintels above new doors to match existing construction.
 - .5 Toothing all new infills into existing masonry and install infills to render them undetectable in the walls.

3.1 FIELD QUALITY CONTROL

- .1 Site Tests, Inspection:
 - .1 Perform field inspection and testing in accordance with Section 01 45 00 - Quality Control.
 - .2 Notify inspection agency minimum of 72 hours in advance of requirement for tests.
- .2 Manufacturer's Services:
 - .1 Have manufacturer of products supplied under this Section review work involved in handling, installation/application, and protection of its products, and submit written reports in acceptable format to verify compliance of work with Contract.
 - .2 Manufacturer's field services: 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 installation is about to begin.
 - .4 Schedule site visits to review work at stages listed:
 - .1 After delivery and storage of products, and when preparatory work on which work of this Section depends is complete, but before installation begins.
 - .2 Twice during progress of work at 25% and 60% complete.
 - .3 Upon completion of work, after cleaning is carried out.
 - .5 Obtain reports within 3 days of review and submit immediately to Departmental Representative.

3.2 CLEANING

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

3.3 PROTECTION

- .1 Temporary Bracing:
 - .1 Provide temporary bracing of masonry work during and after erection until permanent lateral support is in place.
 - .2 Bracing approved by Departmental Representative.

- .3 Brace masonry walls as necessary to resist wind pressure and lateral forces during construction.
- .2 Moisture Protection:
 - .1 Keep masonry dry using waterproof, non staining coverings that extend over walls and down sides sufficient to protect walls from wind driven rain, until completed and protected by flashing or other permanent construction.
 - .2 Cover completed and partially completed work not enclosed or sheltered with waterproof covering at end of each work day. Anchor securely in position.
 - .3 Air Temperature Protection: protect completed masonry as recommended in 1.9, SITE CONDITIONS.

END OF SECTION

1 General

1.1 RELATED REQUIREMENTS

- .1 Section 04 05 00 - Common Work Results for Masonry.
- .2 Section 04 05 19 - Masonry Anchorage and Reinforcing.
- .3 Section 04 22 00 - Concrete Unit Masonry.

1.2 REFERENCES

- .1 CSA Group
 - .1 CAN/CSA-A23.1-14/A23.2-14, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.
 - .2 CSA A179-14, Mortar and Grout for Unit Masonry.
 - .3 CAN/CSA-A371-14, Masonry Construction for Buildings.
 - .4 CSA-A3000-13, Cementitious Materials Compendium.
- .2 International Masonry Industry All-Weather Council (IMIAC)
 - .1 Recommended Practices and Guide Specifications for Cold Weather Masonry Construction.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for masonry mortar and grout and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit 2 copies of WHMIS MSDS in accordance with Section 01 35 29.06 - Health and Safety Requirements.
- .3 Manufacturers' Instructions: submit manufacturer's installation instructions.

1.4 QUALITY ASSURANCE

- .1 Test Reports: submit certified test reports including sand gradation tests in accordance with CAN/CSA-A179 showing compliance with specified performance characteristics and physical properties, and in accordance with Section 04 05 00 - Common Work Results for Masonry.
- .2 Certificates: submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.5 DELIVERY, STORAGE AND HANDLING

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

1.6 SITE CONDITIONS

- .1 Ambient Conditions: maintain materials and surrounding air temperature to:
 - .1 Minimum 5 degrees C prior to, during, and 48 hours after completion of masonry work.
 - .2 Maximum 32 degrees C prior to, during, and 48 hours after completion of masonry work.
- .2 Weather Requirements: CAN/CSA-A371 and International Masonry Industry All-Weather Council (IMIAC) - Recommended Practices and Guide Specifications for Cold Weather Masonry Construction.

2 Products

2.1 MATERIALS

- .1 Use same brands of materials and source of aggregate for entire project.
- .2 Cement:
 - .1 Portland Cement: to CAN/CSA-A3000, Type GU - General use hydraulic cement (Type 10).
 - .2 Packaged Dry Combined Materials for mortar: to CAN/CSA-A179, Type N for brick and concrete block veneer, type S to all interior concrete block and concrete block backup walls.
- .3 Aggregate: supplied by one supplier.
 - .1 Fine Aggregate: to CAN/CSA-A179, natural sand.
- .4 Water: clean and potable.
- .5 Lime: to CAN/CSA-A179, Type N.

2.2 MORTAR MIXES

- .1 Mortar for interior concrete block: type S based on proportion specifications.

2.3 MORTAR MIXING

- .1 Use pre-blended, pre-coloured mortar prepackaged under controlled factory conditions. Ingredients batching limitations to be within 1% accuracy.
- .2 Mix mortar ingredients in accordance with CAN/CSA-A179 in quantities needed for immediate use.
- .3 Maintain sand uniformly damp immediately before mixing process.
- .4 Do not use anti-freeze compounds including calcium chloride or chloride based compounds.
- .5 Do not add air entraining admixture to mortar mix.
- .6 Use a batch type mixer in accordance with CAN/CSA-A179.
- .7 Pointing mortar: prehydrate pointing mortar by mixing ingredients dry, then mix again adding just enough water to produce damp unworkable mix that will retain its form when pressed into ball. Allow to stand for not less than 1 hour no more than 2 hours then remix with sufficient water to produce mortar of proper consistency for pointing.
- .8 Re-temper mortar only within two hours of mixing, when water is lost by evaporation.
- .9 Use mortar within 2 hours after mixing at temperatures of 32 degrees C, or 2-1/2 hours at temperatures under 5 degrees C.

2.4 CONCRETE MIXES

- .1 Bond Beams: concrete mix 10 to 12.5 MPa strength at 28 days; 200-250 mm slump; premixed type in accordance with CSA A23.1/A23.2.
- .2 Lintels: concrete mix 10 to 12.5 MPa strength at 28 days; 200-250 mm slump; premixed type in accordance with CSA A23.1/A23.2.

2.5 MIX TESTS

- .1 Testing Mortar Mix:
 - .1 Test mortar to requirements of Section 01 45 00 - Quality Control, and in accordance with CAN/CSA-A179, for mortar based on property specification or proportion specification. Test during construction for:
 - .1 Compressive strength.
 - .2 Consistency.
 - .3 Mortar aggregate ratio.
 - .4 Sand/cement ratio.
 - .5 Water content and water/cement ratio.
 - .6 Air content.

.7 Splitting tensile strength.

.2 Testing Concrete Mix:

- .1 Test concrete to requirements of Section 01 45 00 - Quality Control, and in accordance with CAN/CSA-A179, for grout based on property specification. Test during construction for:
 - .1 Compressive strength.
 - .2 Sand/cement ratio.
 - .3 Water content and water/cement ratio.
 - .4 Slump.

3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for masonry 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 PREPARATION

- .1 Plug clean-out holes with brick and block masonry units. Brace masonry for wet grout pressure.

3.3 CONSTRUCTION

- .1 Do masonry mortar and grout work in accordance with CAN/CSA-A179 except where specified otherwise.

3.4 MIXING

- .1 All pointing mortar can be mixed using a regular paddle mixer. Only electric motor mixers are permissible. Mixers run on hydrocarbons are not permitted, due to fumes.
- .2 Clean all mixing boards and mechanical mixing machine between batches.
- .3 Mortar must be weaker than the units it is binding.
- .4 Contractor to appoint one individual to mix mortar, for duration of project. In the event that this individual must be changed, mortar mixing must cease until the new individual is trained, and mortar mix is tested.

3.5 MORTAR PLACEMENT

- .1 Install mortar to manufacturer's instructions.
- .2 Install mortar to requirements of CAN/CSA-A179.
- .3 Remove excess mortar from grout spaces.

3.6 CONCRETE PLACEMENT

- .1 Install concrete in accordance with manufacturer's instructions.
- .2 Install concrete infill in accordance with CAN/CSA-A179.
- .3 Work concrete into masonry cores and cavities to eliminate voids.
- .4 Do not install concrete in lifts greater than 400 mm, without consolidating concrete by rodding.
- .5 Do not displace reinforcement while placing grout.

3.7 FIELD QUALITY CONTROL

- .1 Site Tests, Inspection: in accordance with Section 04 05 00 - Common Work Results for Masonry supplemented as follows:
 - .1 Test and evaluate mortar during construction in accordance with CAN/CSA-A179.
 - .2 Test and evaluate concrete infill during construction to CAN/CSA-A179; test in conjunction with masonry unit sections specified.
- .2 Manufacturer's Field Services: in accordance with Section 04 05 00 - Common Work Results for Masonry.

3.8 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Remove droppings and splashings using clean sponge and water.
- .3 Clean masonry with low pressure clean water and soft natural bristle brush.
- .4 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

3.9 PROTECTION

- .1 Cover completed and partially completed work not enclosed or sheltered with waterproof covering at end of each work day. Anchor securely in position.

END OF SECTION

1 General

1.1 REFERENCES

- .1 ASTM International
 - .1 ASTM A123/A123M-13: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - .2 ASTM A951/A951M-14: Standard Specification for Steel Wire for Masonry Joint Reinforcement.
 - .3 ASTM A1011/A1011M-14: Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
- .2 CSA Group
 - .1 CAN/CSA-A23.1-14/A23.2-14: Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.
 - .2 CAN/CSA-A179-14, Mortar and Grout for Unit Masonry.
 - .3 CAN/CSA-A370-14, Connectors for Masonry.
 - .4 CAN/CSA-A371-14, Masonry Construction for Buildings.
 - .5 CSA G30.18-09, Carbon Steel Bars for Concrete Reinforcement.
 - .8 CSA S304-14: Design of Masonry Structures.
 - .9 CSA S304.1-04(R2010): Design of Masonry Structures.
- .3 Reinforcing Steel Institute of Canada (RSIC)
 - .1 Reinforcing Steel Manual of Standard Practice, 2004.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for anchorage and reinforcing materials and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Alberta, Canada.
 - .2 Submit drawings detailing bar bending details, anchorage details lists and placement drawings.
 - .3 On placement drawings, indicate sizes, spacing, location and quantities of reinforcement and connectors.
- .4 Manufacturers' Instructions: submit manufacturer's installation instructions.

1.3 QUALITY ASSURANCE

- .1 Test Reports: submit certified test reports including sand gradation tests in accordance with CAN/CSA-A179 showing compliance with specified performance characteristics and physical properties, and in accordance with Section 04 05 00 - Common Work Results for Masonry.
- .2 Certificates: submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.4 SITE MEASUREMENTS

- .1 Make site measurements necessary to ensure proper fit of members.

1.5 DELIVERY, STORAGE AND HANDLING

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

2 Products

2.1 MATERIALS

- .1 Bar reinforcement: Steel to CAN/CSA-A371 and CSA G30.18, Grade 300.
- .2 Connectors: to CAN/CSA-A370 and CSA S304.1.
- .3 Corrosion protection: to CSA S304.1, galvanized to CSA S304.1 and CAN/CSA-A370.
- .4 Fasteners: installed post-construction:
 - .1 Screw Shields and Plugs: plastic or nylon, water-resistant install in mortar joints or placed directly into solid masonry units.
 - .2 Bolts and Screws: size and type to suit application, locate where indicated.
 - .3 Nails: case-hardened cut or spiral nails, size and type to suit fastening application.
 - .4 Powder-Driven Fasteners: pin styles and lengths to suit fastening application in accordance with manufacturers use, load and hold recommendations.
 - .5 Adhesives: epoxies, mastics and contact cements for fastening applications, use in accordance with manufacturers' recommendations.

- .5 Ties: hot dip galvanized to CAN/CSA-A370 Table 5.2 steel finish.
 - .1 Joint Reinforcement Ties: to CAN/CSA-A370:
 - .1 Single Wythe Joint Reinforcement: ladder type:
 - .1 Steel wire, hot dip galvanized: to ASTM A641, Class 3 after fabrication.
 - .2 Cold drawn steel wire conforming to ASTM A82.
- .6 Anchors: to CAN/CSA-A370:
 - .1 Conventional Anchors: type steel bolts with bent bar anchors or plate anchors or through bolts, shape J or L, size and type to suit application.
 - .2 Wedge Anchors: expansion anchors type, sized to suit application.
 - .3 Sleeve Anchors: type sleeve and bolt, sized to suit application.
- .7 Conventional Bolts:
 - .1 Bolts: to ASTM A36, bar stock shop threaded, bent bar anchors, J shaped.
 - .2 Plate anchors: steel to ASTM A36, weld square of circular steel plate perpendicular to axis of steel bar threaded on opposite end.
 - .3 Through bolt rods: to ASTM A307 threaded rod or threaded ASTM A36 bar stock.

2.2 FABRICATION

- .1 Fabricate reinforcing in accordance with CSA A23.1/A23.2 and Reinforcing Steel Manual of Standard Practice by the Reinforcing Steel Institute of Canada.
- .2 Fabricate connectors in accordance with CAN/CSA-A370.
- .3 Obtain Departmental Representative's approval for locations of reinforcement splices other than shown on placing drawings.
- .4 Upon approval of Departmental Representative, weld reinforcement in accordance with CSA W186.
- .5 Ship reinforcement and connectors, clearly identified in accordance with drawings.

2.3 SOURCE QUALITY CONTROL

- .1 Upon request, provide Departmental Representative with certified copy of mill test report of reinforcement steel and connectors, showing physical and chemical analysis, minimum 5 weeks prior to commencing reinforcement work.
- .2 Upon request inform Departmental Representative of proposed source of material to be supplied.

3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for anchorage and reinforcing materials 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 PREPARATION

- .1 Direct and coordinate placement of metal anchors for masonry supplied to other Sections.

3.3 INSTALLATION

- .1 Supply and install masonry connectors and reinforcement in accordance with CAN/CSA-A370, CAN/CSA-A371, CSA A23.1/A23.2 and CSA S304.1 unless indicated otherwise.
- .2 Prior to placing concrete and mortar, obtain Departmental Representative's approval of placement of reinforcement and connectors.
- .3 Supply and install additional reinforcement to masonry as indicated.

3.4 BONDING AND TYING

- .1 Install unit, adjustable, single wythe joint reinforcement where indicated and in accordance with CAN/CSA-A370 and CAN/CSA-A371 and manufacturer's instructions.
 - .1 Install horizontal joint reinforcement 400 mm on centre.
 - .2 Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 400 mm each side of opening.
 - .3 Place joint reinforcement continuous in first and second joint below top of walls.
 - .4 Lap joint reinforcement ends minimum 150 mm.
 - .5 Connect joint corners and intersections with strap anchors 400 mm on centre.

3.5 REINFORCED LINTELS AND BOND BEAMS

- .1 Reinforce masonry beams, masonry lintels and bond beams as indicated.
- .2 Place and grout reinforcement in accordance with CSA S304.1, CAN/CSA-A371, and CAN/CSA-A179.
- .3 Support and position reinforcing bars in accordance with CAN/CSA-A371.

3.6 CONCRETE INFILL

- .1 Install concrete infill into masonry in accordance with CSA S304.1, CAN/CSA-A371 and CAN/CSA-A179 and as indicated.

3.7 ANCHORS

- .1 Supply and install metal anchors in accordance with CAN/CSA-A370 and CAN/CSA-A371.

3.8 LATERAL SUPPORT AND ANCHORAGE

- .1 Supply and install lateral support and anchorage in accordance with CSA S304.1 and as indicated.

3.9 MOVEMENT JOINTS

- .1 Reinforcement will not be continuous across movement joints unless otherwise indicated.

3.10 FIELD BENDING

- .1 Do not field bend reinforcement and connectors except where indicated or authorized by Departmental Representative.
- .2 When field bending is authorized, bend without heat, applying a slow and steady pressure.
- .3 Replace bars and connectors which develop cracks or splits.

3.11 FIELD QUALITY CONTROL

- .1 Site inspections in accordance with Section 04 05 00 - Common Work Results for Masonry.
- .2 Obtain Departmental Representative approval of placement of reinforcement and connectors, prior to placing concrete infill.

3.12 FIELD TOUCH-UP

- .1 Touch up damaged and cut ends of epoxy coated or galvanized reinforcement steel and connectors with compatible finish to provide continuous coating.

3.13 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .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 - Cleaning.

GOVERNMENT OF CANADA

Existing Building Renovation

Alberta, Canada

Project No.: 144202775.215

Section 04 05 19

MASONRY ANCHORAGE AND REINFORCING

Page 6 of 5

END OF SECTION

1 General

1.1 REFERENCES

- .1 ASTM International
 - .1 ASTM E336-11, Standard Test Method for Measurement of Airborne Sound Attenuation Between Rooms in Buildings.
- .2 CSA Group
 - .1 CAN/CSA-A165 Series-14, CSA Standards on Concrete Masonry Units consists: A165.1, A165.2, A165.3.
 - .2 CAN/CSA-A371-14, Masonry Construction for Buildings.
 - .3 CSA S304.1-04(R2010), Design of Masonry Structures.
- .3 South Coast Air Quality Management District (SCAQMD)
 - .1 SCAQMD Rule 1168-05, Adhesive and Sealant Applications.
- .4 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S101-14, Standard Methods of Fire Endurance Tests of Building Construction and Materials.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

1.3 QUALITY ASSURANCE

- .1 Test Reports: submit certified test reports including sand gradation tests in accordance with CAN/CSA-A179 showing compliance with specified performance characteristics and physical properties, and in accordance with Section 04 05 00 - Common Work Results for Masonry.
- .2 Certificates: submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements 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.
 - .1 Offload concrete unit masonry packages using equipment that will not damage the surfaces.
 - .2 Do not use brick tongs to move or handle masonry.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Do not double stack cubes of concrete unit masonry.
 - .3 Cover masonry units with non-staining waterproof membrane covering.
 - .4 Allow air circulation around units.
 - .5 Installation of wet or stained masonry units is prohibited.
 - .6 Keep concrete unit masonry in individual cardboard packaging provided by manufacturer until units are ready to be installed.
 - .7 Store and protect concrete unit masonry from nicks, scratches, and blemishes.
 - .8 Replace defective or damaged materials with new.

2 Products

2.1 MATERIALS

- .1 Standard concrete block units: to CAN/CSA-A165 Series (CAN/CSA-A165.1) .
 - .1 Facet Designation:
 - .1 Units exposed to view: Hollow concrete blocks to have a facet designation H/15/C/M. Solid concrete block to have facet designation S/15/C/M.
 - .2 Units unexposed to view: Hollow concrete blocks to have a facet designation H/15/C/O. Solid concrete block to have facet designation S/15/C/O.
 - .2 Dimensions Nominal:
 - .1 Concrete block: 200 mm wide (unless noted otherwise) x 200 mm high x 400 mm long.
 - .3 Special shapes: provide square edge except to exposed corner use bull-nosed block and to wall ends, door openings and the like, use double bull-nosed units. Provide purpose-made shapes for lintels, beams and bond beams. Provide additional special shapes as indicated.
- .2 Fire rated concrete block units: to CAN/CSA-A165 Series (CAN/CSA-A165.1) as modified below.
 - .1 Classification: H/15/B/M except as modified by fire resistance requirements specified below.
 - .2 Fire resistant characteristics: aggregate used in units and equivalent thickness of units to the Alberta Building Code 2014 and National Building Code of Canada

2010, and in accordance with CAN/ULC-S101, for fire-resistance ratings indicated.

.3 Size: modular.

.4 Special shapes: provide square to all locations except bull-nosed units for exposed corners and double bullnosed to door openings. Provide purpose-made shapes for lintels and bond beams and provide additional shapes as indicated.

2.2 REINFORCEMENT

.1 Reinforcement in accordance with Section 04 05 19 - Masonry Anchorage and Reinforcing.

2.3 CONNECTORS

.1 Connectors in accordance with Section 04 05 19 - Masonry Anchorage and Reinforcing.

2.4 MORTAR MIXES

.1 Mortar and mortar mixes in accordance with Section 04 05 12 - Masonry Mortar.

2.5 CONCRETE INFILL MIXES

.1 Concrete infill mixes in accordance with Section 04 05 12 - Masonry Mortar.

2.6 CLEANING COMPOUNDS

.1 Use low VOC products.

.2 Compatible with substrate and acceptable to masonry manufacturer for use on products.

.3 Cleaning compounds compatible with concrete unit masonry and in accordance with manufacturer's written recommendations and instructions.

2.7 TOLERANCES

.1 Tolerances for standard concrete unit masonry tolerances in accordance with CAN/CSA-A165.1, supplemented as follows:

.1 Maximum variation between units within specific job lot not to exceed 2 mm.

.2 No parallel edge length, width or height dimension for individual unit to differ by more than 2 mm.

.3 Out of square tolerance not to exceed 2 mm.

3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for concrete unit masonry 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 PREPARATION

- .1 Protect adjacent finished materials from damage due to masonry work.

3.3 INSTALLATION

- .1 Concrete block units:
 - .1 Bond: running or as otherwise required to match existing.
 - .2 Coursing height: 200 mm for one block and one joint.
 - .3 Jointing: concave where exposed or where paint or other finish coating is specified.
- .2 Special Shapes:
 - .1 Install special units to form corners, returns, offsets, reveals and indents without cut ends being exposed and without losing bond or module.
 - .2 Install reinforced concrete block lintels over openings in masonry where steel or reinforced concrete lintels are not indicated.
 - .3 End bearing: not less than 200 mm.
 - .4 Install special shaped units including site cut units.

3.4 REINFORCEMENT

- .1 Install reinforcing in accordance with Section 04 05 19 - Masonry Anchorage and Reinforcing .

3.5 CONNECTORS

- .1 Install connectors in accordance with Section 04 05 19 - Masonry Anchorage and Reinforcing.

3.6 MORTAR PLACEMENT

- .1 Place mortar in accordance with Section 04 05 12 - Masonry Mortar.

3.7 CONCRETE INFILL PLACEMENT

- .1 Place concrete infill in accordance with Section 04 05 12 - Masonry Mortar.

3.8 CONSTRUCTION

- .1 Cull out masonry units, in accordance with CAN/CSA-A165 and reviewed and accepted range of colour samples, with chips, cracks, broken corners, excessive colour and texture variation.
- .2 Build in miscellaneous items such as bearing plates, steel angles, bolts, anchors, inserts, sleeves and conduits.
- .3 Construct masonry walls using running bond unless otherwise noted.
- .4 Build around frames previously set and braced. Fill behind hollow frames within masonry walls with mortar or grout and embed anchors.
- .5 Fit masonry closely against electrical and plumbing outlets so collars, plates and covers overlap and conceal cuts.
- .6 Install movement joints and keep free of mortar where indicated.
- .7 Hollow Units: spread mortar setting bed from outside edge of face shells. Gauge amount of mortar on top and end of unit to create full joints, equivalent to shell thickness. Avoid excess mortar.
- .8 Solid Units: apply mortar over entire vertical and horizontal surfaces. Avoid bridging of airspace between brick veneer and backup wall with mortar.
- .9 Ensure compacted head joints. Use full or face-shell joint as indicated.
- .10 Tamp units firmly into place.
- .11 Do not adjust masonry units after mortar has set. Where resetting of masonry is required, remove, clean and reset units in new mortar.
- .12 Tool exposed joints concave; strike concealed joints flush.
- .13 After mortar has achieved initial set up, tool joints.
- .14 Do not interrupt bond below or above openings.

3.9 REPAIR/RESTORATION

- .1 Upon completion of masonry, fill holes and cracks, remove loose mortar and repair defective work.

3.10 FIELD QUALITY CONTROL

- .1 Site Tests, Inspection: in accordance with Section 04 05 00 - Common Work Results for Masonry supplemented as follows:

- .1 Concrete masonry units will be sampled and tested by independent testing agency appointed and paid by Departmental Representative in accordance with CSA S304.1.
 - .2 Noise reduction between two rooms will be tested by independent testing agency appointed and paid by Departmental Representative in accordance with ASTM E336.
 - .3 Notify inspection agency minimum of 24 hours in advance of requirement for tests.
- .2 Manufacturer's Field Services: in accordance with Section 04 05 00 - Common Work Results for Masonry.

3.11 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
 - .2 Standard Concrete Unit Masonry:
 - .1 Allow mortar droppings on masonry to partially dry then remove by means of trowel, followed by rubbing lightly with small piece of block. Clean wall surface with suitable brush or burlap.
 - .3 Architectural Concrete Unit Masonry:
 - .1 Allow mortar droppings on masonry to partially dry then remove by means of trowel, followed by rubbing lightly with small piece of block. Clean wall surface with suitable brush or burlap.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

3.12 PROTECTION

- .1 Brace and protect concrete unit masonry in accordance with Section 04 05 00 - Common Work Results for Masonry.

END OF SECTION

1 General

1.1 RELATED REQUIREMENTS

.1 Section 09 91 23 - Interior Painting

1.2 REFERENCES

.1 ASME Standards:

- .1 ASME B18.6.3: Machine Screws and Machine Screw Nuts.
- .2 ASME B18.6.7M: Metric Machine Screws.
- .3 ASME B18.2.1: Square and Hex Bolts and Screws, Inch Series.
- .4 ASME B18.2.3.8M: Metric Hex Lag Screws.
- .5 ASME B18.6.1: Wood Screws, Inch Series.

.2 ASTM International:

- .1 ASTM A36/A36M-14: Standard Specification for Carbon Structural Steel.
- .2 ASTM A108-13: Steel Bars, Carbon, Cold-Finished, Standard Quality.
- .3 ASTM A123/A123M-13: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- .4 ASTM A283/A283M-13: Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
- .5 ASTM A307-14: Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
- .6 ASTM A325-14: Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
- .7 ASTM A325M-14: Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength [Metric].
- .8 ASTM A385/A385M-11e1: Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip).
- .9 ASTM A490-14a: Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength.
- .10 ASTM A490M-14a: Standard Specification for High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints (Metric).
- .11 ASTM A563M-15: Standard Specification for Carbon and Alloy Steel Nuts [Metric].
- .12 ASTM A563-07(2013): Standard Specification for Carbon and Alloy Steel Nuts.
- .13 ASTM A780/A780M-09(2015): Repair of Damaged Hot-Dipped Galvanized Coatings.
- .14 ASTM C645-14: Standard Specification for Nonstructural Steel Framing Members.
- .15 ASTM D6386-10: Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting.
- .16 ASTM E488/E488M-10: Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements.
- .17 ASTM F436-11: Standard Specification for Hardened Steel Washers.
- .18 ASTM F436M-11: Standard Specification for Hardened Steel Washers [Metric].

-
- .19 ASTM F959M-13: Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use With Structural Fasteners [Metric].
 - .20 ASTM F1554-07ae1: Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
 - .3 CGSB Standards:
 - .1 CAN/CGSB-1.40-97: Anticorrosive Structural Steel Alkyd Primer.
 - .2 CAN/CGSB-1.181-99: Ready-Mixed Organic Zinc-Rich Coating.
 - .4 CSA Standards:
 - .1 CAN/CSA-G40.20-13: General Requirements for Rolled or Welded Structural Quality Steel.
 - .2 CAN/CSA-G40.21-13: Structural Quality Steels.
 - .3 CAN/CSA-S16-14: Design of Steel Structures.
 - .4 CSA W47.1-09(R2014): Certification of Companies for Fusion Welding of Steel.
 - .5 CSA W48-14: Filler Metals and Allied Materials for Metal Arc Welding.
 - .6 CSA W55.3-08(R2013): Certification of companies for resistance welding of steel and aluminum.
 - .7 CSA W59-13: Welded Steel Construction (Metal-Arc Welding).
 - .8 CSA W178.1-14: Certification of Welding Inspection Organizations.
 - .9 CSA W178.2-14: Certification of Welding Inspectors (Developed in cooperation with the Canadian Welding Bureau).
 - .5 Steel Structures Painting Council (SSPC): Systems and Specifications Manual, Volume 2.
 - .6 The Master Painters Institute (MPI)
 - .1 Architectural Painting Specification Manual - current edition.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for sections, plates, pipe, tubing, bolts and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in the Province of Alberta, Canada.
 - .2 Indicate materials, core thicknesses, finishes, connections, joints, method of anchorage, number of anchors, supports, reinforcement, details, and accessories.

1.4 QUALITY ASSURANCE

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

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

1.5 DELIVERY, STORAGE AND HANDLING

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

2 Products

2.1 MATERIALS

- .1 Miscellaneous steel: to ASTM A36/A36M or to CAN/CSA-G40.20 and CAN/CSA-G40.21, 300W yield strength.
- .2 Hollow Structural Sections (HSS): to ASTM A36/A36M or to CAN/CSA-G40.20 and CAN/CSA-G40.21, 350W yield strength, Class C.
- .3 Structural steel: to ASTM A36/A36M or to CAN/CSA-G40.20 and CAN/CSA-G40.21, 350W yield strength.
- .4 Welding materials: to CSA W59.
- .5 Welding electrodes: to CSA W48 Series.
- .6 Machine bolts: conforming to requirements of ASTM A307, Grade A.
- .7 High tensile bolts for structural connections: conforming to the requirements of ASTM A325/A325M.
- .8 Nuts: conforming to ASTM A194/A194M, Grade 2H nuts.
- .9 Washers: conforming to ASTM F436 and ASTM F436M; type 1 washers.
- .10 Inserts: Hilti HSL-3, Hilti Kwik Bolt 3 or Hilti Kwik Bolt TZ, as required to suit installation.
- .11 Anchoring System: Hilti HIT system HIT H Y70 complete with mesh screen for concrete and solid or concrete filled or grout filled masonry and hollow masonry.

-
- .12 Shear Connectors: Nelson stud.
 - .13 Anchor bolts: conforming to ASTM F1554, Grade 36.
 - .14 Machine screws: conforming to ASME B18.6.3 (ASME B18.6.7M).
 - .15 Lag bolts: conforming to ASME B18.2.1 (ASME B18.2.3.8M).
 - .16 Wood screws: flat head, carbon steel,, conforming to ASME B18.6.1.
 - .17 Grout: non-shrink, non-metallic grout, factory packaged, non-staining, non-corrosive, non-gaseous, grout complying to ASTM C1107, capable of developing compressive strength of 50 MPa at 28 days. Provide grout specifically recommended by manufacturer for interior applications.

2.2 FABRICATION

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

2.3 FINISHES

- .1 Shop galvanizing: hot dipped galvanizing with a minimum zinc coating of 600 g/m² to ASTM A123/A123M.
- .2 Galvanizing Repair paint: high zinc dust content paint for re-galvanizing welds on steel, complying with SSPC - Paint 20.
- .3 Chromium plating: chrome on steel with plating sequence of 0.009 mm thickness of copper 0.010 mm thickness of nickel and 0.0025 mm thickness of chromium.
- .4 Shop coat primer:
 - .1 Interior: MPI- INT 5.1TT, Rust-Inhibitive Primer W.B.
- .5 Zinc primer:
 - .1 Interior: MPI-INT 5.3N, W.B. Galvanized Primer.

2.4 ISOLATION COATING

- .1 Isolate aluminum from following components, by means of bituminous paint:

- .1 Dissimilar metals except stainless steel, zinc, or white bronze of small area.
- .2 Concrete, mortar and masonry.
- .3 Wood.

2.5 FABRICATION

- .1 Perform work to the highest standard of modern shop and field practice, performed by personnel specializing in this work. Accurately fit joints and intersecting members and make in true planes, with adequate fastening. Fabricate work, plumb, true, square, straight, level, accurate to sizes detailed, free from distortion or defects.
- .2 File or grind and sand exposed welds, sharp edges and burrs, smooth and flush. All welds must be ground smooth and flush with adjacent surfaces.
- .3 Fabricate items in accordance with CAN/CSA-S16, of sizes and profiles indicated on drawings and reviewed shop drawings, of sufficient size and strength to perform function for which they are designed with joints neatly fitted and properly secured.
- .4 Shop assemble in largest practical sections for delivery to site.
- .5 Provide flush butt type hairline exposed joints where mechanically fastened.
- .6 Ease exposed edges to a radius of approximately 1 mm, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- .7 Provide flush countersunk screws or bolts to all exposed mechanical fastenings, located consistent with design.
- .8 Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.
- .9 Supply all components required for proper anchorage of metal fabrications. Fabricate anchorage and related components of same material and finish as metal fabrication.
- .10 Where work of other Sections is to be attached to Work of this Section, prepare work by drilling and tapping holes as required to facilitate installation of such work.
- .11 Verify all dimensions on site prior to fabrication.
- .12 Supply all components in ample time for construction schedule as required, for proper anchorage of metal fabrications. Fabricate anchorage and related components of same material and finish as metal fabrication, unless indicated otherwise.
- .13 Thoroughly clean all surfaces of rust, scale, grease and foreign matter prior to prime painting or galvanizing.

2.6 WELDING

- .1 Perform welding in accordance with the requirements of CSA W59.
- .2 Perform welding inspection in accordance with the requirements of CSA W178.1 and W178.2.
- .3 Perform resistance welding to CSA W55.3.
- .4 Weld joints to provide adequate strength and durability with jointing tight and flush. Where it is necessary to weld components already galvanized, remove galvanizing for 50 mm around weld.
- .5 Weld corners and seams to comply with the following:
 - .1 Use materials and methods that minimize distortion and develop strength and corrosion resistance of base materials.
 - .2 Obtain fusion without undercut or overlap.
 - .3 Remove welding flux immediately.
 - .4 At exposed connections, finish exposed welds and surfaces smooth and blend so no roughness shows after finishing and contour of welded surfaces matches that of adjacent surfaces.

2.7 SURFACE PREPARATION

- .1 Thoroughly clean and suitably pretreat steel prior to finishing.
- .2 Remove loose mill scale, rust, oil, grease, dirt and other foreign matter using SSPC - SP No. 6, Commercial Blast Cleaning, followed by SSPC - SP No. 1, solvent cleaning. Shop prime all commercial blast cleaned surfaces immediately after cleaning operations.
- .3 Grind and sand all sharp projections smooth.

2.8 FINISHES

- .1 Shop paint items, all miscellaneous metal items with the exception of those which are to be galvanized.
- .2 Prepare galvanized steel surfaces to be painted, in accordance with ASTM D6386.
- .3 Do prime painting to CSA-S16.
- .4 Use primer as prepared by manufacturer without thinning or adding admixtures. Paint on dry surfaces, free from rust, scale or grease. Do not paint when temperature is lower than 7°C.
- .5 After fabrication, clean, remove rust, mill scale, grease or extraneous material. Unless specified otherwise, apply to all items, in shop, a full smooth coat of primer (see materials). Work paint into corners and open spaces.

-
- .6 Apply two (2) coats of primer to parts inaccessible after assembly.
 - .7 Apply one (1) coat of primer to steel surfaces except where encased in concrete. Leave these surfaces clean and uncoated.
 - .8 Touch-up burnt or scratched surfaces. Touch up bare or worn areas on site after installation, and apply field painting also to field-installed bolts, welds, screws, etc.
 - .9 Make good corrosive protection after welding where burnt by welding operations and where removed to facilitate welding operations, using 2 coats of zinc rich touch-up primer conforming to CAN/CGSB-1.181-99.
 - .10 Back prime with bituminous paint all aluminum surfaces in contact with concrete or masonry.
 - .11 Use primer unadulterated, as prepared by manufacturer.

2.9 LOOSE BEARING PLATES AND LEVELLING PLATES

- .1 Fabricate loose bearing and levelling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts for grouting.

2.10 ANCHOR BOLTS, LAG SCREWS, AND FASTENERS

- .1 Provide anchor bolts, bolts, bolt washers and nuts, lag screws, expansion shields, toggles, straps, sleeves, brackets and fasteners where required and where indicated. Where anchor bolts remain exposed, cut off bolts flush with top of nut once the anchoring is complete.

2.11 MISCELLANEOUS FRAMING AND SUPPORTS

- .1 Fabricate and install all miscellaneous steel framing and supports that are not part of structural steel framework, as necessary to complete the Work.
- .2 Fabricate units from structural steel shapes, plates, and bars of welded construction, unless noted otherwise. Fabricate to sizes, shapes and profiles indicated and as necessary to receive adjacent construction retained by framing supports. Cut, drill and tap units to receive hardware, hangers, and similar items.
 - .1 Fabricate units from slotted channel framing where indicated.

2.12 MISCELLANEOUS FRAMING

- .1 Provide all miscellaneous metal framing and plates, for attachment of items such as ceiling baffles and the like, as detailed on the reviewed shop drawings and as required to support all superimposed loading.
- .2 Refer to structural drawings for miscellaneous metal items which are to be fabricated, supplied and installed under this Section.

- .3 Fabricate all other metal fabrication items or miscellaneous metal items required to complete the project.

3 Execution

3.1 EXAMINATION

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

3.2 ERECTION

- .1 Do welding work in accordance with CSA W59 unless specified otherwise.
- .2 Erect metalwork square, plumb, straight, and true, accurately fitted, with tight joints and intersections.
- .3 Provide suitable means of anchorage acceptable to Departmental Representative such as dowels, anchor clips, bar anchors, expansion bolts and shields, and toggles.
- .4 Exposed fastening devices to match finish and be compatible with material through which they pass.
- .5 Supply components for work by other trades in accordance with shop drawings and schedule.
- .6 Make field connections with bolts to CSA S16 or weld field connection as detailed on the drawings and reviewed shop drawings.
- .7 Deliver items over for casting into concrete and building into masonry together with setting templates to appropriate location and construction personnel.
- .8 Touch-up field welds, bolts and burnt or scratched surfaces with primer after completion.
- .9 Touch-up galvanized surfaces with zinc rich primer where burned by field welding.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .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 - Cleaning.

3.4 PROTECTION

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

END OF SECTION

1 General

1.1 RELATED REQUIREMENTS

- .1 Section 06 40 00 - Architectural Woodwork.

1.2 REFERENCES

- .1 ASTM International:
 - .1 ASTM A240/A240M-15a: Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - .2 ASTM A276/A276M-15: Standard Specification for Stainless Bars and Shapes.
 - .3 ASTM A480/A480M-14b: Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
 - .4 ASTM A484/A484M-15: Standard Specification for General Requirements for Stainless Steel Bars, Billets, and Forgings.
 - .5 ASTM A494/A494M-14a: Standard Specification for Castings, Nickel and Nickel Alloy.
 - .6 ASTM A666-10: Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
 - .7 ASTM F593-13a: Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
 - .8 ASTM F594-09e1: Standard Specification for Stainless Steel Nuts.
- .2 CSA Standards:
 - .1 CAN/CSA-G40.21-13: Structural Quality Steels.
 - .2 CSA W47.1-09(2014): Certification of Companies for Fusion Welding of Steel.
 - .3 CSA W59-13: Welded Steel Construction (Metal-Arc Welding).

1.3 SUBMITTALS

- .1 Submit shop drawings, product data and samples in accordance with Section 01 33 00.
- .2 Indicate all stainless steel fabrications, including counter tops and the like.
- .3 Clearly indicate profiles, fittings, sizes, connection, components, core metal thicknesses, finishes, dimensions, fabrication details, installation details, attachments, anchorage, size and type of fasteners and accessories and finishes.
- .4 Include erection drawings, elevations and details where applicable.
- .5 Submit 300 mm x 300 mm sample of each type of stainless steel sheet, and one of each type of fitting and fastener illustrating the quality, material and finish, to the Departmental Representative for review.

1.4 QUALITY ASSURANCE

- .1 Qualifications of Welders:
 - .1 Perform welding of load supporting elements by companies certified by the Canadian Welding Bureau in accordance with CSA W47.1.
 - .2 Use welders qualified by the Canadian Welding Bureau for classification of work being performed.
- .2 Workmanship Standards:
 - .1 Welding to CSA W59.

1.5 DELIVERY/STORAGE

- .1 Schedule delivery of components to site to coincide with installation of this work.
- .2 Install stainless steel components, immediately upon delivery without intermediate storage on site.
- .3 Do not deliver material to site until all painting has been completed.
- .4 Store all stainless steel items in a dry location, off and away from ground contact to ensure that staining does not occur.
- .5 Protect by a suitable means until required for installation. Brace and stack to prevent warping, bending, twisting and all other damage.
- .6 Protect work of other trades, and work of this trade, from damage of any kind.
- .7 Do not enclose in plastic without ventilation.
- .8 Follow special storage and handling requirements of the manufacturer.
- .9 Make good or replace Work that becomes dented, misaligned or otherwise damaged, as directed by the Departmental Representative.

1.6 MAINTENANCE DATA

- .1 Submit maintenance data for maintenance, cleaning and care of stainless steel components in accordance with Section 01 78 00 - Closeout Submittals.

2 PRODUCTS

2.1 MATERIALS

- .1 Stainless steel sheet: all stainless steel components to be type 316 stainless steel with No. 4 (brushed) finish, except where noted otherwise.

-
- .2 Fasteners: to ASTM A666, type 316 stainless steel, of size and capacity as indicated on the reviewed shop drawings and as required to withstand all super imposed loading and to conform with all code requirements.
 - .3 Isolation Coating: Alkali resistant bituminous paint or epoxy resin solution.
 - .4 Welding Rods: of same analysis or high chromium nickel content than metal being welded.
 - .5 Adhesives: high pressure bonding type, suitable for materials being bonded. Contact adhesives not acceptable.
 - .6 Protective Film: treated paper or clear plastic, self adhesive release type, as recommended by the architectural metal fabrications, to protect finish metals. Film to be easily removable without damaging finished surfaces.

2.2 Fabrication/General

- .1 Refer to the drawings for extent of work, quantity of items and building structure or finishes to which fabrications will be secured.
- .2 Provide highest grade of Workmanship using modern Architectural shop and field practices know to recognized manufacturers specializing in this Work.
- .3 Fabricate accurate to detail, clean and straight with sharply defined profiles, free from waves, buckles, distortion or other defects detrimental to appearance and performance.
- .4 Field joint only where indicated on the reviewed shop drawings and where acceptable to the Departmental Representative.
- .5 File or grind all exposed welds and brazing smooth and flush. Repair or fill all pits, cracks and holes. Grind and polish all work to a smooth flush and even surface. Smooth all inside corners and returns.
- .6 Insulated when necessary to prevent electrolysis due to metal to metal contact or metal to masonry or concrete contact. Use bituminous paint or other approved method.
- .7 All joints (except where welded) to be flush hair-line butt joints, with adjoining surfaces aligned to same plane.
- .8 Use extreme care in handling sheet metal and metal sections so as not to stress material or mar finishes.
- .9 Fabrications to be provided and installed complete with proper anchors, fastenings, trim, closures and accessories as required to provide a fully finished installation.

2.3 SCHEDULE OF COMPONENTS

- .1 Stainless Steel Counter tops:
 - .1 Provide 1.52 mm (16 ga), type 316 stainless steel with No. 4 finish, laminated to plywood core, backsplash on back and edge as follows (refer to Section 06 40 00 for plywood backing):
 - .1 Form edges of exposed tops into a 25 mm thick channel shape with wood inserts on all four edges of underside of top to facility anchoring to the base units.
 - .2 Perform welding without discolouration and grind, polish and passivate to blend harmoniously with the work surface finish.
 - .3 Form mechanical or filed joints to tight butt joint to top surfaces, reinforced and held in alignment with steel reinforcements.
 - .4 Protect the surface of the tops with strippable plastic coating to protect the tops during shipment and installation.
 - .5 Coordinate installation of stainless steel tops with Cabinet work specified in Section 06 40 00.

2.4 PROTECTION

- .1 Cover exposed metal surfaces with pressure sensitive heavy protection paper or apply strippable plastic coating before shipping to job site.
- .2 Leave protective covering in place until final cleaning.

3 Execution

3.1 PREPARATION

- .1 Prior to installation of work of this Section, examine work done under other Sections and report all discrepancies to the Departmental Representative.
- .2 Commencement of work of this Section implies acceptance of the work done by others and of existing conditions.

3.2 INSTALLATION

- .1 Install all stainless steel fabrications, as indicated on the drawings and in accordance with the reviewed shop drawings.
- .2 Securely install items square and level, accurately fitted and free from distortion or defects detrimental to appearance and performance.
- .3 Install stainless steel counter tops as indicated on the drawings and reviewed shop drawings. Use as long lengths as possible with as few joints as possible. Locate joints where indicated on the reviewed shop drawings.

- .4 All joints in counter tops are to be welded and finished to match adjacent stainless steel and are to be rendered so that they are undistiguishable from adjacent stainless steel. Coordinate installation of stainless steel counter tops to cabinet work, with Section 06 40 00.
- .5 Replace items damaged in course of installation.

END OF SECTION

1 General

1.1 REFERENCES

- .1 ABC: Alberta Building Code 2014.
- .2 NBCC: National Building Code of Canada 2010.
- .3 ASTM International
 - .1 ASTM F1667-13: Standard Specification for Driven Fasteners: Nails, Spikes, and Staples.
 - .2 ASTM F2403-09: Standard Specification for Inch Series Machine Screws, Carbon Steel, 60 000 psi Tensile Strength.
- .4 CSA Standards:
 - .1 CSA O121-08(R2013): Douglas Fir Plywood.
 - .2 CAN/CSA O141-05(R2014): Softwood Lumber.
 - .3 CSA O151-09(R2014): Canadian Softwood Plywood.
 - .4 CAN/CSA-O325-07(R2012): Construction Sheathing.
- .5 NLGA Standard Grading Rules for Canadian Lumber, current edition.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

1.3 QUALITY ASSURANCE

- .1 Lumber by grade stamp of an agency certified by Canadian Lumber Standards Accreditation Board.
- .2 Products of This Section: Manufactured to ISO 14000 certification requirements.
- .3 Provide all lumber bearing the grading stamp of an agency certified by the Canadian Lumber Standards Administration Board.
- .4 Perform Work in accordance with the following agencies:
 - .1 Lumber Grading Agency: Certified by NLGA.
 - .2 Plywood Grading Agency: Certified by CANPLY.
- .5 Plywood, and wood based composite panels in accordance with CSA and ANSI standards.

- .6 Supply lumber and panel components marked with a recognized, visible grade stamp.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect wood products from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Store materials on site to prevent deterioration or loss or impairment of structural or other essential properties. Store materials on raised supports. Avoid rapid changes in moisture content. Provide adequate air circulation and ventilation.
- .5 Cover materials with tarpaulins or polyethylene sheets to prevent moisture absorption and impairment of structural or aesthetic properties.
- .6 Do not store seasoned materials in wet or damp areas.
- .7 Damaged material will be rejected and must be removed from site.

2 Products

2.1 MATERIALS

- .1 Dimension lumber: To CAN/CSA-O141 and species group to CAN/CSA-O86.1 as listed and to National Lumber Grades Authority Standard Grading Rules, current edition:
 - .1 All material to be S4S.
 - .2 Maximum moisture content of lumber:
 - .1 Dimension lumber to meet dry service conditions with a maximum moisture content of 15% (fifteen percent) at the time of installation of the surfacing material.
 - .3 All lumber is to be No. 2 or better, S-P-F.
- .2 Furring, blocking and backing:
 - .1 Board sizes: "Standard" or better grade.
 - .2 Dimension sizes: "Standard" light framing or better grade.

2.2 PANEL PRODUCTS

- .1 Canadian softwood plywood: to CSA O151, sheathing grade thickness as indicated on the drawings.

- .2 Douglas fir plywood: to CSA O121, sheathing grade, thickness as indicated on the drawings.

2.3 ACCESSORIES

- .1 Nails, spikes and staples: to ASTM F1667, plain.
- .2 Screw fasteners into metal framing: stainless steel or ceramic coated galvanized steel, self drilling screws of lengths to suit application.
- .3 Rough Hardware and proprietary fasteners: bolts, nuts, toggle bolts, expansion shields, washers, lag bolts, pins, screws (hot dip) galvanized to ASTM A123/A123M where exposed to corrosive conditions, and lead or inorganic fibre plugs; recommended for purpose by manufacturer.

3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for product 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 WORKMANSHIP

- .1 Produce joints which are tight, true and well nailed, with members assembled in accordance with the Drawings and with pertinent codes and regulations.
- .2 Select individual pieces so that knots and obvious defects will not interfere with placing of bolts, or proper nailing, and will allow making of proper connections.
- .3 Cut out and discard defects which render a piece of wood unable to serve its intended function.
- .4 Lumber may be rejected by the Departmental Representative, whether or not it has been installed, for excess warp, twist, bow, crook, mildew, fungus, or mould, as well as for improper cutting and fitting.
- .5 Do not shim any framing components.

- .6 Sequence work to minimize use of temporary HVAC to dry out building and to control humidity.

3.3 FIRE RETARDANT TREATED WOOD

- .1 Fire retardant treated wood: pressure treated to CSA-O80-Series, to provide flame spread rating and smoke developed ratio to meet all Alberta Building Code 2014 and National Building Code of Canada 2010 requirements, and to the satisfaction of the Authority Having Jurisdiction.
- .2 Fire retardant treat all wood members where required by Code and to the satisfaction of the Authority Having Jurisdiction.

3.4 ATTACHMENT METHODS/DEVICES

- .1 Unless otherwise required, fastening methods to conform to Section 9.23 Residential Standards (Table 23A and 23B) and/or Part 4 of the Alberta Building Code 2014 and National Building Code of Canada 2010. Minimize splitting by staggering nails in the direction of the grain and by keeping them well away from edges.
- .2 Adequately mechanically fasten all wood products used in connection with roofing.
- .3 Do not use explosive actuated fastening devices as a method of attachment. Use Nails only when attaching wood to wood.
- .4 When fastening wood products to concrete, brick, concrete block and similar cementitious/masonry material, use only lag bolts or similar fastening system as approved by the Departmental Representative. Install fasteners at 450 mm o.c. each way. In no case use lag bolt less than 10 mm diameter.
- .5 When fastening wood products to metal decks, use only screw fasteners in a size and quantity pattern to be determined by the Departmental Representative, but in no case to less than a 300 mm o.c. each way.

3.5 MISCELLANEOUS BLOCKING, BUCKS, AND PLATES

- .1 Place members true to lines and levels and secure rigidly in place.
- .2 Install plywood blocking where indicated.
- .3 All blocking in fire rated assemblies is to conform to Alberta Building Code 2014 and National Building Code of Canada 2010 requirements.
- .4 Install other blocking where indicated.

3.6 MISCELLANEOUS

- .1 Use dust collectors and high quality respirator masks when cutting or sanding wood panels.
- .2 Frame, anchor, fasten, tie and brace members to provide necessary strength and rigidity.
- .3 Countersink bolts where necessary to provide clearance for other work.

3.7 WORK TO EXISTING

- .1 Provide new blocking, framing, and the like, as required to complete renovations to existing portion of building, to the requirements of this Section.

3.8 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .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 - Cleaning.

3.9 PROTECTION

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

END OF SECTION

1 General

1.1 RELATED REQUIREMENTS

- .1 Section 05 72 00 - Stainless Steel Fabrications
- .2 Section 08 70 05 - Cabinet and Miscellaneous Hardware

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)
 - .1 ANSI A208.1-2009: Particleboard.
 - .2 ANSI A208.2-2009: Medium Density Fibreboard (MDF).
- .2 ASTM International
 - .1 ASTM D1037-12: Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials.
 - .2 ASTM D1761-12: Standard Test Methods for Mechanical Fasteners in Wood.
 - .3 ASTM D2832-92(2011): Standard Guide for Determining Volatile and Nonvolatile Content of Paint and Related Coatings.
 - .4 ASTM D3043-00(2011): Standard Test Methods for Flexural Structural Panels in Flexure.
 - .5 ASTM D3500-14: Standard Test Method for Structural Panels in Tension.
 - .6 ASTM D4442-07: Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials.
 - .7 ASTM D5116-10: Standard Guide For Small-Scale Environmental Chamber Determinations of Organic Emissions From Indoor Materials/Products.
 - .8 ASTM D5582-14: Standard Test Method for Determining Formaldehyde Levels from Wood Products using Desiccator.
 - .9 ASTM E84-15a: Standard Test Method for Surface Burning Characteristics of Building Materials.
 - .10 ASTM E1333-14: Standard Test Method for Determining Formaldehyde Concentrations in Air and Emission Rates From Wood Products Using a Large Chamber.
 - .11 ASTM F1667-13: Standard Specification for Driven Fasteners: Nails, Spikes, and Staples.
- .3 Canadian Plywood Association (CanPly):
 - .1 Canadian Plywood Association (CanPly).
- .4 CGSB Standards:
 - .1 CAN/CGSB-71.20-M88: Adhesive, Contact, Brushable.
- .5 CSA Standards:
 - .1 CSA O112.10-08(R2013): Evaluation of Adhesives for Structural Wood Products (Limited Moisture Exposure).
 - .2 CSA O121-08(R2013): Douglas Fir Plywood.

-
- .3 CAN/CSA O141-05(R2014): Softwood Lumber (contains hardwood provisions).
 - .4 CSA O151-09(R2014): Canadian Softwood Plywood.
 - .6 International Organization for Standardization (ISO):
 - .1 ISO 14040-2006: Environmental Management-Life Cycle Assessment - Principles and Framework.
 - .2 ISO 14041-2000: Environmental Management-Life Cycle Assessment - Goal and Scope Definition and Inventory Analysis.
 - .7 National Lumber Grading Authority (NLGA):
 - .1 NLGA Standard Grading Rules for Canadian Lumber (2010 edition).
 - .8 NEMA Standards:
 - .1 ANSI/NEMA LD-3-2005: High Pressure Decorative Laminates.
 - .9 AWI/AWMAC/WI: Architectural Woodwork Institute / Architectural Woodwork Manufacturer's Association of Canada / Woodwork Institute
 - .1 Architectural Woodwork Standards (Edition 2 - 2014).
 - .10 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 DEFINITIONS

- .1 Refer to the AWI/AWMAC/WI - Architectural Woodwork Standards (Edition 2 - 2014).
- .2 Definitions for exposed, semi-exposed and concealed work:
 - .1 Exposed Exterior Surfaces: all exterior surfaces including:
 - .1 All surfaces visible when doors or drawers are closed, including knee spaces.
 - .2 Underside of cabinet bottoms more than 1067 mm above floor are exposed, including behind light valances, and bottom edge of light valances. Cabinet tops under 2032 mm above finish floor.
 - .3 Visible front edges of stretchers, ends, divisions, tops, bottoms, shelves and nailers.
 - .2 Exposed Interior Surfaces: interior surfaces exposed to view in open casework including:
 - .1 Shelves including edge banding.
 - .2 Division and partitions
 - .3 Interior faces of ends (sides), backs and bottoms (including pullouts). Also included are the interior surfaces of cabinet top members 914 mm or more above the finished floor.
 - .4 Interior face of doors and applied drawer fronts.
 - .3 Semi-Exposed Surfaces: interior surfaces only exposed to view when the doors or drawers are opened, including:
 - .1 Shelves, including edge banding.
 - .2 Divisions.

-
- .3 Interior face of ends (sides), backs, and bottoms (including a bank of drawers). Also included are the interior faces of cabinet top members 914 mm or more above the finish floor.
 - .4 Concealed Surfaces: exterior or interior surfaces that are covered or not normally exposed to view, including:
 - .1 Toe space unless otherwise specified.
 - .2 Sleepers, web frames, dust panels, stretchers and solid sub tops.
 - .3 The underside of cabinet bottoms less than 610 mm above the finished floor.
 - .4 The flat top of cabinets 2032 mm or more above the finished floor, except if visible from an upper floor or building level.
 - .5 The three non-visible edges of adjustable shelves.
 - .6 The underside of countertops, knee spaces and drawer aprons.
 - .7 The faces of cabinet ends of adjoin units that butt together.
 - .8 Other surfaces not usually visible after installation.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for architectural woodwork and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit two copies of WHMIS MSDS in accordance with Section 01 35 29.06 - Health and Safety Requirements.
- .3 Shop Drawings:
 - .1 Indicate details of construction, profiles, jointing, fastening and other related details.
 - .1 Scales: profiles full size, details half full size.
 - .2 Indicate materials, thicknesses, finishes and hardware.
 - .3 Indicate locations of service outlets in casework, typical and special installation conditions, and connections, attachments, anchorage and location of exposed fastenings.
- .4 Samples:
 - .1 Submit duplicate samples of each type of substrate for plastic laminate and melamine: sample size 300 mm x 300 mm.
 - .2 Submit duplicate samples of each type and colour of laminated plastic.
 - .3 Submit duplicate samples of laminated plastic joints, edging, cutouts and profiles.
- .5 Certifications: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.5 QUALITY ASSURANCE

- .1 Lumber by grade stamp of an agency certified by Canadian Lumber Standards Accreditation Board.
- .2 Plywood, particleboard, and wood based composite panels to CSA and ANSI standards.
- .3 Mock-ups:
 - .1 Construct mock-ups in accordance with Section 01 45 00 - Quality Control.
 - .1 Shop prepare one base cabinet unit, wall cabinet counter top, complete with hardware, and install where directed by Departmental Representative.
 - .2 Allow 24 hours for inspection of mock-up by Departmental Representative before proceeding with Work.
 - .3 When accepted, mock-up will demonstrate minimum standard for Work.
 - .4 Do not proceed with work prior to receipt of written acceptance of mock-up by Departmental Representative.
 - .5 Accepted mock-up may remain as part of finished work.
- .4 Coordinate and confirm all Owner supplied equipment sizes and requirements prior to fabrication of cabinet work.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements 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.
 - .1 Protect millwork against dampness and damage during and after delivery.
 - .2 Store millwork in ventilated areas, protected from extreme changes of temperature or humidity.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect architectural woodwork from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

2 Products

2.1 MATERIALS

- .1 Softwood lumber: unless specified otherwise, S4S, moisture content 15 % or less in accordance with following standards:
 - .1 CSA O141.
 - .2 NLGA Standard Grading Rules for Canadian Lumber.

-
- .3 AWMAC custom grade, moisture content as specified.
 - .2 Machine stress-rated lumber is acceptable for all purposes.
 - .3 Douglas fir plywood (DFP): to CSA O121, standard construction; G1S or G2S grade; 19 mm thick unless noted otherwise.
 - .4 Canadian softwood plywood (CSP): to CSA O151, standard construction, G1S or G2S grade; 19 mm thickness unless noted otherwise.
 - .5 Substrate for plastic laminate (except counter tops): conforming to Section 4 - Sheet Products, in the AWI/AWMAC/WI - Architectural Woodwork Standards (Edition 2 - 2014); one of the following:
 - .1 Multi-Layer plywood: Engineered MDF composite cross banding with inner plies of voidless veneer core. Surface to be smooth, MDF ready to receive plastic laminate finish. Ensure MDF is not manufactured with binders, coatings or adhesives which contain resins or other compounds that have potential to release formaldehyde during final product's use;
 - .1 Manufacturing process must adhere to Lifecycle Assessment Standards as ISO 14040/14041 LCA Standards, CSA Z760 LCA Standards.
 - .2 Acceptable Products:
 - .1 Classic Core as manufactured by Columbia Forest Products.
 - .2 Armor Core as manufactured by States Industries Inc.
 - .3 Pro-Core MDF as manufactured by Timber Products.
 - .4 Other preapproved product.
 - .2 Filled industrial grade particle board to ANSI A208.1, with minimum density of 737 kg/m³. Ensure particle board is not manufactured with binders, coatings or adhesives which contain resins or other compounds that have potential to release formaldehyde during final product's use;
 - .1 Manufacturing process must adhere to Lifecycle Assessment Standards as ISO 14040/14041 LCA Standards, CSA Z760 LCA Standards.
 - .3 Sheet size to be 1220 mm x 2440 mm or larger as required to produce as few joints as possible. Thickness to be 19 mm unless indicated otherwise.
 - .4 Note: to doors, use multi-layer plywood core. To all other locations, use either multi-layer plywood core or filled industrial grade particle board core.
 - .6 Substrates for Plastic laminate faced counter tops and backsplashes:
 - .1 Canadian softwood plywood or Douglas fir plywood to CSA O151 and CSA O121 respectively, G1S or G2S grade, 19 mm thickness unless indicated otherwise.
 - .7 Thermofused Melamine: to NEMA LD3 Grade VGL.
 - .1 High wear resistant thermofused melamine: equal or exceed 400 cycles (Minimum standard for HPL abrasion test).
 - .2 Substrates for thermofused melamine:
 - .1 Filled industrial grade particle board to ANSI A208.1, with minimum density of 737 kg/m³. Ensure particle board is not manufactured with

binders, coatings or adhesives which contain resins or other compounds that have potential to release formaldehyde during final product's use;

- .1 Manufacturing process must adhere to Lifecycle Assessment Standards as ISO 14040/14041 LCA Standards, CSA Z760 LCA Standards.
- .3 Sheet size to be 1220 mm x 2440 mm or larger as required to produce as few joints as possible. Thickness to be 19 mm unless indicated otherwise.
- .4 Colour: white.
- .8 Laminated plastic for flatwork: to NEMA LD 3.
 - .1 Type: General purpose.
 - .2 Grade: HGS.
 - .3 Size: 1.27 mm thick.
 - .4 Type: multilayered.
 - .5 Manufacturers, colours, patterns: as selected by the Departmental Representative from the manufacturers' standard range. Note: not all colours and patterns will be from one manufacturer.
 - .6 Finish: matte.
- .9 Laminated plastic for backing sheet: to NEMA LD 3.
 - .1 Type: Backer.
 - .2 Grade: BKH.
 - .3 Size: same thickness as face laminate.
 - .4 Colour: same colour as face laminate.
- .10 Stainless Steel Counter Tops: as specified in Section 05 72 00.
- .11 Nails and other fasteners: to ASTM F1667.
- .12 Screws: to ASTM D1761.
- .13 Bolts, nuts, washers, lags, pins and screws: of size and type to suit application. Where fasteners are exposed, use stainless steel screws with stainless steel or chrome cup washers, and space neatly and evenly to the satisfaction of the Departmental Representative.
- .14 Splines: wood or metal.
- .15 Sealant: in accordance with Section 07 92 00 - Joint Sealants, type 4.
- .16 Laminated plastic adhesive:
 - .1 Adhesive: contact adhesive to CAN/CGSB-71.20.

2.2 MANUFACTURED UNITS

- .1 Casework:
 - .1 Fabricate caseworks to AWMAC custom quality grade.
 - .2 Furring, blocking, nailing strips, grounds and rough bucks and sleepers.

-
- .1 S2S is acceptable for all locations.
 - .2 Board sizes: "standard" or better grade.
 - .3 Dimension sizes: "standard" light framing or better grade.
 - .4 Urea-formaldehyde free.
 - .3 Case bodies (ends, divisions and bottoms).
 - .1 To exposed locations: Multi-core plywood or industrial grade particle board, square edge, 19 mm thick, with plastic laminate finish.
 - .2 To semi-exposed locations: industrial grade particle board, square edge, 19 mm thick, with thermofusible melamine finish, including to all faces ends and edges.
 - .4 Backs:
 - .1 To exposed locations: Multi-core plywood or industrial grade particle board, square edge, 13 mm thick, with plastic laminate finish.
 - .2 To semi-exposed locations: industrial grade particle board, square edge, 13 mm thick, with thermofusible melamine finish, including to all faces ends and edges.
 - .5 Shelving:
 - .1 To exposed locations: Multi-core plywood or industrial grade particle board, square edge, 19 mm thick, with plastic laminate finish.
 - .2 To semi-exposed locations: industrial grade particle board, square edge, 19 mm thick, with thermofusible melamine finish, including to all faces ends and edges.
 - .2 Drawers:
 - .1 Fabricate drawers to AWMAC custom grade supplemented as follows:
 - .2 Sides and Backs.
 - .1 Industrial grade particle board, square edge, 13 mm thick, with thermofusible melamine finish, including to all faces ends and edges.
 - .3 Bottoms:
 - .1 Industrial grade particle board, square edge, 13 mm thick, with thermofusible melamine finish, including to all faces ends and edges.
 - .4 Fronts:
 - .1 Multi-core plywood or industrial grade particle board, square edge, 19 mm thick, with plastic laminate finish.
 - .3 Casework Doors:
 - .1 Fabricate doors to AWMAC custom grade supplemented as follows:
 - .1 Multi-core plywood, square edge, 19 mm thick, with plastic laminate finish.
 - .4 Wall Mounted Shelves:
 - .1 Fabricate to AWMAC custom grade supplemented as follows:
 - .1 Multi-core plywood, square edge, 19 mm thick, with plastic laminate finish.

- .5 Counter Tops:
 - .1 Where stainless steel is indicated: provide 19 mm Douglas Fir plywood (DFP) or Softwood Plywood (CSP), G1S generally, G2S where there are no base cabinets below the counter tops. Laminate stainless steel to 19 mm thick plywood substrate; coordinate with Section 05 72 00.
 - .2 Where plastic laminate counter tops and backsplashes are indicated: provide 19 mm Douglas Fir plywood (DFP) or Softwood Plywood (CSP), G1S generally, G2S where there are no base cabinets below the counter tops. Apply plastic laminate to all exposed faces and edges as specified in this Section.

2.3 APPLICATION OF PLASTIC LAMINATE SURFACING

- .1 Comply with NEMA LD3, Annex A.
- .2 Obtain governing dimensions before fabricating items which are to accommodate or abut appliances, equipment and other materials.
- .3 Ensure adjacent parts of continuous laminate work match in colour and pattern.
- .4 Veneer laminated plastic to core material in accordance with adhesive manufacturer's instructions. Ensure core and laminate profiles coincide to provide continuous support and bond over entire surface. Use continuous lengths up to 3000 mm. Keep joints 600 mm from sink cutouts.
- .5 Use straight self-edging laminate strip for flatwork to cover exposed edge of core material. Chamfer exposed edges uniformly at approximately 20 degrees. Do not mitre laminate edges.
- .6 Apply laminate backing sheet to reverse side of core of plastic laminate work.
- .7 Compliance: comply with manufacturer's written recommendations, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.
- .8 Make allowances around perimeter where fixed objects pass through or project into laminated plastic work to permit normal movement without restriction.
- .9 Use draw bolts and splines in countertop joints. Maximum spacing 450 mm on centre, 75 mm from edge. Make flush hairline joints.
- .10 Provide cutouts for inserts, grilles, appliances, outlet boxes and other penetrations. Round internal corners, chamfer edges and seal exposed core.
- .11 At junction of laminated plastic counter back splash and adjacent wall finish, apply small bead of sealant.

- .12 Site apply laminated plastic to units as indicated. Adhere laminated plastic over entire surface. Make corners with hairline joints. Use full sized laminate sheets. Make joints only where indicated on the reviewed shop drawings. Slightly bevel arrises.

- .13 For site application, offset joints in plastic laminate facing from joints in core.

2.4 FABRICATION

- .1 Set nails and countersink screws apply plain wood filler to indentations, sand smooth and leave ready to receive finish.
- .2 Shop install cabinet hardware for doors, shelves and drawers. Recess shelf standards unless noted otherwise.
- .3 Shelving to cabinetwork to be adjustable unless otherwise noted.
- .4 Provide cutouts for plumbing fixtures, inserts, appliances, outlet boxes and other fixtures.
- .5 Shop assemble work for delivery to site in size easily handled and to ensure passage through building openings.
- .6 Obtain governing dimensions before fabricating items which are to accommodate or abut appliances, equipment and other materials.
- .7 Install all cabinet hardware as specified in Section 08 70 05; adjust as required for smooth operation.

3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for architectural woodwork installation in accordance with manufacturer's 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 Do architectural woodwork to Quality Standards of AWMAC.
- .2 Install prefinished millwork at locations shown on drawings.
 - .1 Position accurately, level, plumb straight.

- .3 Fasten and anchor millwork securely.
 - .1 Supply and install heavy duty fixture attachments for wall mounted cabinets.
- .4 Use draw bolts in countertop joints.
- .5 Scribe and cut as required to fit abutting walls and to fit properly into recesses and to accommodate piping, columns, fixtures, outlets or other projecting, intersecting or penetrating objects.
- .6 At junction of plastic laminate counter back splash and adjacent wall finish, apply small bead of sealant in accordance with Section 07 92 00 - Joint Sealants.
- .7 Apply water resistant building paper over wood framing members in contact with masonry or cementitious construction.
- .8 Fit hardware accurately and securely in accordance with manufacturer's written instructions.
- .9 Install wall mounted shelves and with coat rods complete with end brackets, securely fastened in place, level and true to line. Install shelf support for shelves and coat rods over 1200 mm long. Fabricate and install plastic laminate faced wall mounted shelving complete with brackets and valence lighting as indicated.
- .10 Site apply laminated plastic to units as specified in this Section.
- .11 For site application, offset joints in plastic laminate facing from joints in core.
- .12 Coordinate installation of stainless steel to counter tops, with Section 05 72 00.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .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 - Cleaning.
 - .1 Clean cabinet work including exterior and interior surfaces and inside of drawers.
 - .2 Remove excess glue from surfaces.

3.4 PROTECTION

- .1 Protect cabinet work from damage until final inspection.
- .2 Protect installed products and components from damage during construction.
- .3 Repair damage to adjacent materials caused by architectural woodwork installation.

GOVERNMENT OF CANADA

Existing Building Renovation

Alberta, Canada

Project No.: 144202775.215

Section 06 40 00

ARCHITECTURAL WOODWORK

Page 11 of 10

END OF SECTION

1 General

1.1 REFERENCES

- .1 ASTM International
 - .1 ASTM C553-13, Standard Specification for Mineral Fibre Blanket Thermal Insulation for Commercial and Industrial Applications.
 - .2 ASTM C665-12, Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
 - .3 ASTM C1320-10, Standard Practice for Installation of Mineral Fiber Batt and Blanket Thermal Insulation for Light Frame Construction.
- .2 CSA Group
 - .1 CSA B149 PACKAGE-10, Consists of B149.1, Natural Gas and Propane Installation Code and B149.2, Propane Storage and Handling Code.
- .3 Underwriters Laboratories of Canada (ULC)
- .4 ULC Standards:
 - .1 CAN/ULC-S101-14, Standard Methods of Fire Endurance Tests of Building Construction and Materials.
 - .2 CAN/ULC-S102-10, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
 - .3 CAN/ULC-S114-05, Standard Method of Test for Determination of Non-Combustibility in Building Materials.
 - .4 CAN/ULC-S115-11, Standard Method of Fire tests for Firestop Systems.
 - .5 CAN/ULC-S604-2012, Standard for Factory-Built Type A Chimneys.
 - .6 CAN/ULC-S702-14, Standard for Mineral Thermal Fibre Insulation for Buildings.
 - .7 CAN/ULC-S702.2-10, Mineral Fibre Thermal Installation for Building, Part 2: Application Guidelines.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for blanket insulation and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Certificates:
 - .1 Submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
- .4 Test Reports:

- .1 Submit certified test reports showing compliance with specified performance characteristics and physical properties.

1.3 DELIVERY, STORAGE AND HANDLING

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

2 Products

2.1 INSULATION

- .1 Batt and blanket mineral fibre including acoustic insulation: to ASTM C553, ASTM C665 and CAN/ULC-S702.
 - .1 Type: 1.
 - .2 Thickness: as indicated.

2.2 ACCESSORIES

- .1 Insulation clips:
 - .1 Impale type, perforated 50 x 50 mm cold rolled carbon steel 0.8 mm thick, adhesive back, spindle of 2.5 mm diameter annealed steel, length to suit insulation, 25 mm diameter washers of self locking type.

3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for blanket insulation application 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 INSULATION INSTALLATION

- .1 Install acoustic insulation into interior partitions and assemblies to maintain continuity of acoustic assemblies.
- .2 Fit insulation closely around electrical boxes, pipes, ducts, frames and other objects in or passing through insulation.
- .3 Do not compress insulation to fit into spaces.
- .4 Keep insulation minimum 75 mm from heat emitting devices such as recessed light fixtures, and minimum 50 mm from sidewalls of CAN/ULC-S604 Type A chimneys CSA B149.1 and CSA B149.2 Type B and L vents.
- .5 Do not enclose insulation until it has been inspected and approved by Departmental Representative.

3.3 ACOUSTIC INSULATION

- .1 Install acoustic insulation in corridor partitions and to all demising partitions and elsewhere as indicated on the drawings.
- .2 Fill behind electrical outlets boxes and other openings with at least 150 mm lap around perimeter of opening, packed tight in layers (to approximately 50% of nominal thickness).
- .3 Co-operate with General Contractor, electrical and mechanical Subcontractors to ensure that no back-to-back openings are formed, whether or not so indicated on the drawings. Openings must be offset at least one stud space.
- .4 Thickness of sound insulation batts is to be the full stud depth unless specifically noted otherwise, with material placed after one wall face has been installed, using adhesive to hold the material in place. Use multiple layers of insulation as required to achieve stud depth. Stagger joints between layers minimum 300 mm.
- .5 Comply with manufacturer's directions.

3.4 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .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 - Cleaning.

END OF SECTION

1 General

1.1 RELATED REQUIREMENTS

- .1 Section 07 92 00 - Joint Sealing
- .2 Section 09 21 16 - Gypsum Board Assemblies
- .3 Division 22 & 23 - Mechanical
- .4 Division 26 - Electrical

1.2 REFERENCES

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .2 ASTM International:
 - .1 ASTM E814-13a: Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
 - .2 ASTM E2174-14: Standards Practice of on-site inspection of installed Firestops (Penetration).
 - .3 ASTM E2307-10: Standard Test Method for Determining Fire Resistance of Perimeter Fire Barrier Systems Using Intermediate-Scale, Multi-story Test Apparatus.
 - .4 ASTM E2393-10a: Standard Practice for on-site inspection of installed Fire resistive Joint systems and perimeter fire barriers.
- .3 IFC Guidelines for evaluating Firestop systems engineering Judgments
- .4 Underwriter's Laboratories of Canada (ULC)
 - .1 CAN/ULC-S101-14: Standard Method of Fire Endurance Tests of Building Construction and Materials.
 - .2 CAN/ULC-S115-11: Standard Method of Fire tests for Firestop Systems.
 - .3 ULC: List of Equipment and Materials, Fire stop systems and components (current edition).
 - .4 Underwriter's Laboratories of Canada (ULC): ULC-FS-14 Firestop Systems and Components 2014 Edition, (2 Volumes - Volumes 1 and 2).

1.3 DEFINITIONS

- .1 Fire Stop Material: device intended to close off opening or penetration during fire or materials that fill openings in wall or floor assembly where penetration is by cables, cable trays, conduits, ducts and pipes and poke-through termination devices, including electrical outlet boxes along with their means of support through openings.

-
- .2 Single Component Fire Stop System: fire stop material that has Listed Systems Design and is used individually without use of high temperature insulation or other materials to create fire stop system.
 - .3 Multiple Component Fire Stop System: exact group of fire stop materials that are identified within Listed Systems Design to create on site fire stop system.
 - .4 Tightly Fitted; (ref: NBC Part 3.1.9.1.1 and 9.10.9.6.1): penetrating items that are cast in place in buildings of noncombustible construction or have "0" annular space in buildings of combustible construction.
 - .1 Words "tightly fitted" should ensure that integrity of fire separation is such that it prevents passage of smoke and hot gases to unexposed side of fire separation.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit shop drawings to show location, proposed material, reinforcement, anchorage, fastenings and method of installation.
 - .2 Construction details should accurately reflect actual job conditions.
- .4 Quality assurance submittals: submit following in accordance with Section 01 45 00 - Quality Control.
 - .1 Test reports: in accordance with CAN-ULC-S101 for fire endurance and CAN-ULC-S102 for surface burning characteristics.
 - .1 Submit certified test reports from approved independent testing laboratories, indicating compliance of applied fire stopping with specifications for specified performance characteristics and physical properties.
 - .2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .3 Manufacturer's Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, cleaning procedures and all other related information.
 - .4 Manufacturer's Field Reports: submit to manufacturer's written reports within 3 days of review, verifying compliance of Work, as described in PART 3 - FIELD QUALITY CONTROL.

1.5 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Installer: company specializing in fire stopping installations approved by manufacturer with 5 years documented experience.
- .2 Pre-Installation Meetings: convene pre-installation meeting one week prior to beginning work of this Section, with contractor's representative and Departmental Representative in accordance with Section 01 31 19 - Project Meetings. Arrange this meeting only when the representative of the Departmental Representative can attend or alternatively, on a conference call with the Departmental Representative. Methods of operation, and trade responsibility will be resolved. Provide photos to the Departmental Representative, if the Departmental Representative does not attend the site meeting. Site meeting is to:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions and warranty requirements.
- .3 Site Meetings: as part of Manufacturer's Services described in PART 3 - FIELD QUALITY CONTROL, schedule site visits, to review Work, at stages listed.
 - .1 After delivery and storage of products, and when preparatory Work is complete, but before installation begins.
 - .2 Twice during progress of Work at 25% and 60% completion of work of this Section.
 - .3 Upon completion of Work, after cleaning is carried out.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
 - .3 Deliver materials to the site in undamaged condition and in original unopened containers, marked to indicate brand name, manufacturer and ULC markings.
- .2 Storage and Protection:
 - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.

2 Products

2.1 MATERIALS

- .1 Fire stopping and smoke seal systems: in accordance with CAN-ULC-S115.
 - .1 Asbestos-free materials and systems capable of maintaining effective barrier against flame, smoke and gases in compliance with requirements of CAN-ULC-S115 and not to exceed opening sizes for which they are intended and conforming to specified special requirements described in PART 3.
 - .2 All materials to provide a flame rating (F) to penetrations equal to the rating of the Fire Separation. A flame and temperature rating (FT) is required on all penetration in fire walls and assemblies. All construction joint firestopping systems must provide a rating equal to the rating of the surrounding assemblies.
- .2 Service penetration assemblies: systems tested to CAN-ULC-S115.
- .3 Service penetration fire stop components: certified by test laboratory to CAN-ULC-S115.
- .4 Fire-resistance rating of installed fire stopping assembly in accordance with NBC.
- .5 Fire stopping and smoke seals at openings intended for ease of re-entry such as cables: elastomeric seal.
- .6 Fire stopping and smoke seals at openings around penetrations for pipes, ductwork and other mechanical items requiring sound and vibration control: elastomeric seal.
- .7 Primers: to manufacturer's recommendation for specific material, substrate, and end use.
- .8 Water (if applicable): potable, clean and free from injurious amounts of deleterious substances.
- .9 Damming and backup materials, supports and anchoring devices: to manufacturer's recommendations, and in accordance with tested assembly being installed as acceptable to authorities having jurisdiction.
- .10 Sealants for vertical joints: non-sagging.

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 PREPARATION

- .1 Examine sizes and conditions of voids to be filled to establish correct thicknesses and installation of materials.
 - .1 Ensure that substrates and surfaces are clean, dry and frost free.
- .2 Prepare surfaces in contact with fire stopping materials and smoke seals to manufacturer's instructions.
- .3 Maintain insulation around pipes and ducts penetrating fire separation without interruption to vapour barrier where applicable.
- .4 Mask where necessary to avoid spillage and over coating onto adjoining surfaces; remove stains on adjacent surfaces.

3.3 INSTALLATION

- .1 Install fire stopping and smoke seal material and components in accordance with manufacturer's certified tested system listing.
- .2 Seal holes or voids made by through penetrations, poke-through termination devices, and unpenetrated openings or joints to ensure continuity and integrity of fire separation are maintained, including new and existing fire separations.
- .3 Provide temporary forming as required and remove forming only after materials have gained sufficient strength and after initial curing.
- .4 Tool or trowel exposed surfaces to neat finish.
- .5 Remove excess compound promptly as work progresses and upon completion.

3.4 SPECIAL REQUIREMENTS

- .1 Provide special requirements for fire stopping and smoke seal materials at openings and penetrations in fire resistant rated assemblies where required, as follows:
 - .1 Movement.
 - .2 Designed for re-entry, removable.
 - .3 To obtain fire rating to match adjacent assembly.

3.5 SEQUENCES OF OPERATION

- .1 Proceed with installation only when submittals have been reviewed by Departmental Representative.
- .2 Install floor fire stopping before interior partition erections.
- .3 Mechanical pipe insulation: certified fire stop system component.

- .1 Ensure pipe insulation installation precedes fire stopping.

3.6 FIELD QUALITY CONTROL

- .1 Inspections: notify Departmental Representative when ready for inspection and prior to concealing or enclosing fire stopping materials and service penetration assemblies.
- .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.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

3.7 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.
- .3 Remove temporary dams after initial set of fire stopping and smoke seal materials.

3.8 SCHEDULE

- .1 Fire stop and smoke seal at:
 - .1 Penetrations through fire-resistance rated masonry, concrete, and gypsum board partitions and walls.
 - .2 Top of fire-resistance rated gypsum board partitions.
 - .3 Penetrations through floors.
 - .4 Openings and sleeves installed for future use through fire separations.
 - .5 Around mechanical and electrical assemblies penetrating fire separations.
 - .6 Rigid ducts: greater than 129 cm² : fire stopping to consist of bead of fire stopping material between retaining angle and fire separation and between retaining angle and duct, on each side of fire separation.

END OF SECTION

1 General

1.1 RELATED REQUIREMENTS

- .1 Section 05 72 00 - Stainless Steel Fabrications
- .2 Section 06 40 00 - Architectural Woodwork
- .3 Section 09 21 16 - Gypsum Board Assemblies
- .4 Section 09 67 10 - Epoxy Flooring

1.2 REFERENCES

- .1 ASTM International:
 - .1 ASTM C603-04(2008): Standard Test Method for Extrusion Rate and Application Life of elastomeric Sealants.
 - .2 ASTM C919-12: Standard Practice for Use of Sealants in Acoustical Applications.
 - .3 ASTM C920-14a: Standard Specification for Elastomeric Joint Sealants.
 - .4 ASTM C1193-13: Standard Guide for Use of Joint Sealants.
 - .5 ASTM C1518-04(2009): Standard Specification for Precured Elastomeric Silicone Joint Sealant.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-19.13-M87, Sealing Compound, One-component, Elastomeric, Chemical Curing.
 - .2 CAN/CGSB-19.17-M90, One-Component Acrylic Emulsion Base Sealing Compound.
 - .3 CAN/CGSB-19.24-M90, Multi-component, Chemical Curing Sealing Compound.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for joint sealants and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Manufacturer's product to describe:
 - .1 Caulking compound.
 - .2 Primers.
 - .3 Sealing compound, each type, including compatibility when different sealants are in contact with each other.

- .3 Submit 2 copies of WHMIS MSDS in accordance with Section 01 35 29.06 - Health and Safety Requirements.

- .3 Samples:

- .1 Submit 2 samples of each type of material and colour.
 - .2 Cured samples of exposed sealants for each colour where required to match adjacent material.

- .4 Manufacturer's Instructions:

- .1 Submit instructions to include installation instructions for each product used.

1.4 CLOSEOUT SUBMITTALS

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

1.5 DELIVERY, STORAGE AND HANDLING

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

1.6 SITE CONDITIONS

- .1 Ambient Conditions:
 - .1 Proceed with installation of joint sealants only when:
 - .1 Ambient and substrate temperature conditions are within limits permitted by joint sealant manufacturer or are above 4.4 degrees C.
 - .2 Joint substrates are dry.
 - .3 Conform to manufacturer's recommended temperatures, relative humidity, and substrate moisture content for application and curing of sealants including special conditions governing use.
- .2 Joint-Width Conditions:
 - .1 Proceed with installation of joint sealants only where joint widths are more than those allowed by joint sealant manufacturer for applications indicated.
- .3 Joint-Substrate Conditions:

- .1 Proceed with installation of joint sealants only after contaminants capable of interfering with adhesion are removed from joint substrates.

1.7 ENVIRONMENTAL REQUIREMENTS

- .1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of hazardous materials; and regarding labelling and provision of Material Safety Data Sheets (MSDS) acceptable to Health Canada.
- .2 Departmental Representative will arrange for ventilation system to be operated on maximum outdoor air and exhaust during installation of caulking and sealants. Ventilate area of work as directed by Departmental Representative by use of approved portable supply and exhaust fans.

2 Products

2.1 SEALANT MATERIALS

- .1 Do not use caulking that emits strong odours, contains toxic chemicals or is not certified as mould resistant in air handling units.
- .2 When low toxicity caulks are not possible, confine usage to areas which off gas to exterior, are contained behind air barriers, or are applied several months before occupancy to maximize off gas time.
- .3 Where sealants are qualified with primers use only these primers.

2.2 SEALANT MATERIAL DESIGNATIONS

- .1 Sealant Type 1: one component paintable acrylic latex, to CAN/CGSB-19.17-M90.
- .2 Sealant Type 2: multi component, chemical curing, self levelling, polyurethane sealant, conforming to CAN/CGSB-19.24-M90, type 1, Class B, and U.S Federal Specification TT-S-00227E, and ASTM C920, type M, Grade P, Class 25.
- .3 Sealant Type 3: one component, mildew resistant, silicone rubber sealant, conforming to ASTM C920.
- .4 Sealant Type 4: Acoustical sealant to ASTM C919.
- .5 Joint Filler: Round closed cell, non-staining, non-absorbent foam, extruded polyethylene shore hardness 20, tensile strength 138-207 KPa oversized 30-50%. For backup to large joints, cavities or voids, use fibreglass wool.
- .6 Bond Breaker: Pressure sensitive polyethylene or PVC tape, not bondable to sealant.

2.3 COLOURS

- .1 Colours: to match adjacent material, as selected by the Departmental Representative.

2.4 SEALANT SELECTION

- .1 Use Sealant type 1 to all other joints to interior such as between dissimilar materials around door frames and between drywall and concrete block. Apply sealant prior to painting. Allow sealant to cure properly prior to paint application.
- .2 Apply traffic Grade sealant type 2 around openings and joints in floor slabs, including sawcuts, and where slabs abut foundation walls to provide a continuous watertight joint. Install sealant type 3 to construction and expansion joints in floors with urethane coating in strict accordance with manufacturer's recommendations. Joints to be 3 mm wide x 32 mm deep. Provide 5 mm backer rod to joints.
- .3 Apply silicone sealant type 3 at joints between counter tops and adjacent walls, and all inside corner joints of ceramic tile and between floor tile and wall tile. Also, apply silicone sealant at all other joints requiring a high degree of adhesion under severe wetting conditions.
- .4 Apply sealant type 4 to edges of gypsum board and steel stud partitions which receive acoustical batt insulation. Apply sealant at each face of partition. Locate the sealant bead at the corner where track or stud meets the surface to which it is mounted. This will seal the sound transmission path between substrate and framing, and also between the board and the framing when the board fits close at the edge. Apply 12 mm diameter bead of acoustic sealant continuously around periphery of each face of partitioning to acoustically seal gypsum board/structure junction where partitions abut fixed building components. Seal full perimeter of cut-outs around electrical boxes and ducts in partitions where perimeter sealed with acoustic sealant.

2.5 JOINT CLEANER

- .1 Non-corrosive and non-staining type, compatible with joint forming materials and sealant in accordance with sealant manufacturer's written recommendations.
- .2 Primer: in accordance with sealant manufacturer's written recommendations.

3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for joint sealants 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 SURFACE PREPARATION

- .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.

3.3 PRIMING

- .1 Where necessary to prevent staining, mask adjacent surfaces prior to priming and caulking.
- .2 Prime sides of joints in accordance with sealant manufacturer's instructions immediately prior to caulking.

3.4 BACKUP MATERIAL

- .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.

3.5 MIXING

- .1 Mix materials in strict accordance with sealant manufacturer's instructions.

3.6 APPLICATION

- .1 Sealant:
 - .1 Apply sealant in accordance with manufacturer's written instructions.
 - .2 Mask edges of joint where irregular surface or sensitive joint border exists to provide neat joint.
 - .3 Apply sealant in continuous beads.
 - .4 Apply sealant using gun with proper size nozzle.
 - .5 Use sufficient pressure to fill voids and joints solid.

- .6 Form surface of sealant with full bead, smooth, free from ridges, wrinkles, sags, air pockets, embedded impurities.
- .7 Tool exposed surfaces before skinning begins to give slightly concave shape.
- .8 Remove excess compound promptly as work progresses and upon completion.

.2 Curing:

- .1 Cure sealants in accordance with sealant manufacturer's instructions.
- .2 Do not cover up sealants until proper curing has taken place.

3.7 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
 - .2 Clean adjacent surfaces immediately.
 - .3 Remove excess and droppings, using recommended cleaners as work progresses.
 - .4 Remove masking tape after initial set of sealant.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

3.8 PROTECTION

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

END OF SECTION

1 General

1.1 RELATED REQUIREMENTS

- .1 Section 08 71 00 - Door Hardware
- .2 Section 09 91 23 - Interior Painting

1.2 REFERENCES

- .1 ASTM Standards:
 - .1 ASTM A480/A480M-14b: Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
 - .2 ASTM A653/A653M-13: Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .3 ASTM E90-09: Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
 - .4 ASTM E336-14: Standard Test Method for Measurement of Airborne Sound Attenuation between Rooms in Buildings.
 - .5 ASTM E413-10: Classification for Rating Sound Insulation.
- .2 AWS D1.1/D1.1M 2006: Structural Welding Code - Steel.
- .3 Canadian Standards Association (CSA International):
 - .1 CAN/CSA-G40.20-13: General Requirements for Rolled or Welded Structural Quality Steel.
 - .2 CAN/CSA-G40.21-13: Structural Quality Steels.
 - .3 CSA W59-13: Welded Steel Construction (Metal Arc Welding) (Metric Version).
- .4 Canadian Steel Door Manufacturers' Association, (CSDMA).
 - .1 Recommended Dimensional Standards, 2000.
 - .2 Recommended Selection and Usage Guide - Section 08 11 00, 2009.
 - .3 CSDMA Recommended Specifications for Commercial Steel Door and Frame Products - Section 08 11 00, 2009.
 - .4 CSDMA Fire Labelling Guide, 2009.
- .5 Hollow Metal Manufacturer's Association (HMMA).
 - .1 HMMA 802-92: Manufacturing of Hollow Metal Doors and Frames.
 - .2 HMMA 840-07: Installation and Storage of Hollow Metal Doors and Frames.
 - .3 HMMA 865-03: Guide Specifications For Swinging Sound Control Hollow Metal Doors and Frames.
- .6 ITS/Warnock Hersey Professional Services Ltd. (WHI):
 - .1 Fire Rating Services, Building Materials and Equipment, Listings (ITS/WH).
- .7 National Fire Protection Association (NFPA)
 - .1 2013 NFPA 80: Standard for Fire Doors and Fire Windows.

- .2 NFPA 252: Standard Methods of Fire Tests of Door Assemblies.
- .8 Underwriters Laboratories Inc.:
 - .1 UL 752: Ratings for Bullet Resistant Materials.
- .9 National Institute of Justice (NIJ) 108.01: Ratings of Bullet Resistant Materials.
- .10 NATO: AEP-55 STANAG 4569: Procedures for Evaluating and Protection Levels of Logistic and Light Armoured Vehicles for KE and Artillery Threats.
 - .1 NATO M80: 25 shots in an 200 mm circle.
- .11 MIL-SAMIT Part 1: 30 cal 7.62.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop Drawings:
 - .1 Indicate door and frame elevations, anchorage types, closure methods, finishes, locations of cut-outs for hardware, arrangement of hardware, frames, required clearances and installation details.
- .3 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for acoustic doors and frames and include product characteristics, performance criteria, physical size, finish and limitations. Indicate bullet resistance performance requirements for doors.
- .4 Test Data:
 - .1 Submit independent test data from a recognized licenced laboratory indicating the acoustic door assemblies meet the Sound Transmission Class (STC rating) specified in this Section. Include laboratory name, test report number, and date of test.
 - .2 Submit certification from test laboratory qualified under the National Voluntary Accreditation Program (NVLAP) of the U.S. Bureau of Standards.
 - .3 Submit test and certification in accordance with UL-752, NIJ 0108.91 and MIL-SAMIT.
- .5 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
- .6 Installation Instructions: Submit manufacturer's installation instructions.
- .7 Samples:
 - .1 Submit manufacturer's door finish sample, frame corner sample, as well as perimeter acoustic gasket.
- .8 Manufacturer's Instructions: submit manufacturer's installation instructions.

1.4 PERFORMANCE REQUIREMENTS

- .1 Doors and frames must have a minimum Sound Transmission Class (STC) rating of 51 and a field test rating of STC 46 or better when tested in situ; in accordance with ASTM E90. Apply labels indicating sound transmission class, to each acoustic door and frame.
- .2 Ballistic Performance:
 - .1 Bullet resistance to UL 752: level 5: 7.62 mm rifle lead core full metal copper jacket military ball.

1.5 REGULATORY REQUIREMENTS

- .1 Install fire labelled steel door and frame products in accordance with NFPA-80 except where otherwise noted. Apply labels indicating fire rated sound transmission class, to each acoustic door and frame.
- .2 Test product in conformance with established test procedures for measuring acoustic performance and in particular with ASTM E90 and ASTM E413.

1.6 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for acoustic doors and frames for incorporation into manual.

1.7 QUALITY ASSURANCE

- .1 Perform work to requirements of CSDMA (Canadian Steel Door Manufacturers Association) and HMMA (Hollow Metal Manufacturers Association) standards.
- .2 Manufacturer: Minimum 5 years documented experience manufacturing acoustic steel door and frame assemblies.
- .3 Installer: use a manufacturer's trained and approved installer to install all work of this Section.
- .4 Pre-installation Meeting: Convene a pre-installation meeting 2 weeks before start of installation of acoustic door and frame assemblies. Require attendance of parties directly affecting work of this section, including Contractor, Departmental Representative, installer, and manufacturer's representative. Review installation and coordination with other work.

1.8 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions and HMMA 840.

- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect acoustic door assemblies from nicks, scratches, and blemishes.
 - .3 Protect prefinished surfaces with wrapping.
 - .4 Replace defective or damaged materials with new.
 - .5 Handle and protect doors and ancillary equipment to prevent damage.
 - .6 Weld minimum two temporary jamb spreaders per frame prior to shipment.
 - .7 Remove doors and frames from wrappings or coverings upon receipt on site and inspect for damage.
 - .8 Store in vertical position, spaced with blocking to permit air circulation between components.

1.9 COORDINATION

- .1 Coordinate installation of anchorages for acoustic door frames.
- .2 Furnish setting drawings, templates and directions for installing anchorages.
- .3 Coordinate with hardware trade to ensure the proper preparation and fabrication of doors and frames. Coordinate where holes and grommets are required in framing system to accommodate cabling.
- .4 Deliver such items to Project site in time for installation.

2 Products

2.1 ACOUSTIC SWING DOORS & FRAMES

- .1 Swing type acoustic door and frame: proprietary construction, tested and engineered as part of a fully operable assembly and including doors, frames, gasketing, hardware, and cam-lift hinges, meeting ASTM E330. STC rating of 51, 45 mm thick steel door, double frame assembly. The following manufacturer's meet the specification:
 - .1 Overly Manufacturing Company, telephone (724)-834-7300.
 - .2 Krieger Specialty Products, telephone 1-800-251-3396.
 - .3 Ambico Ltd., as distributed by RW Architectural Sales Ltd., telephone 403-259-6966.
 - .4 Other preapproved product.

-
- .2 Swing type acoustic and bullet resistant door and frame: proprietary construction, tested and engineered as part of a fully operable assembly and including doors, frames, gasketing, hardware, and cam-lift hinges, meeting ASTM E330. STC rating of 51, 45 mm thick steel door, double frame assembly. Doors to be bullet resistant to performance requirements specified in item 1.4.2 of this Section. The following manufacturer's meet the specification:
 - .1 KriegerPlate doors as manufactured by Krieger Specialty Products, telephone 1-800-251-3396.
 - .2 Other preapproved product.
 - .3 Provide doors and frames complete with manufacturer's hardware and double drop seal, neoprene gaskets and perimeter acoustic seals as required to provide the STC rating of 51.

2.2 MATERIALS

- .1 Steel: commercial grade zinc coated steel to ASTM A653/A653M, ZF180.
- .2 Reinforcement: To CSA G40.20/G40.21, coating designation to ASTM A653/A653M, ZF75.
- .3 Acoustic Composite Core: manufacturer's proprietary standard, tested as part of a fully operable assembly in accordance with ASTM E90 and E413 to provide STC rating specified.
- .4 Blank, reinforce, drill and tap doors and frames for mortised, templated hardware.
- .5 Reinforce frames and doors where required for surface mounted hardware.
- .6 Provide manufacturer's proprietary design of frame gasketing system and prepare frames to receive gasketing system.
- .7 Provide factory applied, touch up primer at areas where zinc coating has been removed during fabrication.

2.3 ACCESSORIES

- .1 Hinges: Cam lift type; manufacturer's standard.
- .2 Primer: Rust inhibitive zinc chromate.
- .3 Threshold: Smooth and flush, to provide a seal for door in closed position.
- .4 Astragal: To be supplied loose ready for field assembly.
- .5 Perimeter and bottom acoustic seals: To provide a seal for door in closed position.
- .6 Do not install peep hole door viewers in acoustic doors.

2.4 FABRICATION/GENERAL

- .1 Manufacture doors and frames to STC rating of 51, measured in accordance with ASTM E90.

2.5 FABRICATION/WELDED FRAMES

- .1 Sheet steel, metal thickness and appropriate to maintain door STC and fire ratings, mitred corners, fully welded seams.
- .2 Factory assemble and weld frames.
- .3 Accurately mitre and securely weld frames on inside of the profile.
- .4 Grind welded joints smooth and to a uniform finish.
- .5 Securely attach floor anchors to inside of each jamb profile.
- .6 Weld in two (2) temporary jamb spreaders per frame to maintain proper alignment during shipment.
- .7 Affix permanent metal nameplates to frame, indicating manufacturer's name, door tag, and STC rating where it will be clearly visible.

2.6 FABRICATION/DOORS

- .1 Fabricate swing type, flush doors as indicated on the door schedule.
- .2 Sheet steel faces, thickness, design, and core suitable to achieve specified STC performance.
- .3 Fabricate doors with acoustic core construction, longitudinal edges, mechanically inter-locked with visible edge seams.
- .4 Provide proprietary acoustic composite core as tested by the manufacturer to meet the specified STC rating.
- .5 Reinforce doors where surface-mounted hardware is required.
- .6 Drill and tap for mortised, templated hardware.
- .7 Provide top and bottom of doors with inverted, recessed channels, spot welded to door face and flush, closed top channels.
- .8 Astragals: Metal acoustic astragals with integral acoustic seals for double doors.

- .9 Affix permanent metal nameplates to door, indicating manufacturer's name, door tag, and STC rating where it will be clearly visible.

2.7 FINISHES

- .1 Factory Door Finish: Factory applied zinc chromate primer to be applied to all exposed surfaces, ready to receive finish paint specified in Section 09 91 23.

3 Execution

3.1 INSTALLATION

- .1 Install doors and frames in accordance with manufacturer's recommendations and with the reviewed shop drawings, plumb, true, with all hardware, templates, fastenings and accessories, securely anchored to adjacent structure.
- .2 Install steel doors and frames to CSDMA and HMMA 840 standards and in accordance with NFPA 80 and UL 10C, and local authority having jurisdiction.
- .3 Install fire rated acoustic doors to meet fire ratings indicated and to meet all Alberta Building Code 2014 and National Building Code of Canada 2010 requirements.
- .4 Utilize welders certified by Canadian Welding Bureau (CWB) for field welding.
- .5 Coordinate with steel stud and gypsum board wall construction for anchor placement.
- .6 Secure anchorage and connections to adjacent construction as indicated on the reviewed shop drawings and to suit adjacent construction.
- .7 Set frames plumb, square, level and at correct elevation.
- .8 Make allowance for deflection to ensure structural loads are not transmitted to the door frames.
- .9 Fit, align and adjust complete door assembly level and plumb, to provide smooth operation.
- .10 Adjust operable parts for correct clearances and function.
- .11 Install and adjust perimeter and bottom acoustic seals. Adjust seals as required to achieve the required STC rating.
- .12 Finish paint in accordance with Section 09 91 23.

3.2 ERECTION TOLERANCES

- .1 Installation tolerances of installed frame for squareness, alignment, twist and plumbness are to be no more than +/- 1.5mm in compliance with HMMA 841.

3.3 FIELD QUALITY CONTROL

- .1 Provide qualified manufacturer's representative to instruct installers on the proper installation and adjustment of door assemblies.
- .2 Provide manufacturer's representative to inspect door installation, and test minimum ten (10) cycles of operation. Correct any deficient doors.

3.4 CLEANING

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

END OF SECTION

1 General

1.1 RELATED REQUIREMENTS

- .1 Section 08 34 73 - Acoustic Doors & Frames
- .2 Section 09 21 16 - Gypsum Board Assemblies
- .3 Section 09 91 23 - Interior Painting

1.2 REFERENCES

- .1 ASTM International:
 - .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 A1008/A1008M-15: Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
 - .3 ASTM A1011/A1011M-14: Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability. and Ultra-High Strength.
 - .4 ASTM ASTM B117-11: Standard Practice for Operating Salt Spray (Fog) Apparatus.
 - .5 ASTM D1735-14: Standard Practice for Testing Water Resistance of Coatings Using Water Fog Apparatus.
 - .6 ASTM E90-09: Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
 - .7 ASTM E336-14: Standard Test Method for Measurement of Airborne Sound Insulation in Buildings.
 - .8 ASTM E413-10: Classification for Rating Sound Insulation.

1.3 PERFORMANCE REQUIREMENTS

- .1 Acoustically rated window assemblies must have a minimum Sound Transmission Class (STC) ratings that meet or exceed the values scheduled in the contract documents, when tested in accordance with ASTM E90. Apply labels indicating sound transmission class, to each acoustically rated window assembly.
- .2 Install window assemblies to have a field-tested Noise Isolation Class (NIC) rating that meets or exceeds the following values:
 - .1 NIC 41 for STC-46 windows

1.4 SYSTEM DESCRIPTION

- .1 Design requirements: Acoustical window assemblies include frames, glass and the gasketing system required to achieve specified performance requirements.

- .2 Performance requirements: Sound Transmission Coefficient rating of STC 46 for installed assembly, when tested as an assembly in accordance with ASTM E90 and ASTM E413.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for acoustic window assemblies, glazing and integral blind units and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Indicate window opening criteria, elevations, sizes, type; identify and detail cutouts. Indicate integral blinds and hardware.
- .4 Quality assurance submittals:
 - .1 Test Reports:
 - .1 Certified laboratory reports, performed in accordance with ASTM E90 and ASTM E413, from independent testing laboratory qualified under the National Voluntary Laboratory Accreditation Program (NVLAP) supporting compliance of assemblies to specified requirements.
 - .2 Certificates:
 - .1 Contractor's certification that:
 - .1 Products of this Section, as provided, meet or exceed specified requirements.
 - .2 Manufacturer of products of this Section meets specified qualifications.
 - .3 Manufacturer's instructions: Printed installation instructions for each component.

1.6 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for acoustic windows for incorporation into manual, including:
 - .1 Warranty documents, executed by manufacturer in Owner's name.
 - .2 Operation and maintenance data for assembly components.
 - .3 Certified statement of manufacturer's authorized representative, as specified in FIELD QUALITY CONTROL Article of PART 3 of this Section.
 - .4 Certified test reports of independent testing agency, as specified in FIELD QUALITY CONTROL Article of PART 3 of this Section.

1.7 QUALITY ASSURANCE

-
- .1 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
 - .2 Qualifications:
 - .1 Manufacturer: Minimum five (5) years-documented experience producing systems specified in this Section.
 - .2 Installer: Minimum five (5) years documented experience producing systems specified in this Section, and approved by manufacturer.

1.8 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect acoustic window assemblies from damage.
 - .3 Protect prefinished surfaces with wrapping.
 - .4 Replace defective or damaged materials with new.
- .4 Store frames in accordance with requirements of HMMA 840.
- .5 Remove wraps or covers from frames upon delivery at the building site; clean and touch-up scratches or disfigurement caused by shipping or handling promptly with rust inhibitive primer.
- .6 Store windows on planks or dunnage in a dry location; store in a vertical position spaced by blocking.
- .7 Store units covered to protect them from damage, but permitting air circulation.

2 Products

2.1 ACCEPTABLE MANUFACTURERS

- .1 The following manufacturers are acceptable for use on this project:
 - .1 Overly Door Company, Greensburg, PA 15601.
 - .2 Krieger Steel Products, 4880 Gregg Road, Pico Rivera CA 90660; Telephone 562-695-0645, FAX 562-692-0146
 - .3 Ambico Ltd., 1120 Cummings Avenue, Ottawa, Ont. K1J 7R8, TELEPHONE: (613) 746-4663, FAX (800) 465-8561.
 - .4 Other preapproved product.

-
- .2 Unless otherwise specified for an individual product or material, supply all products specified in this Section from the same manufacturer.

2.2 MATERIALS

- .1 Steel sheet: One of the following:
- .1 Cold-rolled steel sheet conforming to ASTM A1008/A1008M, commercial quality.
 - .2 Hot-rolled steel sheet conforming to ASTM A1011/A1011M, pickled and oiled, commercial quality.
- .2 Galvanized steel sheet: ASTM A653/A653M, commercial quality, minimum G60 zinc coating.
- .3 Acoustical material: Manufacturer's standard for required STC rating.
- .4 Primer: Meeting ASTM B117 salt spray for 150 hours, and ASTM D1735 water fog test for organic coatings for 200 hours.
- .5 Glazing:
- .1 To outside of gun range: Conforming to CAN/CGSB-12.1-M90, 14.3 mm thick, laminated tempered acoustic glazing.
 - .2 To gun range side: double sealed glazing consisting of 6 mm clear tempered acoustic glass conforming to CAN/CGSB-12.1-M90.

2.3 COMPONENTS

- .1 Frames: Fabricate in accordance with reviewed shop drawings, and as follows:
- .1 Frames for interior use: Fabricate from steel sheet, minimum 1.9 mm (14 gauge) base metal thickness.
 - .2 Form frame members straight, and of uniform profile through lengths, as welded units with integral trim, of sizes and profiles indicated.
 - .1 Weld contact edges of joints closed tight.
 - .2 Miter perimeter trim faces and weld continuously.
 - .3 Provide frames with 2 purging ports as indicated on the reviewed shop drawings.
 - .3 Stops:
 - .1 Where integral stops are indicated, form minimum 16 mm in depth.
 - .2 Planted stops to be butt stop joints.
 - .4 When shipping limitations so dictate, fabricate frames for large openings in sections designed for assembly in the field; install alignment plates or angles, of same material and gauge as frame, at each joint.
 - .5 Jamb anchors:
 - .1 Fabricate of same material as frame material; weld anchors inside each jamb for wall anchorage.

- .2 Provide anchor types for indicated adjacent wall construction:
 - .1 Frames for installation in stud partitions: Horizontal 1.52 mm (16 gauge) steel “zee” sections to attach metal studs, welded inside each jamb.
 - .6 Plaster guards: Fabricate from minimum 0.76 mm (22 gauge) steel; weld in place at hardware mortises on frames.
 - .2 Glass and Glazing:
 - .1 Supply laminated Acoustical glass in the thickness required to meet the STC ratings. The manufacturer will supply the materials.
- 2.4 FINISHES
- .1 Shop priming for window frames:
 - .1 After fabrication, fill and sand tool marks and surface blemishes on both faces and both vertical edges smooth and free from irregularities.
 - .2 Treat for paint adhesion, then apply primer to all accessible surfaces; allow to cure prior to shipment.
- 3 Execution
- 3.1 Examination
- .1 Verification of conditions:
 - .1 Prior to installation, check and correct frames for size, squareness, alignment, twist and plumb.
 - .2 Verify openings are in accordance with reviewed shop drawings.
 - .2 Installer's examination:
 - .1 Have installer of this Section examine conditions under which construction activities of this Section are to be performed, then submit written notification if such conditions are unacceptable.
 - .2 Transmit two copies of installer's report to Departmental Representative within 24 hours of receipt.
 - .3 Beginning construction activities of this Section before unacceptable conditions have been corrected is prohibited.
 - .4 Beginning construction activities of this Section indicates installer's acceptance of conditions.
- 3.2 INSTALLATION
- .1 Install units in accordance with reviewed shop drawings and manufacturer's printed installation instructions; in addition, install steel components in accordance with HMMA 840.
 - .2 Oversize assemblies:
 - .1 Weld field joints in accordance with AWS D1.1 and approved shop drawings.

- .2 Finish exposed field welds smooth; touch-up with rust inhibitive primer.
- .3 Fill voids between concealed side of frame and adjacent wall construction with dense fiberglass or lightweight gypsum plaster in accordance with approved shop drawings or manufacturer's printed installation instructions.
- .4 Finish surfaces having abrasion damage smooth; touch-up with rust inhibitive primer.
- .5 Install glass & gasketing systems in accordance with manufacturer's printed instructions.
- .6 Field painting is specified in Section 09 91 23 - Interior Painting.

3.3 FIELD QUALITY CONTROL

- .1 The Departmental Representative will engage for the services of independent testing agency to:
 - .1 Test acoustic window assemblies in accordance with ASTM E336.
 - .2 Issue certified report-documenting compliance of installed borrowed lite assemblies to specified acoustical performance requirements.
- .2 The Contractor is to pay for independent testing agency out of the Cash Allowance as specified in Section 01 21 00.
- .3 Notify Departmental Representative a minimum of four (4) calendar days prior to scheduled testing dates.

3.4 CLEANING

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

END OF SECTION

1 General

1.1 RELATED REQUIREMENTS

- .1 Section 06 40 00 - Architectural Woodwork

1.2 REFERENCES

- .1 American National Standards Institute (ANSI) / Builders Hardware Manufacturers Association (BHMA)
 - .1 ANSI/BHMA A156.9-2010, Cabinet Hardware.
 - .2 ANSI/BHMA A156.11- 2011, Cabinet Locks.
 - .3 ANSI/BHMA A156.16-2013, Auxiliary Hardware.
 - .4 ANSI/BHMA A156.18-2012, Materials and Finishes.
 - .5 ANSI/BHMA A156.20-2006 (R2012), Strap and Tee Hinges and Hasps.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for cabinet hardware and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Samples:
 - .1 Provide sample of each type of hardware used for this project.
- .4 Hardware List:
 - .1 Submit contract hardware list.
 - .2 Indicate specified hardware, including make, model, material, function, finish and other pertinent information.
- .5 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.
- .6 Manufacturer's Instructions: submit manufacturer's installation instructions.

1.4 CLOSEOUT SUBMITTALS

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

1.5 QUALITY ASSURANCE

- .1 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements 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 Package items of hardware including fastenings, separately or in like groups of hardware, label each package as to item definition and location.
- .4 Storage and Handling Requirements:
 - .1 Store materials off ground, indoors and in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect cabinet hardware from nicks, scratches, and blemishes.
 - .3 Protect prefinished surfaces with wrapping.
 - .4 Replace defective or damaged materials with new.

2 Products

2.1 HARDWARE ITEMS

- .1 Use one manufacturer's product for all similar items.

2.2 CABINET HARDWARE

- .1 Cabinet hardware: to ANSI/BHMA A156.9, designated by letter B and numeral identifiers as listed below.
 - .1 Hinges: concealed self closing hinge, 115°, complete with mounting plates. For doors over 900 mm high use 3 hinges per leaf. For doors over 1500 mm high, use 4 hinges per leaf; finish 26D.
 - .2 Pulls: surface mounted pull, Brushed Stainless steel "D" pulls, 96 mm c.c., 106 mm long, 10 mm diameter, 35 mm high.
 - .3 Catches: magnetic touch or secret panel catch, finished to 26D.
 - .4 Shelf rests and standards: shelf rest installed in holes spaced at 13 mm apart, Zinc finish, length to suit, with matching shelf rests.
 - .5 Drawer slides for bottom file drawers: Full extension, heavy duty, minimum 68 kg. load capacity, zinc finish, complete with steel ball bearings.
 - .6 Drawer slides for all other drawers: Full extension, medium duty, minimum 45 kg. load capacity, zinc finish, complete with steel ball bearings.

- .2 Cabinet locks: to ANSI/BHMA A156.11, as listed below.
 - .1 Door or drawer locks: half mortised into back of door or drawer, heavy duty type.
 - .2 Cylinders: key into keying system as directed.
 - .3 Finished to 26D.

2.3 MISCELLANEOUS HARDWARE

- .1 Auxiliary hardware: to ANSI/BHMA A156.16, as listed below.
 - .1 Garment hooks: Chrome plated, 2 hook type, c/w 4 anchor screws.
- .2 Shelf supports: heavy duty support with brace for shelf.
- .3 Coat rods: chrome-plated 2.3 mm heavy wall steel tube, 33.3 mm (15/16") outside diameter. If over 1200 mm long, include 25 mm x 3.0 mm enamelled shelf and rod support at centre. Flanges to be heavy duty.

2.4 FASTENINGS

- .1 Supply screws, bolts, expansion shields and other fastening devices required for satisfactory installation and operation of hardware.
- .2 Exposed fastening devices to match finish of hardware.
- .3 Use fasteners compatible with material through which they pass.

2.5 KEYING

- .1 Cabinet locks to be master keyed as directed. Submit keying schedule for approval.
- .2 Supply keys in duplicate for every lock in this Contract.
- .3 Supply 3 master keys for each master key group.
- .4 Stamp keying code numbers on keys and cylinders.
- .5 Install key cabinet where indicated.

3 Execution

3.1 INSTALLATION

- .1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

-
- .2 Install hardware to standard hardware location dimensions in accordance with manufacturer's recommendations and to project design requirements. Coordinate with Section 06 40 00 - Architectural Woodwork.

- .3 Install key control cabinet and establish key control set-up.

3.2 ADJUSTING

- .1 Adjust cabinet hardware for optimum, smooth operating condition.
- .2 Lubricate hardware and other moving parts.
- .3 Adjust cabinet door hardware to ensure tight fit at contact points with frames.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
 - .2 Clean hardware with damp rag and approved non-abrasive cleaner, and polish hardware in accordance with manufacturer's instructions.
 - .3 Remove protective material from hardware items where present.
 - .4 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

3.4 DEMONSTRATION

- .1 Keying System Setup and Cabinet:
 - .1 Set up key control system with file key tags, duplicate key tags, numerical index, alphabetical index and key change index, label shields, control book and key receipt cards.
 - .2 Place file keys and duplicate keys in key cabinet on their respective hooks.
 - .3 Lock key cabinet and turn over key to Departmental Representative.
- .2 Maintenance Staff Briefing:
 - .1 Brief maintenance staff regarding:
 - .1 Proper care, cleaning, and general maintenance of projects complete hardware.
 - .2 Description, use, handling, and storage of keys.
- .3 Demonstrate operation, operating components, adjustment features, and lubrication requirements.

3.5 PROTECTION

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

GOVERNMENT OF CANADA

Existing Building Renovation

Alberta, Canada

Project No.: 144202775.215

Section 08 70 05

CABINET AND MISCELLANEOUS HARDWARE

Page 5 of 4

END OF SECTION

1 General

1.1 RELATED REQUIREMENTS

.1 Section 08 34 73 - Acoustic Doors and Frames

1.2 REFERENCES

.1 American National Standards Institute (ANSI) / Builders Hardware Manufacturers Association (BHMA)

- .1 ANSI/BHMA A156.1 - 2013 Butts and Hinges.
- .2 ANSI/BHMA A156.2 - 2011 Bored and Preambled Latches.
- .3 ANSI/BHMA A156.3 - 2014 Exit Devices.
- .4 ANSI/BHMA A156.4 - 2008 Door Controls - Closers.
- .5 ANSI/BHMA A156.5 - 2014 Cylinders and Input Devices for Locks.
- .6 ANSI/BHMA A156.6 - 2010 Architectural Door Trim.
- .7 ANSI/BHMA A156.7 - 2009 Template Hinge Dimensions.
- .8 ANSI/BHMA A156.8 - 2010 Door controls - Overhead Holders.
- .9 ANSI/BHMA A156.13 - 2012 Mortise Locks and Latches.
- .10 ANSI/BHMA A156.15 - 2011 Closer/Holder/Release Devices.
- .11 ANSI/BHMA A156.16 - 2013 Auxiliary Hardware.
- .12 ANSI/BHMA A156.18 - 2012 Materials and Finishes.
- .13 ANSI/BHMA A156.21 - 2014 Thresholds.
- .14 ANSI/BHMA A156.22 - 2012 Door Gasketing Systems.
- .15 ANSI/BHMA A156.23 - 2010 Electromagnetic Locks.
- .16 ANSI/BHMA A156.25 - 2013 Electrified Locking Devices.
- .17 ANSI/BHMA A156.28 - 2013 Master Keying Systems.
- .18 ANSI/BHMA A156.31 - 2013 Electric Strikes and Frame Mounted Actuators.
- .19 ANSI/BHMA A156.115 - 2014: Hardware Penetration in Steel Door and Steel Frames.

.2 National Fire Protection Association:

- .1 2013 NFPA 80: Standard for Fire Doors and Fire Windows.
- .2 ANSI/NFPA 101 - Life Safety Code 2009.
- .3 ANSI/NFPA 105 - Smoke and Draft Control Door Assemblies 2010.

.3 Door Hardware Institute:

- .1 Recommended Locations for Architectural Hardware - Standard Steel Door & Frames 2004.
- .2 Door & Hardware Institute Sequence Format for Hardware Schedule - 1996.

.4 Codes:

- .1 ABC - Alberta Building Code 2014 edition.

.5 Canadian Steel Door and Frame Manufacturers' Association (CSDMA)

- .1 CSDMA Recommended Dimensional Standards for Commercial Steel Doors and Frames - 2009.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for door hardware and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Hardware List:
 - .1 Submit contract hardware list.
 - .2 Indicate specified hardware, including make, model, material, function, size, finish and other pertinent information.
 - .3 All hardware schedules including key controls must be reviewed and signed off by Protective Technical Services Section to ensure continuity of security and hardware compatibility with existing division hardware.
- .4 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.
- .5 Manufacturer's Instructions: submit manufacturer's installation instructions.

1.4 CLOSEOUT SUBMITTALS

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

1.5 MAINTENANCE MATERIALS SUBMITTALS

- .1 Extra Stock Materials:
 - .1 Supply maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
 - .2 Tools:
 - .1 Supply 2 sets of wrenches for door closers and locksets and fire exit hardware.

1.6 QUALITY ASSURANCE

- .1 Regulatory Requirements:
 - .1 Hardware for doors in fire separations and exit doors certified by a Canadian Certification Organization accredited by Standards Council of Canada.
- .2 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.7 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Note: special orders from outside of Canada may require up to 12 weeks delivery time. Ensure such special orders are made to meet the construction schedule.
- .3 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .4 Package items of hardware including fastenings, separately or in like groups of hardware, label each package as to item definition and location.
- .5 Storage and Handling Requirements:
 - .1 Store materials off ground, indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect door hardware from nicks, scratches, and blemishes.
 - .3 Protect prefinished surfaces with wrapping.
 - .4 Replace defective or damaged materials with new.

2 Products

2.1 HARDWARE ITEMS

- .1 Use one manufacturer's products only for similar items.

2.2 DOOR HARDWARE

- .1 Locks and latches:
 - .1 Bored and preassembled locks and latches: to ANSI/BHMA A156.2, grade, manufacturers, product numbers and finishes as listed in the hardware schedule appended to this Section.
 - .2 Mortise locks and latches: to ANSI/BHMA A156.13, series 1000 mortise lock, grade, manufacturers, product numbers and finishes as listed in the hardware schedule appended to this Section. Use high security cylinders conforming to ANSI/BHMA A156.30 where indicated.
 - .3 Knobs and Lever handles: plain design.
 - .4 Roses and Escutcheons: round.
 - .5 Normal strikes: box type, lip projection not beyond jamb.
 - .6 Cylinders: key into keying system as directed. Do not use locks or cylinders having core removable functions.
 - .7 Finished: as indicated in the hardware schedule.
- .2 Butts and hinges:
 - .1 Butts and hinges: to ANSI/BHMA A156.1, grade, manufacturers, product numbers and finishes as listed in the hardware schedule appended to this Section.

- .3 Exit devices: to ANSI/BHMA A156.3, grade, manufacturers, product numbers and finishes as listed in the hardware schedule appended to this Section.
 - .1 Auxiliary items: door co-ordinator, type 21, for pairs of doors with overlapping astragals.
- .4 Door Closers and Accessories:
 - .1 Door controls (closers): to ANSI/BHMA A156.4, grade, manufacturers, product numbers and finishes as listed in the hardware schedule appended to this Section.
 - .2 Door controls - overhead holders: to ANSI/BHMA A156.8, grade, manufacturers, product numbers and finishes as listed in the hardware schedule appended to this Section.
 - .3 Closer/holder release devices: to ANSI/BHMA A156.15, grade, manufacturers, product numbers and finishes as listed in the hardware schedule appended to this Section.
 - .4 Door co-ordinator: grade, manufacturers, product numbers and finishes as listed in the hardware schedule appended to this Section.
- .5 Door Operators:
 - .1 Power-operated pedestrian doors: to ANSI/BHMA A156.10.
 - .2 Power assist and low energy power operated doors: to ANSI/BHMA A156.19.
- .6 Auxiliary locks and associated products: to ANSI/BHMA A156.5, grade, manufacturers, product numbers and finishes as listed in the hardware schedule appended to this Section.
 - .1 Latch bolt and dead bolt: as indicated in the hardware schedule. Key into keying system as directed.
 - .2 Cylinders: type as indicated in the hardware schedule, for installation in deadlocks provided with special doors as listed in Hardware Schedule. Key into keying system as directed.
- .7 Architectural door trim: to ANSI/BHMA A156.6, grade, manufacturers, product numbers and finishes as listed in the hardware schedule appended to this Section.
 - .1 Door protection plates: kick plate, 1.27 mm thick stainless steel, bevelled edges; sizes and finish as indicated in the hardware list.
 - .2 Push plates: type 1.27 mm thick stainless steel, bevelled edges, sizes and finish as indicated in the hardware schedule.
- .8 Auxiliary hardware: to ANSI/BHMA A156.16, grade, manufacturers, product numbers and finishes as listed in the hardware schedule appended to this Section.

2.3 MISCELLANEOUS HARDWARE

- .1 Indexed key control system: to ANSI/BHMA A156.5.
- .2 Wall Mounted Cabinet: Cabinet with hinged-panel door equipped with key holding panels and pin-tumbler cylinder door lock. Locate where directed by the Departmental Representative.

.3 Capacity: Able to hold keys for 150 percent of the number of locks.

.4 Permanent Tags: Key system identity.

2.4 FASTENINGS

.1 Use only fasteners provided by manufacturer. Failure to comply may void warranties and applicable licensed labels.

.2 Supply screws, bolts, expansion shields and other fastening devices required for satisfactory installation and operation of hardware.

.3 Exposed fastening devices to match finish of hardware.

.4 Use screwless escutcheon plates on exterior doors and doors in high security areas.

.5 Where pull is scheduled on one side of door and push plate on other side, supply fastening devices, and install so pull can be secured through door from reverse side. Install push plate to cover fasteners.

.6 Use fasteners compatible with material through which they pass.

.7 Fasteners in secure area must be security type. All cell locks are to be installed in tamperproof security machine screws, available from A-Line Distributors of Edmonton.

2.5 KEYING

.1 Provide BLANK keys in duplicate for every lock in this Contract, except for cell door locks where a total of four working keys are required.

.2 To order and purchase the restricted Government of Canada cylinders/keys in IIFF profile, supplier shall request a "Purchase Authorization" letter from Departmental Representative to the Alberta Abloy representative, Ted Tetreau.

.3 Provide six pin design cylinders keyed to 000000. Forward cylinders prepaid to Departmental Representative. Cylinders having removable cores MUST NOT BE USED.

.4 Keyways to be Abloy cylinders and Padlocks - No Alternatives.

.5 Hardware supplier will supply a sufficient number of unrestricted keyway cylinders to the Contractor to secure the perimeter of the building and one storage room. The Contractor will return the cylinders to the supplier upon turnover of the building.

3 Execution

3.1 INSTALLATION

- .1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.
- .2 Supply metal door and frame manufacturers with complete instructions and templates for preparation of their work to receive hardware.
- .3 Supply manufacturers' instructions for proper installation of each hardware component.
- .4 Install hardware to standard hardware location dimensions in accordance with CSDFMA Canadian Metric Guide for Steel Doors and Frames (Modular Construction).
- .5 Where door stop contacts door pulls, mount stop to strike bottom of pull.
- .6 Install key control cabinet.
- .7 Use only manufacturer's supplied fasteners.
 - .1 Use of "quick" type fasteners, unless specifically supplied by manufacturer, is unacceptable.

3.2 SECURITY SYSTEM INSTALLATION INSTRUCTIONS

- .1 Install electric strikes, consoles, and switches according to manufacturer's instructions.
- .2 Tag all wires and label each connection in tabular form indicating unit, location, lead, sig name, colour, pin and marker.
- .3 Commission system ensuring all doors function properly and according to approved schematics.

3.3 ADJUSTING

- .1 Adjust door hardware, operators, closures and controls for optimum, smooth operating condition, safety and for weather tight closure.
- .2 Lubricate hardware, operating equipment and other moving parts.
- .3 Adjust door hardware to ensure tight fit at contact points with frames.

3.4 CLEANING

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

- .2 Clean hardware with damp rag and approved non-abrasive cleaner, and polish hardware in accordance with manufacturer's instructions.
- .3 Remove protective material from hardware items where present.
- .4 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

3.5 DEMONSTRATION

- .1 Keying System Setup and Cabinet:
 - .1 Set up key control system with file key tags, duplicate key tags, numerical index, alphabetical index and key change index, label shields, control book and key receipt cards.
 - .2 Place file keys and duplicate keys in key cabinet on their respective hooks.
 - .3 Lock key cabinet and turn over key to Departmental Representative.
- .2 Maintenance Staff Briefing:
 - .1 Brief maintenance staff regarding:
 - .1 Proper care, cleaning, and general maintenance of projects complete hardware.
 - .2 Description, use, handling, and storage of keys.
 - .3 Use, application and storage of wrenches for door closers, locksets and fire exit hardware.
- .3 Demonstrate operation, operating components, adjustment features, and lubrication requirements.

3.6 PROTECTION

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

3.7 SCHEDULE

- .1 As attached to the end of this Section

END OF SECTION

HARDWARE SET 001

1	Single Door SB01A.1 Room SB01 From Vestibule SB01A		LHR
	900mm x 2150mm x 45mm	HMD x PSF STC55 Acoustic Doors	
1	Sets Cam Lift Hinges	Cam Lift Hinges By Door Supplier	
1	Locksets (F15)	L9485P-03B	626
1	Abloy Cylinders	CY415 x 28 x Cam To Suit	626
1	Closers	4040XP RW/PA	689
1	Kick Plates	K10A-900mm x 860mm x D/S Tape	32D
1	Floor Stops	S115	26D

Balance Of Hardware By Door Supplier**HARDWARE SET 002**

1	Single Door SB01A.2 Vestibule SB01A From Room SB05		RHR
	900mm x 2150mm x 45mm	HMD x PSF STC55 Acoustic Doors	
1	Sets Cam Lift Hinges	Cam Lift Hinges By Door Supplier	
1	Passage Set (F01)	L9010-03B	626
1	Closers	4040XP RW/PA	689
1	Kick Plates	K10A-900mm x 860mm x D/S Tape	32D
1	Floor Stops	S115	26D

Balance Of Hardware By Door Supplier**HARDWARE SET 003**

1	Single Door SB05.1 Corridor SBOE To Room SBO5		LH
	900mm x 2150mm x 45mm	HMD x PSF 45 Min. ATC55 Acoustic Door	
1	Sets Cam Lift Hinges	Cam Lift Hinges By Door Supplier	
1	Locksets (F15)	L9485P-03B	626
1	Abloy Cylinders	CY415 x 28 x Cam To Suit	626
1	Closers	4040XP RW/PA	689
1	Kick Plates	K10A-900mm x 860mm x D/S Tape	32D
1	Floor Stops	S115	26D

Balance Of Hardware By Door Supplier

1 General

1.1 RELATED REQUIREMENTS

- .1 Section 07 21 16 - Acoustic Insulation
- .2 Section 07 84 00 - Fire Stopping
- .3 Section 07 92 00 - Joint Sealing
- .4 Section 09 91 23 - Interior Painting

1.2 REFERENCES

- .1 ASTM International
 - .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 A1008/ A1008M-15: Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
 - .3 ASTM C473-15: Standard Test Methods for Physical Testing of Gypsum Panel Products.
 - .4 ASTM C474-15: Standard Test Methods for Joint Treatment Materials for Gypsum Board Construction.
 - .5 ASTM C475/C475M-15: Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
 - .6 ASTM C645-13: Standard Specification for Nonstructural Steel Framing Members.
 - .7 ASTM C754-15: Standard Specification for Installation of Steel Framing Members to Receive Screw Attached Gypsum Panel Products.
 - .8 ASTM C840-13: Standard Specification for Application and Finishing of Gypsum Board.
 - .9 ASTM C919-12: Standard Practice for Use of Sealants in Acoustical Applications.
 - .10 ASTM C1002-14: Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
 - .11 ASTM C1047-14a: Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base.
 - .12 ASTM C1280-13a: Standard Specification for Application of Gypsum Sheathing Board.
 - .13 ASTM C1396/C1396M-14a: Standard Specification for Gypsum Board.
- .2 AWCC: Association of Wall and Ceiling Contractors/Wall & Ceiling Institute, Specification Standards Manual, 2012 (5th Edition).

- .3 Association of the Wall and Ceilings Industries International (AWCI)
 - .1 AWCI Levels of Gypsum Board Finish.
- .4 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-10: Standard Method of Test of Surface Burning Characteristics of Building Materials and Assemblies.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements 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 gypsum board assemblies materials level off ground, indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect gypsum board assemblies from nicks, scratches, and blemishes.
 - .3 Protect from weather, elements and damage from construction operations.
 - .4 Handle gypsum boards to prevent damage to edges, ends or surfaces.
 - .5 Replace defective or damaged materials with new.
 - .6 Do not load any area of the building beyond the design limits.

1.5 EXAMINATION

- .1 Examine drawings, details and schedules. Determine the intent, extent, materials, location, conditions of interfacing with other work. Be aware of requirements set out therein.
- .2 Inspect surfaces on which the work of this Section is dependent, for unevenness, moisture and other irregularities detrimental to the application and performance of the work. Confirm that conditions are satisfactory before proceeding.
- .3 Examine and co-ordinate work with other trades and ensure that anchors, blocking, grounds, electrical conduit, wiring and mechanical work, which is to be installed in or behind work of this Section, has been installed, tested and accepted.

- .4 Inspect existing conditions which will affect the Work of this Section. Report any unacceptable conditions to the Departmental Representative. Do not proceed with Work of this Section until unacceptable conditions have been rectified. Starting Work implies acceptance of existing conditions.

1.6 PROTECTION

- .1 Protect the work against damage by others, from weather or other causes. Protect other work against damage. Make good any damage caused.
- .2 Protect other surfaces from accidental application of taping compound, take particular care with finished surfaces and glass. Restore damaged work to its original condition.

1.7 AMBIENT CONDITIONS

- .1 Maintain temperature 10 degrees C minimum, 21 degrees C maximum for 48 hours prior to and during application of gypsum boards and joint treatment, and for 48 hours minimum after completion of joint treatment.
- .2 Apply board and joint treatment to dry, frost free surfaces.
- .3 Ventilation: ventilate building spaces as required to remove excess moisture that would prevent drying of joint treatment material immediately after its application.

1.8 FIRE RATED CONSTRUCTION

- .1 Erect materials and components to partitions and the like, which are required to have a fire resistance rating, to meet the Authority Having Jurisdiction listed requirements for the required rating.
- .2 Where a ULC (or other testing laboratory) listing is quoted, ensure that all work and materials comply with the listed requirements, or are approved by the Authority Having Jurisdiction.
- .3 Erect fire rated partitions to provide the fire separations required. Confirm fire rated enclosures with mechanical & electrical drawings.

1.9 ACOUSTIC ASSEMBLIES

- .1 Maintain continuity of acoustic rated assemblies, including at junction with dissimilar adjacent materials and components.

2 Products

2.1 METAL STUDS, FURRING AND SUSPENSION MATERIALS

- .1 Metal studs: fabricated from hot dipped or wiped coat galvanized sheet steel conforming to ASTM C645 and CAN/CGSB-7.1-98. Flanges not less than 32 mm wide, edges bent back 90° and doubled over to form a 5 mm return. Faces knurled. Knock-out service holes at 600 mm centres. Widths as noted on the drawings. Use minimum 0.475 mm core thickness studs. Provide 0.672 mm base metal thickness studs at all door jambs.
- .2 Tracks: hot dipped galvanized sheet steel. Width to suit studs. Flanges to be 50 mm. Track base metal thickness is to match stud thickness as noted above.
- .3 Drywall furring channels: hat-shaped, from 0.457 mm core thickness hot-dipped galvanized sheet steel 22 mm deep x 32 mm wide face.
- .4 Other fasteners, clips, splices and the like: suitable for intended application.

2.2 GYPSUM BOARD

- .1 Regular Gypsum Board: to ASTM C1396/C1396M, plain, 15.9 mm thick or as indicated, x 1200 mm wide x maximum permissible length, ends square cut, edges tapered, paper/paper faced. For gypsum board in acoustically rated partitions, use type X gypsum board conforming to ASTM C1396/1396M, whether drawings indicate Type X gypsum board or not.
- .2 For use in fire rated construction: to ASTM C1396/C1396M, Type 'X' special ULC approved fire retardant type, 15.9 mm thickness unless noted otherwise, 1200 mm wide x maximum permissible length, ends square cut, edges tapered, paper/paper faced. Where required to meet ULC or Intertek Testing Services (Warnock Hersey) designs, use "C" formulation fire rated gypsum board, to the satisfaction of the Authority Having Jurisdiction.

2.3 MISCELLANEOUS MATERIALS

- .1 Tape: to ASTM C475, 50 mm wide spark perforated tape; as recommended by the gypsum board manufacturer.
- .2 Jointing compound: to ASTM C475, slow setting, vinyl bedding and finishing compound, as recommended by gypsum board manufacturer.
- .3 Screws: to ASTM C1002, type W for application of gypsum board to wood, Type S for application of gypsum board to metal framing and type G for application of gypsum board to gypsum board; Power drilling self-applying type, case hardened, socketed countersunk head, galvanized, of type and sizes recommended by gypsum board manufacturer and as required for fire rated partitions.

-
- .4 Trim: conforming to ASTM C1047; minimum 0.5 mm thickness commercial grade sheet steel with wiped coat zinc finish to ASTM A924/A924M, type specially design for use in gypsum board applications, flanges designed to be concealed with taping compound and as follows:
 - .1 Casing beads and trim: metal or metal and paper combination "J" type, beaded angle, with one side perforated for joint filling, to suit gypsum board thickness.
 - .2 Corner beads: square, metal or metal and paper combination, beaded angle, flanges 28.6 mm or 32 mm.
 - .3 Expansion joints: preformed metal, beaded, with one side perforated for joint filling.
 - .4 Control Joints: to ASTM C1047, pre-formed galvanized metal or plastic "V" type, perforated flanges.
 - .5 Acoustical sealant: To ASTM C919 as specified in Section 07 92 00.
 - .6 Fasteners: manufacturer's standard suitable for intended application.
 - .7 Wood and Plywood blocking, framing and backing: as specified in Section 06 10 00 - Rough Carpentry.
 - .8 Fire safing filler: rock wool or mineral fibre, conforming to ASTM C612.
 - .9 Polyethylene Gaskets: 6 mm thick x 89 mm wide, polyethylene foam, "Ethafom 222" as manufactured by Dow Chemical Company or Foam Seal R as manufactured by Owens Corning or preapproved product.
- 3 Execution
- 3.1 EXAMINATION
- .1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for gypsum board assemblies 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 PREPARATION
- .1 Do not commence work of this Section until all framing is acceptable to receive gypsum board.
- 3.3 ERECTION/METAL STUDS

-
- .1 Install metal studs and framing in accordance with AWCC Specification Standards Manual, Section 9.2.
 - .2 Execute work neatly and accurately, plumb and true, co-ordinated with work of other trades.
 - .3 Align walls correctly on accepted lay-out.
 - .4 Install continuous polyethylene gasket to underside of track to all partitions containing acoustic batt insulation. Also, install polyethylene gasket where studs abutting existing and dissimilar construction. Install studs tight against gasket to form a complete acoustic seal. At corners, intersections and end joints, overlap gasket minimum 75 mm.
 - .5 Floor and overhead tracks:
 - .1 For partitions extending to underside of structure, anchor the galvanized sheet metal channel retaining the top track (for deflection control) to sheet metal blocking or underside of structure using drilled screw on fasteners at 600 mm o.c. to concrete structure. Form the upper track 1.6 mm wider to nest with the lower. Screw studs to the lower track, near the bottom edge of the flange. **DO NOT SCREW STUDS OR TOP CHANNEL THROUGH TO RETAINING CHANNEL.**
 - .2 Where top track is exposed to permit structural deflection, completely fill void between double track with 'Fire Safing Insulation'.
 - .3 Secure floor track in place to concrete slab, at 600 mm o.c. using drilled screw on fasteners or other accepted fasteners. At exterior walls secure floor track in place to concrete slab, at 600 mm o.c. using drilled screw in anchors.
 - .6 Position studs vertically in the tracks, spaced not more than 400 mm o.c., unless indicated otherwise and not more than 50 mm from abutting walls, and at each side of openings and corners. Crimp lock studs to tracks except where screw fixing is specified or required, such as to top track where double top track is indicated. At door frames and other frames, double up jamb studs. Use minimum 0.762 mm base metal thickness studs at both door jambs.
 - .7 Construct corners using minimum three studs.
 - .8 Provide one continuous row of horizontal bracing in all partitions up to 2.7 m in height, two rows equally spaced in partitions 2.7 m to 3.6 m in height. Over 3.6 m in height provide one addition row of bracing for every additional 1.2 m of wall height.
 - .9 For partitions type with 92 mm wide studs or smaller, with ceiling on one side or no ceiling on either side of partition, provide diagonal bracing where required. Install so that underside of bracing is approximately 600 mm above underside of adjacent ceilings. To all other locations, install horizontal carrying channel brace at 1200 mm maximum o.c. to interior walls more than 2.4 m high, unless indicated otherwise.
 - .10 Erect metal studding to tolerance of 1:1000.

-
- .11 Co-ordinate simultaneous erection of studs with installation of service lines. When erecting studs ensure web openings are aligned. Install gaskets for all plumbing supports in steel stud walls.
 - .12 Jog framing around mechanical ducts or joists as required to maintain fire ratings.
 - .13 Set door and similar frames into position, align and brace securely until properly anchored. Anchor bottom of door frames to floors with drilled inserts. Install temporary horizontal spreader at door mid-height to ensure maintenance of frame width until adjacent work is completed. After removing bottom (steel) spreader, grind frame smooth.
 - .14 Erect track at head of door/window openings and sills of sidelight/window openings to accommodate intermediate studs. Secure track to studs at each end, in accordance with manufacturer's instructions. Install intermediate studs above and below openings in same manner and spacing as wall studs.
 - .15 Frame openings and around built-in equipment, cabinets, access panels, on four sides. Extend framing into reveals. Check clearances with equipment suppliers.
 - .16 Install header framing suspended from structure using screws only.
 - .17 Extend all metal stud partitions to underside of structure except where indicated otherwise.
 - .18 Allow for structural deflection on all stud walls which terminate at underside of structure, as follows:
 - .1 For non-fire rated walls, allow + 25 mm.
 - .2 For fire rated walls, allow + 15 mm.
 - .19 At openings, install cut-to-length sections of track with web flanges bent at each end and securely attached to jamb studs. Where directed, place end infill studs so that it is possible to have a control joint in line with a door jamb. Frame for all openings larger than 150 mm diameter or side.
 - .20 Install steel studs or furring channel between studs for attaching electrical and other boxes.
 - .21 Form control joints in long runs of wall. Place double studs so that control joints will be no more than 9 m apart. Wherever possible locate control joints at door or window jambs or as otherwise indicated on the drawings.
 - .22 Make allowance for packings to furring and the like, as required to provide vertical and true plane surfaces when furring to and around concrete work.
 - .23 Where polyethylene gasket is used, ensure that it is compressed for its entire length, to provide acoustic seal.

3.4 APPLICATION /GYPSUM BOARD

-
- .1 Generally, apply gypsum board to the requirements of the ASTM C840 and to the AWCC Specification Standards Manual, Section 9.5 and other referenced standards.
 - .2 Ensure that blocking, electrical and mechanical work required in or behind gypsum board has been installed and accepted.
 - .3 Install gypsum board with face side out.
 - .4 Apply gypsum board to framing with self-drilling screws of suitable length driven with power screw driver and set with countersunk head slightly below gypsum board surface. Screw spacing to ASTM C840 and ASTM C1280 and as noted below. Do not secure gypsum board to top track where deflection is to be accommodated.
 - .5 Install screws at a maximum of 200 mm o.c. at periphery of board and at 300 mm o.c. in field, along each framing member for both single and double application. For fire rated assemblies, install screws at 175 mm o.c. for partition.
 - .1 Single-Layer Application:
 - .1 Apply gypsum board on ceilings prior to application of walls to ASTM C840.
 - .2 Apply gypsum board vertically or horizontally, providing sheet lengths that will minimize end joints.
 - .2 Double-Layer Application:
 - .1 Install gypsum board for base layer and exposed gypsum board for face layer.
 - .2 Apply base layer to ceilings prior to base layer application on walls; apply face layers in same sequence. Offset joints between layers at least 250 mm.
 - .3 Apply base layers at right angles to supports unless otherwise indicated.
 - .4 Apply base layer on walls and face layers vertically with joints of base layer over supports and face layer joints offset at least 250 mm with base layer joints.
 - .6 For double layer application, use fire rated gypsum board for first layer; screw apply the second layer of fire rated gypsum board in accordance with fire rating test requirements. Stagger joints of second layer over underlay.
 - .7 Apply gypsum tile backer to framing using screws at 150 mm oc along each framing member.
 - .8 Install gypsum board to the face of framing around openings where there is no other finish. Use gypsum board to satisfy all Alberta Building Code 2014 and National Building Code of Canada 2010 requirements. Install gypsum board to framing around openings at fire damper locations, to match adjacent gypsum board on walls and to maintain the required fire ratings and to meet all Alberta Building Code 2014 and National Building Code of Canada 2010 requirements.

-
- .9 Fit gypsum board openings snugly to electrical outlets, plumbing piping, and the like, and make small enough to be covered by plates and escutcheons. Cut both face and back paper for all cut-outs not made by saw. Seal around all openings using accepted sealant. In fire rated partitions, ensure that sealant proposed is acceptable to the Authority Having Jurisdiction. Ensure cut-outs for electrical installations are neatly done using a saw or knife. Back-cut for clearance to plaster ring. Do not punch holes.
 - .10 Install control joints in walls and ceilings using back-to-back filled metal beads with 200 mm strip of poly sheet backing, or manufactured control joint with recess for caulking. Install each member or side of control joint on a separate framing member. Install at 9 m o.c., at locations acceptable to the Departmental Representative.
 - .11 Install gypsum board vertically with joints occurring on studs.
 - .12 Install gypsum board with a minimum 6 mm and maximum 12 mm space between floor and bottom of gypsum board.
 - .13 In fire-rated partitions and assemblies, maintain the fire-rating maintained behind receptacles, switches, panel boxes, and any other penetration of the wall, as required by the Authority having Jurisdiction and the NBCC 2010.
 - .14 Verify that all gypsum board is tight to framing prior to application of tape and joint compound and trim.
 - .15 Infill, repair, patch and make good existing gypsum board surfaces where damaged or demolished due to work of this contract. Use gypsum board type and thickness to match existing gypsum board. Ensure that openings are filled in with gypsum board and that surfaces are flush with tight joints.

3.5 ACCESSORIES

- .1 Erect accessories straight, plumb or level, rigid and at the proper plane. Use full length pieces where practical. Make joints tight, accurately aligned and rigidly secure. Mitre and fit corners accurately, free from rough edges. Completely adhere in place in a bed of jointing compound wherever possible, elsewhere, secure at 800 mm o.c.
- .2 Place casing and corner beads straight and rigid. Secure in place in a continuous bed of jointing compound. For metal corner and casing bead, secure in place at maximum 225 mm o.c. Use longest practical lengths. Place corner beads at all external corners. Place fill type casing beads where gypsum board abuts a dissimilar material.
- .3 Install fill type casing beads where gypsum butts against surfaces having no trim concealing the junction. Secure beads as for corner beads.
- .4 At junctions of partitions and suspended acoustic ceilings, use corner bead in lieu of casing bead and use dust strips of polyethylene film. Install to achieve a true, even and level top edge to the gypsum board.

-
- .5 At junctions between gypsum board ceilings and concrete block walls, install fill type casing bead tight to walls around edge of ceiling, and fill joint between ceiling and wall with latex caulking prior to painting.
 - .6 In non-fire rated partitions and ceiling form control joints using one piece control joint or back-to-back casing beads with polyethylene dust protector behind joint.
 - .7 In fire rated partitions and ceilings, install 2 studs at either side of the control joints. Install 2 layers of 15.9 mm thick fire rated gypsum board to the full length and width of the stud web at the control joint. Install second stud with 15.9 mm joint between stud face and face of gypsum board applied to the other stud web as indicated in current edition Gypsum Association Fire Resistance Design manual. Ensure that control joints are centred on the edge of the 2 layers of gypsum board applied to the stud web. Fasten backing and facing panels on one side of joint only. Install one piece control joint at face of gypsum board, as specified for non-fire rated gypsum board control joints.
 - .8 Control joints to be at 9 metres o.c. maximum for ceilings and partitions.
 - .9 At locations where deflection tracks occurs, and the gypsum sheathing or gypsum board extends up above the deflection tracks, provide a 25 mm wide horizontal control joint in the gypsum board occurring at the deflection track location, to allow for the deflection in the studs and gypsum board or gypsum sheathing.

3.6 ACCESS PANELS

- .1 Install access panels provided by the mechanical and electrical trades, in positions as directed by them. Erect plumb and square. Leave clean and operable.

3.7 FINISHING

- .1 Mix joint compound in accordance with manufacturer's specifications. Finish joints in accordance with AWCC Specifications Standards Manual to produce smooth surfaces ready to receive finishes.
- .2 Fill gaps and screw depressions with two coats of joint compound. Allow preceding coat to set before applying second coat.
- .3 On corners apply joint compound to one side of corner and allow to set before applying compound to the other side of corner.
- .4 Apply a thin coat of joint compound over the board on each side of joint and embed the reinforcing tape and roll firmly in place. Cover edges of tape with a thin coat of joint compound. Neatly crease tape at internal corners.
- .5 To fibreglass faced gypsum board, where fibreglass tape is used, install fibreglass tape into bedding compound as recommended by the manufacturer.

-
- .6 Apply joint compound over the flanges of corner and casing beads flush with nose of the bead and extending at least 75 mm onto the surface of the board.
 - .7 After bedding coat has set, apply a second coat of joint compound feathered at least 150 mm on each side of butt joint and 100 mm past the flanges of beads.
 - .8 After the second coat has set apply a third coat of joint compound and feather to 200 mm on each side of butt joints and 125 mm past the flanges of beads.
 - .9 Feather coats of joint compound onto adjoining surfaces so that joints, tape holes and flanges of beads are invisible and so that the camber is 1.6 mm maximum.
 - .10 After complete treatment has thoroughly set and after at least twenty-four (24) hours, sand the surface lightly with fine grit sandpaper to leave it smooth and ready for decoration.
 - .11 Ensure that finish work is seamless, plumb, true, flush and with square, plumb and neat corners. Sand lightly to remove burred edges and other imperfections. When sanding, avoid sanding adjacent surface of board and raising nap of paper face.
 - .12 Completed installation to be smooth, level or plumb, free from waves and other defects and ready for surface finish.
 - .13 Tape gypsum board in areas not exposed to view but need not be finished.
 - .14 Where new gypsum board meets existing gypsum board, tape and fill joints as specified above, to render joint between new and existing invisible.
 - .15 Retouch all defects in taping and filling and all other depressions or imperfections in gypsum board applications after the first prime application under illumination of not less than 540 lumens/m².
 - .16 Gypsum Board Finish: finish gypsum board walls and ceilings to following levels in accordance with AWCI and AWCC Levels of Gypsum Board Finish:
 - .1 Levels of finish:
 - .1 Level 1: embed tape for joints and interior angles in joint compound. Surfaces to be free of excess joint compound; tool marks and ridges are acceptable. Use level 1 finish to Where gypsum board is unexposed, such as above ceilings.
 - .2 Level 2: embed tape for joints and interior angles in joint compound and apply one separate coat of joint compound over joints, angles, fastener heads and accessories; surfaces free of excess joint compound; tool marks and ridges are acceptable. Use Level 2 finish to gypsum tile backer.
 - .3 Level 3: embed tape for joints and interior angles in joint compound and apply two separate coats of joint compound over joints, angles, fastener heads and accessories; surfaces smooth and free of tool marks and ridges. Where gypsum board surfaces are to receive special wall coating, finish to

a level 3 finish, if recommended by the special wall coating manufacturer; otherwise finish to a Level 4 finish.

- .4 Level 4: embed tape for joints and interior angles in joint compound and apply three separate coats of joint compound over joints, angles, fastener heads and accessories; surfaces smooth and free of tool marks and ridges. Use Level 4 where gypsum board surfaces are painted.

3.8 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .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 - Cleaning.

3.9 PROTECTION

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

END OF SECTION

1 General

1.1 SUMMARY

.1 Section Includes:

- .1 Materials and application of acoustical units for application and installation within a suspended ceiling.

1.2 RELATED REQUIREMENTS

- .1 Section 09 21 16 - Gypsum Board Assemblies

1.3 REFERENCES

.1 ASTM International:

- .1 ASTM A641/A641M-09: Specification for Steel Sheet, Zinc-Coated (galvanized) Carbon Steel Wire.
- .2 ASTM C423-09a: Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
- .3 ASTM C635/C635M-13a: Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.
- .4 ASTM C636/C636M-13: Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.
- .5 ASTM E84-15a: Standard Test Method for Surface Burning Characteristics of Building Materials.
- .6 ASTM E119-12a: Standard Test Methods for Fire Test of Building Construction and Materials.
- .7 ASTM E580/E580M-14: Standard Practice for Application of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Requiring Moderate Seismic Restraint.
- .8 ASTM E795-05(2012): Standard Practice for Mounting Test Specimens During Sound Absorption Tests.
- .9 ASTM E1111-07: Standard Test Method for Measuring Interzone Attenuation of Ceiling Systems.
- .10 ASTM E1264-14: Standard Classification for Acoustical Ceiling Products.
- .11 ASTM E1414/E1414M-11a: Standard Test Method for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum.
- .12 ASTM E1477-98a(2013): Standard Test Method for Luminous Reflectance Factor of Acoustical Materials by Use of Integrating-Sphere Reflectometers.

.2 CGSB Standards:

- .1 CAN/CGSB-92.1-M89: Sound Absorptive Prefabricated Acoustical Units.

.3 CISCA (AC) - Acoustical Ceilings: Use and Practice; Ceilings & Interior Systems Construction Association; Current Edition.

- .4 International Organization for Standardization (ISO):
 - .1 ISO 4611-2008: Plastic - Determination of the Effects of Exposure to Damp, Heat, Water Spray and Salt Mist.
 - .2 ISO 11654-2002: Sound Absorbers for Use in Buildings - Rating of Sound Absorption.
 - .3 ISO 14644-1: Classification of Air Cleanliness.
- .5 Underwriters' Laboratories of Canada (ULC):
 - .1 CAN/ULC-S102-10: Surface Burning Characteristics of Building Materials and Assemblies.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit product data, shop drawings and samples in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: submit manufacturer's standard product data for all acoustic ceiling tiles and suspension systems.
- .3 Shop Drawings:
 - .1 Clearly indicate all system components, types of grid and grid layout, suspension methods, requirements, and location of mechanical and electrical services and fixtures, details of components, finish, texture, and all related trim.
 - .2 Submit proposed methods for attaching hangers to soffits.
 - .3 Submit duplicate full size samples of each type acoustical units.

1.5 DESIGN

- .1 Design acoustical suspension systems for deflection not exceeding 1/360 of span, considering that lighting fixtures in ceiling area are directly or indirectly supported by the suspension systems.
- .2 Conform to the requirements of ASTM E580.

1.6 QUALITY ASSURANCE

- .1 Perform Work of this Section using a well established acoustical ceiling Subcontractor, employing skilled mechanics. Ensure installer has minimum of five years experience in performance of product application.
- .2 Use a manufacturer specializing in manufacturing of the type of acoustic ceilings specified in this Section, with a minimum of five (5) years of documented successful experience, and have the facilities capable of meeting all requirements of Contract Documents as a single-source responsibility and warranty.
- .3 Submit manufacturer's certification that materials meet or exceed specified requirements.

-
- .4 Obtain each type of acoustic ceiling tile and T bar grid through one source from a single manufacturer and from the same production run.
 - .5 Provide acoustic ceilings that comply with the following requirements:
 - .1 Surface-Burning Characteristics: provide acoustic panels with surface burning characteristics complying with CAN/ULC-S102, for class "A" materials as determined by testing identical products as per CAN/ULC-S102.
 - .6 Mock-up:
 - .1 Construct mock-ups in accordance with Section 01 45 00 - Quality Control.
 - .2 Construct mock-up 10 m² minimum of each type acoustical tile ceiling including one inside corner one outside corner.
 - .3 Construct mock-up where directed.
 - .4 Allow 72 hours for inspection of mock-up by Departmental Representative before proceeding with ceiling work.
 - .5 When accepted, mock-up will demonstrate minimum standard for this work. Mock-up may remain as part of the finished work.
 - .7 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.7 DELIVERY, STORAGE AND HANDLING

- .1 Protect on site stored or installed absorptive material from moisture damage.
- .2 Store extra materials required for maintenance, where directed by Departmental Representative.
- .3 Deliver material to the job site, store and handle in original packages, in an undamaged condition, with the manufacturer's seals and labels intact.
- .4 Do not pile acoustical materials more than 6 cartons high.
- .5 Store materials to prevent damage caused by water or breakage, until ready to use.
- .6 Damaged materials will be rejected.

1.8 ENVIRONMENTAL REQUIREMENTS

- .1 Permit wet work to dry before beginning to install and until mechanical, electrical and all other systems installed above the ceiling are inspected, tested and accepted.
- .2 Maintain uniform minimum temperature of 15 degrees C and humidity of 20% before and during installation.
- .3 Store materials in work area 48 hours prior to installation.

1.9 EXTRA MATERIALS

- .1 Provide extra materials of acoustic units in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Provide acoustical units amounting to 2% of gross ceiling area for each pattern and type required for project, from the same production run as the installed tiles.
- .3 Ensure extra materials are from same production run as installed materials.
- .4 Clearly identify each type of acoustic unit, including colour and texture.
- .5 Deliver to Departmental Representative, upon completion of the work of this section.

2 Products

2.1 ACOUSTIC TILE

- .1 Acoustic units for suspended ceiling system: to CAN/CGSB-92.1 and ASTM E1264; sizes, patterns and types as indicated in the Finish Schedule.
 - .1 Flame spread rating of 25 or less in accordance with CAN/ULC-S102.
 - .2 Class A fire rating in accordance with CAN/ULC-S102.
 - .3 Noise Reduction Coefficient (NRC) designation of 0.55.
 - .4 Ceiling Attenuation Class (CAC) rating 35, in accordance with ASTM E1264
 - .5 Light Reflectance (LR) range of 0.82 to ASTM E1477.
 - .6 Edge type: square.
 - .7 Colour: white.
 - .8 Size 610 mm x 1220 mm x 16 mm thick.
 - .9 Shape flat.

2.2 SUSPENSION SYSTEMS

- .1 Suspension System: non fire rated standard profile exposed tee bar grid conforming to ASTM C635, as follows:
 - .1 Commercial quality cold rolled steel zinc coated, shop painted flat], white. Die cut interlocking components. Main and cross tee of double web with rectangular bulb, depth governed by span. Include wall moulding. All components 23.8 mm exposed face.

2.3 ACCESSORIES

- .1 Hangers: pre-stretched galvanized annealed steel wire of adequate gauge for the specified design conditions.
- .2 Fasteners to underside of structure: to concrete structure, use expansion anchor to suit installation. To wood structure, screw connections with eyebolts.

-
- .3 Splices, stabilizer bars: as required to complete and complement the suspended ceiling grid system.
 - .4 Edge Trim: 0.556 mm thick zinc coated cold rolled steel with flat white baked enamel matte finish, 23.8 mm wide on exposed face, regressed edge profile.
 - .5 Hold down clips: purpose made clips to secure tile to suspension system, approved for use in fire-rated systems and for use above firing lines.

3 Execution

3.1 EXAMINATION

- .1 Do not install acoustical panels and tiles until work above ceiling has been inspected by Departmental Representative.

3.2 INSTALLATION

- .1 Perform Work in strict accordance with material manufacturer's directions to produce an installation in accordance with the workmanship and performance clauses of the Code of Practice of 'The National Acoustical Contractors Association' and ASTM C636.
- .2 Install ceiling suspension systems to lay-out and heights indicated on reflected ceiling plans.
- .3 Install suspension system level within a tolerance of 1:1000. Finished ceiling system to be square with adjoining walls.
- .4 Install runners supporting ceiling fixtures to remain horizontal across their width within 2 degrees after the fixture loads are imposed.
- .5 Attach hangers to underside of the structure using appropriate fasteners to suit existing conditions and to withstand all superimposed loading. Obtain Departmental Representative's acceptance of hanger fastenings.
- .6 Install hangers at 1.2 m maximum oc and within 150 mm from ends of main tees; securely attach to the overhead structure. Install additional hangers at each corner of light fixtures and diffusers. Ensure hangers are well hooked and twisted to prevent loosening under load. Position wire ends so lifting out does not cause damage to ceiling board.
- .7 Install hangers perpendicular to the ceiling both ways. Hangers installed at an angle to the ceiling will not be accepted.
- .8 Co-ordinate the location of hangers with other work. Ensure layout of hangers and carrying channels are located to accommodate fitting and equipment to be placed after installation of ceilings.
- .9 Hang independently of walls, columns, ducts, pipes and conduit.

- .10 Install the main tees and cross tees at correct centre to receive the acoustic tile. Install all acoustic tiles, cut tiles as required.
- .11 Install systems in each room or area symmetrical with all other panels of equal dimension, or as otherwise noted in the reflected ceiling plan.
- .12 Install fixtures so that main runners and cross runners are not eccentrically loaded. Where fixture installation would produce rotation of runner, provide stabilizer bars.
- .13 Install regressed edge mouldings at intersection of ceiling and vertical surfaces, using maximum lengths, straight, true to line and level. Mitre all corners. Provide edge mouldings at junction with other ceiling finishes.
- .14 Under no circumstances suspend the ceiling grid system from any mechanical and electrical work.
- .15 Under no circumstances support or suspend any mechanical work from the ceiling suspension system.
- .16 Immediately reject acoustic board panels which are damaged in any way.
- .17 Ensure exposed grids, tiles, and accessories, are free from waves, smears, sags, soiling, dents, and all other defects.
- .18 Do not use "tees" which are chipped, cut, bent out of alignment or damaged in any way and reject immediately.
- .19 Where perimeter supply air diffusers are located, install double tees to accommodate diffusers.
- .20 Install tiles, cut tiles as required. Do not mix lots in the same ceiling area.
- .21 Fit acoustic board in place, free from damaged edges or other defects detrimental to appearance and function.
- .22 Install hold-down clips on all lay in tiles to hold such tiles tight to grid system within 3 m of exterior doors and to ceiling tiles within 2440 mm of firing lines.
- .23 Co-operate with the respective trades regarding the installation of ceiling mounted objects. Cut holes for diffusers, light fixtures, grilles, speakers, smoke detectors, sprinklers, alarms and the like which are to be installed in the ceiling board. Cut and neatly form and fit openings in ceilings.
- .24 Provide all T bar as required to accommodate mechanical and electrical items such as light fixtures, diffusers and the like.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .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 - Cleaning.
- .3 Following installation, clean soiled or discoloured surfaces of suspension system and of acoustical board.

3.4 ADJUSTMENTS

- .1 At completion, replace any uneven or defective work, eliminate any waves and sags, and remedy any damage to exposed surfaces.

END OF SECTION

1 General

1.1 REFERENCES

- .1 ASTM International
 - .1 ASTM F1859-14: Standard Specification for Rubber Sheet Floor Covering Without Backing.
 - .2 ASTM F1861-08(2012)e1: Standard Specification for Resilient Wall Base.
 - .3 ASTM F1869-11: Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
 - .4 ASTM F2034-08(2013): Standard Specification for Sheet Linoleum Floor Covering.
 - .5 ASTM F3041-14: Bonded Rubber Crumb Floor Coverings.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for resilient sheet flooring and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Samples:
 - .1 Submit four (4), 300 x 300 mm sample pieces of sheet material, 300 mm long treads, base, edge strips, nosing.
- .4 Submit seaming plan for review.
- .5 Maintenance Data: Submit maintenance instructions for insertion in operations and maintenance manuals include recommended methods and frequency of maintenance for maintaining optimum condition of work under anticipated usage and use conditions. Include precautions against using cleaning materials and methods that may be detrimental to finishes and performance. Include product data for maintenance products recommended by installer and names, addresses, and telephone numbers of local sources for products.

1.3 QUALIFICATIONS

- .1 Installers Qualifications: Trained and approved by the manufacturer and having a minimum five (5) years experience in the installation of the work described in this Section and can show evidence of satisfactory completion of projects of similar size, scope and type with a record of successful in-service performance. If requested, provide letter of certification from manufacturer stating that installer is certified applicator of its products, and is familiar with proper procedures and installation requirements required by the manufacturer.
 - .1 Qualifications include having the necessary experience, staff, and training to install manufacturer's products. Manufacturer's willingness to sell its products to installers does not in itself confer qualification on installer.
 - .2 Mechanics installing resilient flooring to have a minimum of five (5) years experience in heat welding installation of linoleum flooring in institutional or related facilities.
 - .3 Installers of linoleum to be trained and approved by the linoleum manufacturer and must be a manufacturer's master Installer.
- .2 Source Limitations: Obtain each type of product from a single manufacturer.
- .3 Products: Provide like Products from same production run. Install Products in sequence from sequentially numbered dye lots.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Materials:
 - .1 Provide extra materials of resilient sheet flooring and adhesives in accordance with Section 01 78 00 - Closeout Submittals.
 - .2 Provide 2% extra of each colour, pattern and type flooring material in full roll widths, required for project for maintenance use.
 - .3 Extra materials one piece and from same production run as installed materials.
 - .4 Identify each roll of sheet flooring and each container of adhesive.
 - .5 Deliver to Departmental Representative, upon completion of the work of this section.
 - .6 Store where directed by Departmental Representative.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section with manufacturer's written instructions and 01 61 00 - Common Product Requirements.
- .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, indoors, off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

- .2 Store and protect specified materials from damage.
- .3 Replace defective or damaged materials with new.

1.6 SITE CONDITIONS

- .1 Store flooring materials in area of application and allow three days for material to reach the area air temperature.
- .2 Maintain temperatures within range recommended by the manufacturer, but not less than 20°C or more than 29°C at flooring installation area for three (3) days prior to, during and for two (2) days after installation. Arrange for controlled ventilation during this period to avoid high humidity and cold drafts.
- .3 After post installation period, maintain temperatures within range recommended by manufacturer, but not less than 13°C or more than 35°C.
- .4 Install floor coverings after other finishing operations, including painting, have been completed.
- .5 Perform moisture tests on all slabs receiving floor finishes, using the Calcium Chloride Test procedure in accordance with ASTM F1869. Conduct one test for every 93 m² of flooring with test results not exceeding 1.36 kg per 93 m². If moisture content exceeds 1.36 kg per 93 m² or as otherwise recommended by the flooring manufacturers at time of installation of flooring, then apply moisture reduction barrier over slabs prior to installation of flooring.
- .6 Store all linoleum products in the building to acclimatize linoleum as recommended by the manufacturer prior to installation, under proper and protected ventilation. Ensure that the building is weather tight and dry with all exterior doors and windows in place.

1.7 PROTECTION

- .1 Lay protective covering in traffic areas. Maintain floors in good condition until completion.
- .2 Apply the specified floor finishing as soon as possible after flooring application to protect the surface.
- .3 Prohibit traffic from floor finish for two days after installation.
- .4 Protect the walls and work of other Sections before and during the execution of the work of this Section.

1.8 SITE MEETING

- .1 Before commencement of work on site, arrange a site meeting to be attended by the General Contractor's superintendent, the Subcontractor's representative, the

Subcontractor's foreman for this project, the flooring manufacturer's representative, and the Departmental Representative.

- .2 Specifications and details will be reviewed, including the following:
 - .1 Scheduling for manufacturer's supervision.
 - .2 Confirmation of all colours, patterns, samples and miscellaneous materials.
 - .3 Condition of surfaces.
 - .4 State of completion of areas.
 - .5 Protection of finished floor surfaces.
 - .6 Temperature conditions.
 - .7 Rolling requirements.
 - .8 Floor dressing requirements.

1.9 MANUFACTURER SUPERVISION

- .1 Make necessary arrangements for initial installation of floor covering materials, to be supervised by the material manufacturer's representatives.
- .2 Obtain Material manufacturer's representative written assurance that installation is carried out in accordance with manufacturer's specification. Should such specifications conflict with these specifications, inform the Departmental Representative.
- .3 Ensure that the manufacturer's representative makes the inspections together with the Departmental Representative's Site Representative.

2 Products

2.1 MATERIALS

- .1 Linoleum sheet flooring (RES-1): to ASTM F2034, composed of natural ingredients which are mixed and calendered onto a jute backing:
 - .1 Type: 1, linoleum sheet with backing.
 - .2 Backing: jute.
 - .3 Width: 2 metres.
 - .4 Pattern: marbleized.
 - .5 Thickness: 2.5 mm.
 - .6 Manufacturer, Colour and Type: as indicated in the Finish Schedule.
- .2 Rubber sheet flooring (RRF-1): post consumer recycled vulcanized rubber, and coloured rubber EPDM chips, bonded rubber crumb floor covering conforming to ASTM F3041, Type 1 & 2, Class A, B, C & D.
 - .1 Width: 1220 mm.
 - .2 Length: 15.09 m
 - .3 Thickness: 9.52 mm (3/8")
 - .4 Manufacturer, Colour and Type: as indicated in the Finish Schedule.
- .3 Resilient base (RCB-1): continuous, top set, complete with premoulded end stops and external corners:

-
- .1 Type: rubber.
 - .2 Style: cove.
 - .3 Thickness: 3.17 mm.
 - .4 Height: 101.6 mm.
 - .5 Lengths: cut lengths minimum 2400 mm.
 - .6 Manufacturer, Colour and Type: as indicated in the Finish Schedule.
- .
- i) Primers and adhesives: of types recommended by resilient flooring manufacturer for specific material on applicable substrate, above, on or below grade.
- .4 Sub-floor filler and leveller: white premix latex requiring water only to produce cementitious paste as recommended by flooring manufacturer for use with their product.
 - .5 Welding Rod: designed to weld seams of sheet flooring, as recommended by flooring manufacturer, colour to match flooring material.
 - .6 Metal edge strips:
 - .1 Aluminum extruded, smooth, polished stainless steel with lip to extend under floor finish, shoulder flush with top of adjacent floor finish.
 - .7 Edging to floor penetrations: aluminum, type recommended by flooring manufacturer.
 - .8 Moisture Reduction Barrier: two component, solvent free, fluid applied breathable epoxy coating, specially formulated to treat high moisture vapour transmitting concrete surfaces as determined by a Calcium Chloride Test as per ASTM F1869. Moisture reduction barrier must be compatible with all flooring adhesives, self levelling compounds and components applied over it.
 - .9 Sealer and wax: type recommended by resilient flooring material manufacturer for material type and location.
- 3 Execution
- 3.1 EXAMINATION
- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for resilient sheet flooring 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.
 - .2 Examine surfaces in advance of application. Ensure that floors are protected from moisture entry.

- .3 Check floor surfaces for evidence of carbonation, dusting and excessive moisture. Ensure Concrete is at least 28 days old, straight, level and firm, free from grease, oil or other matter detrimental to bond. Do not apply resilient floor to any surface with moisture content in excess that which is recommended by the flooring manufacturer.
- .4 Ensure new floor surfaces are smooth and flat to plus or minus 3 mm over 3 metres.
- .5 Do not apply the work of this Section until work which is to receive it and site conditions are satisfactory.
- .6 Notify the Departmental Representative in writing of any defects in such surfaces. Commencement of work implies acceptance of surfaces and conditions.
- .7 When subfloors are ready for installation, request an inspection of the subflooring by the Departmental Representative and Flooring Manufacturer. Do not proceed with installation of resilient flooring until sub floors are acceptable to the Departmental Representative and flooring manufacturer.

3.2 SITE VERIFICATION OF CONDITIONS

- .1 Ensure concrete floors are clean and dry by using test methods recommended by flooring manufacturer.

3.3 PREPARATION

- .1 Remove existing resilient flooring, where applicable.
- .2 Remove or treat old adhesives to prevent residual, old flooring adhesives from bleeding through to new flooring and/or interfering with the bonding of new adhesives.
- .3 Clean floor and apply filler; trowel and float to leave smooth, flat hard surface. Prohibit traffic until filler cured and dry.
- .4 Remove sub-floor ridges and bumps. Fill low spots, cracks, joints, holes and other defects with sub-floor filler.
- .5 Prime sub-floor to resilient flooring manufacturer's printed instructions.
- .6 Before applying flooring adhesive or primer, sweep, clean and vacuum the area involved thoroughly with industrial vacuum cleaner. Remove all substances deleterious to adhesive bond.
- .7 Feather floors as required using substrate filler, to bring floor covering flush with adjacent floor surfaces such as porcelain tile, carpet and the like. Ensure that the area feathered is large enough so that no noticeable slopes or irregularities are created. Extend feathering out minimum 900 mm, and ramp slope maximum 1 in 30.

3.4 INSTALLATION/MOISTURE REDUCTION BARRIER

- .1 If the moisture content of slabs to receive flooring finishes including sports floorings, is greater than 1.36 kg per 93 m² at time of flooring installation or less as may be required by the flooring manufacturers, then apply moisture reduction barrier membrane over all slabs to receive flooring.
- .2 Ensure moisture reduction barrier is compatible with floor finishes and adhesives.
- .3 Apply moisture reduction barrier in strict accordance with manufacturer's recommendations. Prepare concrete surfaces in strict accordance with manufacturer's recommendations.
- .4 Apply moisture reduction barrier at rates as recommended by the manufacturer, to suit existing conditions.
- .5 Allow membrane to cure as recommended by the manufacturer, prior to application of self levelling compounds and finish flooring.
- .6 Ensure that the moisture reduction barrier installation is accepted by the Departmental Representative and the moisture reduction barrier manufacturer's representative prior to application of flooring.

3.5 APPLICATION GENERALLY

- .1 Install materials according to manufacturer's recommendations using mechanics skilled in the trade.
- .2 Consult other trades in advance and build in or make provisions for installation of their work to avoid cutting and patching.
- .3 Take necessary precautions to minimize noise, odors, dust and inconvenience during installation.
- .4 Spread adhesives, and primers where recommended, evenly over the entire surface according to manufacturer's directions, using correct type and notching of trowel as recommended by the flooring and adhesive manufacturer. Do not spread more adhesive than can be covered before the adhesive hardens. Install materials within time limit recommended by manufacturer. Remove any overdried adhesive and apply new adhesive.
- .5 Cut and fit neatly to frames, breaks, openings, fixtures and around all projections through flooring. Carry into all closets, toe spaces, recesses, and the like, and under all movable fittings.
- .6 Securely bond entire undersurface of flooring in place. Install flooring continuous through doorways for similar patterns. Roll flooring with 45.45 kg roller to ensure full bonding to floor.

-
- .7 Fit corners neatly and accurately scribe around door frames, fitments and such obstructions.
 - .8 Distribute variation in shade or pattern of production run to obtain a uniform effect. Abrupt variations will not be allowed.
 - .9 Install edge strips to unprotected or exposed edges where floor terminates. Cement edging strips with contact cement.
 - .10 Install reducer strips to unprotected or exposed edges where floor terminates against concrete floor, using one length pieces per locations wherever possible. If joints are required, use as few joints as possible. Cement reducer strips with contact cement.
 - .11 Install adapter strips between resilient flooring and carpeting, using one length pieces per locations wherever possible. If joints are required, use as few joints as possible. Cement adapter strips with contact cement.
 - .12 Install adapter strips at doorways with bottom weatherstripping or seals, so that the weatherstripping or seal does not occur directly over or interfere with adapter strip.
 - .13 Install reducer strips, adapter strips and edge strips in bed full adhesive, at interface of dissimilar floorings, where flooring terminates at floors, at flooring exposed edges and where indicated. Set mouldings with top flush with adjacent floorings. Locate mouldings below centre of door when door is in closed position, where doors occur.

3.6 APPLICATION: FLOORING

- .1 Provide high ventilation rate, with maximum outside air, during installation, and for 48 to 72 hours after installation. If possible, vent directly to outside. Do not let contaminated air recirculate through district or whole building air distribution system. Maintain extra ventilation for at least 1 month following building occupation.
- .2 Apply adhesive uniformly using recommended trowel. Do not spread more adhesive than can be covered by flooring before initial set takes place.
- .3 Lay flooring with seams parallel to building lines as indicated on the reviewed seaming plan, to produce a minimum number of seams. Border widths minimum 1/3 width of full material.
- .4 Run sheets in direction of traffic.
- .5 Heat weld seams of linoleum sheet flooring in accordance with manufacturer's printed instructions. Use fully filled welded seams to produce square, straight, flat joints. Install using the 'double pass' procedure. Install the abutting edges of the covering welded to form a homogeneous unit, under the action of hot air using a round welding bead.
- .6 Install sheet rubber flooring in strict accordance with manufacturer's recommendations.

- .7 Install continuously through doorways for similar patterns. Butt joints under doors if colours or patterns are dissimilar.
- .8 As installation progresses, and after installation roll flooring with 45 kg minimum roller to ensure full adhesion.
- .9 Cut flooring around fixed objects.
- .10 Continue flooring over areas which will be under built-in furniture.
- .11 Terminate flooring at centreline of door in openings where adjacent floor finish or colour is dissimilar.

3.7 APPLICATION: BASE

- .1 Lay out base to keep number of joints at minimum.
- .2 Clean substrate and prime with one coat of adhesive.
- .3 Apply adhesive to back of base.
- .4 Set base against wall and floor surfaces tightly by using 3 kg hand roller.
- .5 Install straight and level to variation of 1:1000.
- .6 Scribe and fit to door frames and other obstructions. Use premoulded end pieces at flush door frames.
- .7 Cope internal corners. Use premoulded corner units for right angle external corners. Use formed straight base material for external corners of other angles.

3.8 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .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 - Cleaning.
 - .1 Clean flooring and base surfaces to flooring manufacturer's printed instructions.

3.9 PROTECTION

- .1 Protect new floors from time of final set of adhesive until final inspection.
- .2 Prohibit traffic on floor for 48 hours after installation.
- .3 Use only water-based coating for linoleum.

GOVERNMENT OF CANADA

Existing Building Renovation

Alberta, Canada

Project No.: 144202775.215

Section 09 65 16

RESILIENT SHEET FLOORING

Page 10 of 9

END OF SECTION

1 General

1.1 REFERENCES

.1 ASTM Standards:

- .1 ASTM C413-01(2012): Standard Test Method for Absorption of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacing and Polymer Concretes.
- .2 ASTM C531-00(2012): Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
- .3 ASTM C579-01(2012): Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing and Polymer Concretes.
- .4 ASTM D523-14: Standard Test Method for Specular Gloss.
- .5 ASTM D580/D580M-10: Standard Specification for Greige Woven Glass Tapes and Webbing.
- .6 ASTM D635-10: Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
- .7 ASTM D638-10: Standard Test Method for Tensile Properties of Plastics.
- .8 ASTM D695-10: Standard Test Method for Compressive Properties of Rigid Plastics.
- .9 ASTM D790-10: Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
- .10 ASTM D1864/D1864M-89(2009)e1: Standard Test Method for Moisture in Mineral Aggregate Used on Built-Up Roofs.
- .11 ASTM D2047-11: Standard Test Method for Static Coefficient of Friction of Polish-Coated Flooring Surfaces as Measured by the James Machine.
- .12 ASTM D2240-05(2010): Standard Test Method for Rubber Property - Durometer Hardness.
- .13 ASTM D4060-10: Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser.
- .14 ASTM D4226-11: Standard Test Methods for Impact Resistance of Rigid Poly(Vinyl Chloride) (PVC) Building Products.
- .15 ASTM D4258-05(2012): Standard Practice for Surface Cleaning Concrete for Coating.
- .16 ASTM D4259-88(2012): Standard Practice for Abrading Concrete.
- .17 ASTM D4260-05(2012): Standard Practice for Acid Etching Concrete.
- .18 ASTM D4262-05(2012): Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces.
- .19 ASTM D4263-83(2012): Standard Test Method for Indicating Moisture in Concrete by Plastic Sheet.
- .20 ASTM D4541-09e1: Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
- .21 ASTM E84-15a: Standard Test Method for Surface Burning Characteristics of Building Materials.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for epoxy flooring and include product characteristics, performance criteria, thickness, finish and limitations.
- .3 Samples:
 - .1 Submit four (4), 300 x 300 mm sample of each type of epoxy flooring applied to Concrete. Submit additional samples until Departmental Representative's acceptance is obtained. Make changes in aggregate mix as required to secure correct colour and texture. Label sample(s) with Project name and number, applicator, names of material and manufacturer, colour, gloss, texture and aggregate mix proportion.
- .4 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.
- .5 Manufacturer's Instructions: submit manufacturer's installation instructions.

1.3 JOB MOCKUP

- .1 Construct mockup of epoxy flooring to a 5 m² area, in a location as directed by the Departmental Representative. Do not proceed until the mockup has been accepted by the Departmental Representative.
- .2 If accepted, the mockup may be incorporated into the work.
- .3 If it is not accepted, remove and re-install another mockup and do not proceed until mockup has been accepted by the Departmental Representative.

a) CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Provide specific instructions for maintenance, preservation and cleaning. Provide adequate warning of maintenance materials or practices which may be detrimental to flooring.

1.4 QUALITY ASSURANCE

- .1 Installer Qualifications: Trained and approved by the manufacturer and having a minimum five years experience in the installation of the work described in this Section and can show evidence of satisfactory completion of projects of similar size, scope and type with a record of successful in-service performance. If requested, provide letter of certification from manufacturer stating that installer is certified applicator of its products, and is familiar with proper procedures and installation requirements required by the manufacturer.
 - .1 Qualifications include having the necessary experience, staff, and training to install manufacturer's products. Manufacturer's willingness to sell its products to installers does not in itself confer qualification on installer.
- .2 Maintenance Seminars: Engage a factory authorized service representative to train Owner's maintenance personnel on proper maintenance procedures.
- .3 Pre-Installation Meeting: Prior to commencing work of this Section, arrange for manufacturer's technical representative to visit the site and review preparatory and installation procedures to be followed, conditions under which the work will be done, and inspect the surfaces to receive the work of this Section. Advise the Departmental Representative of the date and time of the meeting.
- .4 Manufacturer's Site Inspection: Have the manufacturer's technical representative inspect the Work at suitable intervals during application and at conclusion of the work of this Section, to ensure the Work is correctly installed. When requested, submit manufacturer's inspection reports and verification that the work of this Section is correctly installed.
- .5 Testing of Concrete Floors: Test floors that have been cured for minimum 28 days, and after preparation for Product installation is complete and patching or levelling compound is fully cured. Conduct testing simultaneously on floors free of sealer, curing compounds, oil, grease and other agents detrimental to the test and Product performance. Locate test sites to cover representative installation areas. Do not proceed with work when the test results do not conform to the specified allowable.
 - .1 Cohesive Strength: Minimum 1.45 MPa by tensile load as tested to CSA A23.2-6B. Do one test for every 9 sq.m. or fraction thereof.
 - .2 Moisture Vapour Transmission: ASTM D4263 plastic sheet method, no visible condensation or vapour allowed. Do one test for every 4.5 sq.m. or fraction thereof.
 - .3 Surface Moisture Content: Maximum 4%, tested by moisture meter. Do one test for every 4.5 sq.m. or fraction thereof.
 - .4 Surface Temperature: Minimum 3 degree C above the measured dew point.
- .6 Apply epoxy flooring in accordance with the most recent installation instructions of the manufacturer.

1.5 ENVIRONMENTAL REQUIREMENTS

-
- .1 Maximum moisture content of substrate: 4%.
 - .2 Temperature: maintain minimum temperature of substrate 12°C for a minimum of 48 hours before, during and after installation or until cured unless otherwise required by the flooring manufacturer. Minimum temperature of air during and for 48 hours after coating is applied 16°C.
 - .1 Alkali: Ensure negative alkalinity of substrate before application of coating.
 - .3 Alkali: Ensure negative alkalinity of substrate before application of coating.
 - .4 Ventilation: provide continuous ventilation during and after coating application to control dangerous vapour build-up, odours and fumes.
 - .5 Maintain well lit work area.
 - .6 Post and enforce "No smoking or open flame" signs until flooring has cured. Eliminate all spark producing devices (furnaces, all pilot lights, spark-producing switches and the like) in or near the work area.
 - .7 Provide uniform and sufficient lighting in areas of installation.
 - .8 Do not begin flooring installation until all other work which would cause damage, dirt dust or interruption of normal installation pace has been completed.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect epoxy flooring materials from damage.
 - .3 Protect prefinished surfaces with wrapping.
 - .4 Replace defective or damaged materials with new.
- .4 Designate a room for storage of flooring materials and equipment. Keep room neat and clean at all times, under lock and key, and surrounding surfaces protected from damage. Keep material temperatures at 16°C minimum.
- .5 Store flammable materials in safe, approved containers to eliminate fire hazards and remove from Site at end of each work shift.
- .6 Do not use materials that has been stored for period of time exceeding maximum recommended shelf life of materials

1.7 PROTECTION

- .1 Protect adjacent surfaces from damage resulting from work of this Section. If necessary, cover or mask adjacent surfaces to those receiving flooring including fixtures and equipment. Make good any damage so caused, to the satisfaction of the Departmental Representative.
- .2 Replace materials soiled during application, and from which soil cannot be completely removed, at no extra cost.
- .3 Ensure that spark-proof electrical equipment is used in areas where inflammable materials are being applied. Prevent use of open flames or equipment that may cause sparks.
- .4 Keep all traffic out of all areas receiving flooring until it has been completed and cured.
- .5 Apply temporary protection until floor is fully cured.

2 Products

2.1 MATERIALS

- .1 Epoxy Floor Coating (to flooring SFC-1): Low VOC, low odour, 100% solids; coating and sealer; slip-resistant finish; manufacturer, colour and type as indicated in on the Drawings.
- .2 Primer: As recommended by manufacturer supplying flooring material for types of surface to be primed.
- .3 Subfloor Filler: Compatible to floor coating and as recommended by coating manufacturer.
- .4 Joint and crack sealant: manufacturer's standard.
- .5 Surface conditioner: to manufacturer's standard.
- .6 Aggregate: manufacturer's standard as required to achieve a slip resistant finish.

3 Execution

3.1 INSPECTION

- .1 Ensure concrete floors conform to manufacturer's requirements.
- .2 Ensure that items penetrating coating are placed before application of coating.
- .3 Ensure that all surfaces are clean and dry.

- .4 Ensure slabs are properly sloped to drain and that a heavy polyethylene vapour retarder is installed under the slab.

3.2 PREPARATION OF SURFACES

- .1 Protect adjacent surfaces and equipment from damage by overspray, fall-out and dusting.
- .2 Ensure surfaces are clean, sound and dry; in all cases requiring some form of preparation. Prepare substrates in accordance with manufacturer's printed instructions.
- .3 Effectively remove concrete laitance by steel shot blasting, grit blasting or method approved by manufacturer.
- .4 Prefill and repair surface irregularities, holes, cracks and other defects in accordance with manufacturer's recommendations. Level subfloor with filler.
- .5 Clean subfloor free of laitance, oil, grease, curing and sealing compounds, hardeners, chemical additives and other foreign matter detrimental to flooring application.
- .6 Prepare concrete floors with shot blasting or other method recommended by manufacturer. Remove weak concrete, uneven joints, rough areas, foreign and projection off surfaces. Surface to be hard, and sound. Equip dry blasting machine with vacuum to minimize dust.
- .7 Blow clean control joints, sawcuts and cracks with compressed air and grout with material compatible with floor coating materials.
- .8 Ensure that gypsum board backing surfaces for cove bases are free of voids and irregularities.
- .9 Before commencement of application of flooring, ensure that concrete floors are acceptable in accordance with manufacturer's recommendations.
- .10 Commencement of work implies acceptance of surfaces and working conditions.

3.3 APPLICATION/EPOXY FLOORING

- .1 Ensure that floors have been prepared in accordance with manufacturer's instructions prior to application of epoxy flooring.
- .2 Install cove and base including top cap in accordance with manufacturer's instructions. Ensure top of base is level, and true to line.
- .3 Mix and apply work in strict accordance manufacturer's printed directions in specified thickness, with integral cove bases, uninterrupted except at sawn joints or other types of joints required, free of laps, pin holes, voids, crawls, skips or other marks or irregularities are visible, and to provide uniform appearance.

-
- .4 Work coating into corners and other restricted areas, up and over bases, and into recesses in floors to ensure full coverage.
 - .5 Make clean true junctions with no visible overlap between adjoining applications of coatings.
 - .6 Primer: Apply primer over prepared substrate, at manufacturer's recommended spreading rate with timing of application co-ordinated with subsequent application of topping mix to ensure optimum adhesion between flooring materials and substrate. Prime entire surface with recommended primer.
 - .7 Apply flooring in accordance with manufacturer's instructions to the proper thickness.
 - .8 Apply grout coats and top coats at recommended coverage, to provide a uniform, dense surface.
 - .9 Finish flooring uniformly, free from surface imperfections, and to match the accepted sample in the Departmental Representative's office.
 - .10 Allow proper cure time for each installation procedure.
 - .11 Apply flooring up adjoining walls 150 mm to form base to flooring. Top of base to be level, true, and even.
 - .12 Where applicable, flash pipes, conduits and other penetrations to manufacturer's standards.
 - .13 Incorporate aggregate into topping at rate recommended by the manufacturer to achieve a slip resistant surface.
 - .14 Apply sealers over epoxy flooring in strict accordance with manufacturer's recommendations.

3.4 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
 - .2 Remove protective material from materials where present.
 - .3 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .2 Upon completion of work of this Section clean area up of debris, remove flooring material from adjacent surfaces where splattered and leave area in clean, tidy condition acceptable to the Departmental Representative.
- .3 Touch up and refinish minor defects in work. Refinish entire coated surface areas where finish is damaged or otherwise unacceptable.

- .4 Remove promptly as work progresses spilled or splattered coating materials from adjacent surfaces. Clean floors on completion of Work. Do not mar surfaces while removing splatters.
- .5 Protect completed work from traffic for at least one week to allow proper curing of floor finish. Protect work from any trades using area after completion of installation.

END OF SECTION

1 General

1.1 SUMMARY

.1 Section Includes:

- .1 Material and installation of site applied paint finishes to new interior surfaces, including site painting of shop primed surfaces.

1.2 RELATED REQUIREMENTS

- .1 Section 05 50 00 - Metal Fabrications
- .2 Section 08 34 73 - Acoustic Doors & Frames
- .3 Section 08 56 73 - Sound Control Windows
- .4 Section 09 21 16 - Gypsum Board
- .5 Section 09 91 23.01 - Interior Re-Painting

1.3 REFERENCES

- .1 Department of Justice Canada (Jus)
 - .1 Canadian Environmental Protection Act (CEPA), 1999, c. 33
- .2 Environmental Protection Agency (EPA)
 - .1 EPA Test Method for Measuring Total Volatile Organic Compound Content of Consumer Products, Method 24 - 1995, (for Surface Coatings).
- .3 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .4 Master Painters Institute (MPI)
 - .1 MPI Architectural Painting Specifications Manual, current edition.
- .5 National Fire Code of Canada
- .6 Society for Protective Coatings (SSPC)
 - .1 SSPC Painting Manual, Volume Two, 8th Edition, Systems and Specifications Manual.
- .7 Transport Canada (TC)
 - .1 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34 .

1.4 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Contractor: minimum of five years proven satisfactory experience. Provide list of last three comparable jobs including, job name and location, specifying authority, and project manager.
 - .2 Journeymen: qualified journeymen who have "Tradesman Qualification Certificate of Proficiency" engaged in painting work.
 - .3 Apprentices: working under direct supervision of qualified trades person in accordance with trade regulations.
- .2 Pre-Installation Meeting:
 - .1 Convene pre-installation meeting one week prior to beginning work of this Section in accordance with Section 01 31 19 - Project Meetings.
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Coordination with other building subtrades.
 - .4 Review manufacturer's installation instructions and warranty requirements.
- .3 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.5 SCHEDULING

- .1 Submit work schedule for various stages of painting to Departmental Representative for review. Submit schedule minimum of 48 hours in advance of proposed operations.
- .2 Obtain written authorization from Departmental Representative for changes in work schedule.
- .3 Schedule painting operations to prevent disruption of occupants.

1.6 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit product data and instructions for each paint and coating product to be used.
 - .2 Submit product data for the use and application of paint thinner.
 - .3 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures. Indicate VOCs during application and curing.

-
- .3 Samples:
 - .1 Submit full range colour sample chips to indicate where colour availability is restricted.
 - .2 Submit duplicate 200 x 300 mm sample panels of each paint and with specified paint or coating in colours, gloss/sheen and textures required to MPI Architectural Painting Specification Manual standards submitted on following substrate materials:
 - .1 3 mm for finishes over metal surfaces.
 - .2 13 mm gypsum board for finishes over gypsum board and other smooth surfaces.
 - .3 Retain reviewed samples on-site to demonstrate acceptable standard of quality for appropriate on-site surface.
 - .4 Test reports: submit certified test reports for paint from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.
 - .1 Lead, cadmium and chromium: presence of and amounts.
 - .2 Mercury: presence of and amounts.
 - .3 Organochlorines and PCBs: presence of and amounts.
 - .5 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .6 Manufacturer's Instructions:
 - .1 Submit manufacturer's application instructions.
 - .7 Closeout Submittals: submit maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals include following:
 - .1 Product name, type and use.
 - .2 Manufacturer's product number.
 - .3 Colour numbers.
 - .4 MPI Environmentally Friendly classification system rating.

1.7 MAINTENANCE

- .1 Extra Materials:
 - .1 Deliver to extra materials from same production run as products installed. Package products with protective covering and identify with descriptive labels. Comply with Section 01 78 00 - Closeout Submittals.
 - .2 Quantity: provide one - four litre can of each type and colour of finish coating and stain. Identify colour and paint type in relation to established colour schedule and finish system.
 - .3 Delivery, storage and protection: comply with Departmental Representative requirements for delivery and storage of extra materials.

1.8 DELIVERY, STORAGE AND HANDLING

- .1 Packing, Shipping, Handling and Unloading:
 - .1 Pack, ship, handle and unload materials in accordance with Section 01 61 00 - Common Product Requirements and manufacturer's written instructions.

- .2 Acceptance at Site:
 - .1 Identify products and materials with labels indicating:
 - .1 Manufacturer's name and address.
 - .2 Type of paint or coating.
 - .3 Compliance with applicable standard.
 - .4 Colour number in accordance with established colour schedule.
- .3 Remove damaged, opened and rejected materials from site.
- .4 Storage and Protection:
 - .1 Provide and maintain dry, temperature controlled, secure storage.
 - .2 Store materials and supplies away from heat generating devices.
 - .3 Store materials and equipment in well ventilated area with temperature range 7 degrees C to 30 degrees C.
- .5 Store temperature sensitive products above minimum temperature as recommended by manufacturer.
- .6 Keep areas used for storage, cleaning and preparation clean and orderly. After completion of operations, return areas to clean condition.
- .7 Remove paint materials from storage only in quantities required for same day use.
- .8 Fire Safety Requirements:
 - .1 Provide one 9 kg Type ABC fire extinguisher adjacent to storage area.
 - .2 Store oily rags, waste products, empty containers and materials subject to spontaneous combustion in ULC approved, sealed containers and remove from site on a daily basis.
 - .3 Handle, store, use and dispose of flammable and combustible materials in accordance with National Fire Code of Canada requirements.

1.9 SITE CONDITIONS

- .1 Heating, Ventilation and Lighting:
 - .1 Ventilate enclosed spaces in accordance with Section 01 51 00.
 - .2 Provide heating facilities to maintain ambient air and substrate temperatures above 10 degrees C for 24 hours before, during and after paint application until paint has cured sufficiently.
 - .3 Provide continuous ventilation for seven days after completion of application of paint.
 - .4 Coordinate use of existing ventilation system with Departmental Representative and ensure its operation during and after application of paint as required.
 - .5 Provide temporary ventilating and heating equipment where permanent facilities are not available or supplemental ventilating and heating equipment if ventilation and heating from existing system is inadequate to meet minimum requirements.
 - .6 Provide minimum lighting level of 323 Lux on surfaces to be painted.

-
- .2 Temperature, Humidity and Substrate Moisture Content Levels:
 - .1 Unless pre-approved written approval by Paint Inspection Agency Authority and product manufacturer, perform no painting when:
 - .1 Ambient air and substrate temperatures are below 10 degrees C.
 - .2 Substrate temperature is above 32 degrees C unless paint is specifically formulated for application at high temperatures.
 - .3 Substrate and ambient air temperatures are not expected to fall within MPI or paint manufacturer's prescribed limits.
 - .4 The relative humidity is under 85% or when the dew point is more than 3 degrees C variance between the air/surface temperature. Paint should not be applied if the dew point is less than 3 degrees C below the ambient or surface temperature. Use sling psychrometer to establish the relative humidity before beginning paint work.
 - .5 Rain or snow are forecast to occur before paint has thoroughly cured or when it is foggy, misty, raining or snowing at site.
 - .6 Ensure that conditions are within specified limits during drying or curing process, until newly applied coating can itself withstand 'normal' adverse environmental factors.
 - .2 Perform painting work when maximum moisture content of the substrate is below:
 - .1 12% for plaster and gypsum board.
 - .3 Test for moisture using calibrated electronic Moisture Meter. Test concrete floors for moisture using "cover patch test".
 - .3 Surface and Environmental Conditions:
 - .1 Apply paint finish in areas where dust is no longer being generated by related construction operations or when wind or ventilation conditions are such that airborne particles will not affect quality of finished surface.
 - .2 Apply paint to adequately prepared surfaces and to surfaces within moisture limits.
 - .3 Apply paint when previous coat of paint is dry or adequately cured.
 - .4 Additional interior application requirements:
 - .1 Apply paint finishes when temperature at location of installation can be satisfactorily maintained within manufacturer's recommendations.
 - .2 Apply paint in occupied facilities during silent hours only. Schedule operations to approval of Departmental Representative such that painted surfaces will have dried and cured sufficiently before occupants are affected.
- 2 Products
- 2.1 MATERIALS
- .1 Paint materials listed in the MPI Approved Products List (APL) are acceptable for use on this project.
 - .2 Provide paint materials for paint systems from single manufacturer.

-
- .3 Only qualified products with E2 "Environmentally Friendly" rating are acceptable for use on this project.
 - .4 Conform to latest MPI requirements for interior painting work including preparation and priming.
 - .5 Materials (primers, paints, coatings, varnishes, stains, lacquers, fillers, thinners, solvents, etc.) in accordance with MPI Architectural Painting Specification Manual "Approved Product" listing.
 - .6 Linseed oil, shellac, and turpentine: highest quality product from approved manufacturer listed in MPI Architectural Painting Specification Manual, compatible with other coating materials as required.
 - .7 Provide paint products meeting MPI "Environmentally Friendly" E2 ratings based on VOC (EPA Method 24) content levels.
 - .8 Use MPI listed materials having minimum E2 rating where indoor air quality (odour) requirements exist.
 - .9 Formulate and manufacture water-borne surface coatings with no aromatic solvents, formaldehyde, halogenated solvents, mercury, lead, cadmium, hexavalent chromium or their compounds.
 - .10 Flash point: 61.0 degrees C or greater for water-borne surface coatings and recycled water-borne surface coatings.
 - .11 Ensure manufacture and process of both water-borne surface coatings and recycled water-borne surface coatings does not release:
 - .1 Matter in undiluted production plant effluent generating 'Biochemical Oxygen Demand' (BOD) in excess of 15 mg/L to natural watercourse or sewage treatment facility lacking secondary treatment.
 - .2 Total Suspended Solids (TSS) in undiluted production plant effluent in excess of 15 mg/L to natural watercourse or a sewage treatment facility lacking secondary treatment.
 - .12 Water-borne paints and stains, recycled water-borne surface coatings and water borne varnishes to meet minimum "Environmentally Friendly" E2 rating.

2.2 COLOURS

- .1 Colours to be as indicated in the Finish Schedule or as otherwise selected by the Departmental Representative.
- .2 Second coat in three coat system to be tinted slightly lighter colour than top coat to show visible difference between coats.

2.3 MIXING AND TINTING

- .1 Perform colour tinting operations prior to delivery of paint to site. Obtain written approval from Departmental Representative for tinting of painting materials.
- .2 Mix paste, powder or catalyzed paint mixes in accordance with manufacturer's written instructions.
- .3 Use and add thinner in accordance with paint manufacturer's recommendations. Do not use kerosene or similar organic solvents to thin water-based paints.
- .4 Thin paint for spraying in accordance with paint manufacturer's instructions.
- .5 Re-mix paint in containers prior to and during application to ensure break-up of lumps, complete dispersion of settled pigment, and colour and gloss uniformity.

2.4 GLOSS/SHEEN RATINGS

- .1 Paint gloss is defined as sheen rating of applied paint, in accordance with following values:

	Gloss @ 60 degrees	Sheen @ 85 degrees
Gloss Level 1 - Matte Finish (flat)	Max. 5	Max. 10
Gloss Level 2 - Velvet-Like Finish	Max.10	10 to 35
Gloss Level 3 - Eggshell Finish	10 to 25	10 to 35
Gloss Level 4 - Satin-Like Finish	20 to 35	min. 35
Gloss Level 5 - Traditional Semi-Gloss Finish	35 to 70	
Gloss Level 6 - Traditional Gloss	70 to 85	
Gloss Level 7 - High Gloss Finish	More than 85	

- .2 Gloss level ratings of painted surfaces as indicated.

2.5 INTERIOR PAINTING SYSTEMS

- .1 All painting to be to MPI premium grade.
- .2 Galvanized metal: doors, frames, railings, misc. steel, pipes, overhead decking, and ducts.
 - .1 INT 5.3N - Institutional low odour/low VOC G5 gloss finish.
- .3 Gypsum board: gypsum wallboard, drywall, "sheet rock type material", and textured finishes:
 - .1 INT 9.2L - Waterborne light industrial G3 gloss level coating.
- .4 Canvas and cotton coverings.
 - .1 INT 10.1D - Institutional low odour/low VOC G3 gloss level finish.

2.6 SOURCE QUALITY CONTROL

- .1 Perform following tests on each batch of consolidated post-consumer material before surface coating is reformulated and canned. Testing by laboratory or facility which has been accredited by Standards Council of Canada.
 - .1 Lead, cadmium and chromium are to be determined using ICP-AES (Inductively Coupled Plasma - Atomic Emission Spectroscopy) technique no. 6010 as defined in EPA SW-846.
 - .2 Mercury is to be determined by Cold Vapour Atomic Absorption Spectroscopy using Technique no. 7471 as defined in EPA SW-846.
 - .3 Organochlorines and PCBs are to be determined by Gas Chromatography using Technique no. 8081 as defined in EPA SW-846.

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 data sheet.

3.2 GENERAL

- .1 Perform preparation and operations for interior painting in accordance with MPI Architectural Painting Specifications Manual except where specified otherwise.
- .2 Apply paint materials in accordance with paint manufacturer's written application instructions.

3.3 EXAMINATION

- .1 Investigate existing substrates for problems related to proper and complete preparation of surfaces to be painted. Report to Departmental Representative damages, defects, unsatisfactory or unfavourable conditions before proceeding with work.
- .2 Conduct moisture testing of surfaces to be painted using properly calibrated electronic moisture meter, for moisture using simple "cover patch test". Do not proceed with work until conditions fall within acceptable range as recommended by manufacturer.
- .3 Maximum moisture content as follows:
 - .1 Gypsum board: 12%.

3.4 PREPARATION

- .1 Protection:
 - .1 Protect existing building surfaces and adjacent structures from paint spatters, markings and other damage by suitable non-staining covers or masking. If damaged, clean and restore surfaces as directed by Departmental Representative.
 - .2 Protect items that are permanently attached such as Fire Labels on doors and frames.
 - .3 Protect factory finished products and equipment.
 - .4 Protect building occupants in and about the building.
- .2 Surface Preparation:
 - .1 Remove electrical cover plates, light fixtures, surface hardware on doors, bath accessories and other surface mounted equipment, fittings and fastenings prior to undertaking painting operations. Identify and store items in secure location and re-installed after painting is completed.
 - .2 Move and cover furniture and portable equipment as necessary to carry out painting operations. Replace as painting operations progress.
 - .3 Place "WET PAINT" signs in occupied areas as painting operations progress. Signs to approval of Departmental Representative.
- .3 Clean and prepare surfaces in accordance with MPI Architectural Painting Specification Manual requirements. Refer to MPI Manual in regard to specific requirements and as follows:
 - .1 Remove dust, dirt, and other surface debris by vacuuming, wiping with dry, clean cloths or compressed air.
 - .2 Wash surfaces with a biodegradable detergent and bleach where applicable and clean warm water using a stiff bristle brush to remove dirt, oil and other surface contaminants.
 - .3 Rinse scrubbed surfaces with clean water until foreign matter is flushed from surface.
 - .4 Allow surfaces to drain completely and allow to dry thoroughly.
 - .5 Prepare surfaces for water-based painting, water-based cleaners should be used in place of organic solvents.
 - .6 Use trigger operated spray nozzles for water hoses.
 - .7 Many water-based paints cannot be removed with water once dried. Minimize use of mineral spirits or organic solvents to clean up water-based paints.
- .4 Prevent contamination of cleaned surfaces by salts, acids, alkalis, other corrosive chemicals, grease, oil and solvents before prime coat is applied and between applications of remaining coats. Apply primer, paint, or pretreatment as soon as possible after cleaning and before deterioration occurs.
- .5 Sand and dust between coats as required to provide adequate adhesion for next coat and to remove defects visible from a distance up to 1000 mm.

- .6 Clean metal surfaces to be painted by removing rust, loose mill scale, welding slag, dirt, oil, grease and other foreign substances in accordance with MPI requirements. Remove traces of blast products from surfaces, pockets and corners to be painted by brushing with clean brushes, blowing with clean dry compressed air or vacuum cleaning.
- .7 Touch up of shop primers with primer as specified.
- .8 Do not apply paint until prepared surfaces have been accepted by Departmental Representative.

3.5 APPLICATION

- .1 Method of application to be as approved by Departmental Representative. Apply paint by brush, roller or airless sprayer. Conform to manufacturer's application instructions unless specified otherwise.
- .2 Brush and Roller Application:
 - .1 Apply paint in uniform layer using brush and/or roller type suitable for application.
 - .2 Work paint into cracks, crevices and corners.
 - .3 Paint surfaces and corners not accessible to brush using spray, daubers and/or sheepskins. Paint surfaces and corners not accessible to roller using brush, daubers or sheepskins.
 - .4 Brush and/or roll out runs and sags, and over-lap marks. Rolled surfaces free of roller tracking and heavy stipple.
 - .5 Remove runs, sags and brush marks from finished work and repaint.
- .3 Spray application:
 - .1 Provide and maintain equipment that is suitable for intended purpose, capable of atomizing paint to be applied, and equipped with suitable pressure regulators and gauges.
 - .2 Keep paint ingredients properly mixed in containers during paint application either by continuous mechanical agitation or by intermittent agitation as frequently as necessary.
 - .3 Apply paint in uniform layer, with overlapping at edges of spray pattern. Back roll first coat application.
 - .4 Brush out immediately all runs and sags.
 - .5 Use brushes and rollers to work paint into cracks, crevices and places which are not adequately painted by spray.
- .4 Use dipping, sheepskins or daubers only when no other method is practical in places of difficult access.
- .5 Apply coats of paint continuous film of uniform thickness. Repaint thin spots or bare areas before next coat of paint is applied.

-
- .6 Allow surfaces to dry and properly cure after cleaning and between subsequent coats for minimum time period as recommended by manufacturer.
 - .7 Sand and dust between coats to remove visible defects.
 - .8 Finish surfaces both above and below sight lines as specified for surrounding surfaces, including such surfaces as tops of interior cupboards and cabinets and projecting ledges.
 - .9 Finish inside of cupboards and cabinets as specified for outside surfaces.
 - .10 Finish closets and alcoves as specified for adjoining rooms.
 - .11 Finish top, bottom, edges and cutouts of doors after fitting as specified for door surfaces.

3.6 MECHANICAL/ELECTRICAL EQUIPMENT

- .1 Paint finished area exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment with colour and finish to match adjacent surfaces, except as indicated.
- .2 Boiler room, mechanical and electrical rooms: paint exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment.
- .3 Other unfinished areas: leave exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment in original finish and touch up scratches and marks.
- .4 Touch up scratches and marks on factory painted finishes and equipment with paint as supplied by manufacturer of equipment.
- .5 Do not paint over nameplates.
- .6 Keep sprinkler heads free of paint.
- .7 Paint inside of ductwork where visible behind grilles, registers and diffusers with primer and one coat of matt black paint.
- .8 Paint fire protection piping red.
- .9 Paint disconnect switches for fire alarm system and exit light systems in red enamel.
- .10 Paint natural gas piping yellow.
- .11 Paint both sides and edges of backboards for telephone and electrical equipment before installation. Leave equipment in original finish except for touch-up as required, and paint conduits, mounting accessories and other unfinished items.
- .12 Do not paint interior transformers and substation equipment.

3.7 SITE TOLERANCES

- .1 Walls: no defects visible from a distance of 1000 mm at 90 degrees to surface.
- .2 Ceilings: no defects visible from floor at 45 degrees to surface when viewed using final lighting source.
- .3 Final coat to exhibit uniformity of colour and uniformity of sheen across full surface area.

3.8 FIELD QUALITY CONTROL

- .1 Interior painting and decorating work shall be inspected by a Paint Inspection Agency (inspector) acceptable to the specifying authority and local Painting Contractor's Association. Painting contractor shall notify Paint Inspection Agency a minimum of one week prior to commencement of work and provide a copy of project painting specification, plans and elevation drawings (including pertinent details) as well as a Finish Schedule.
- .2 Interior surfaces requiring painting shall be inspected by Paint Inspection Agency who shall notify Departmental Representative and General Contractor in writing of defects or problems, prior to commencing painting work, or after prime coat shows defects in substrate.
- .3 Where "special" painting, coating or decorating system applications (i.e. elastomeric coatings) or non-MPI listed products or systems are to be used, paint or coating manufacturer shall provide as part of this work, certification of surfaces and conditions for specific paint or coating system application as well as on site supervision, inspection and approval of their paint or coating system application as required at no additional cost to Departmental Representative.
- .4 Standard of Acceptance: meeting tolerances specified in item 3.7 of this Section.
- .5 Field inspection of painting operations to be carried out by independent inspection firm as designated by Departmental Representative.
- .6 Advise Departmental Representative when surfaces and applied coating is ready for inspection. Do not proceed with subsequent coats until previous coat has been approved.
- .7 Cooperate with inspection firm and provide access to areas of work.
- .8 Retain purchase orders, invoices and other documents to prove conformance with noted MPI requirements when requested by Departmental Representative.

3.9 RESTORATION

- .1 Clean and re-install hardware items removed before undertaken painting operations.
- .2 Remove protective coverings and warning signs as soon as practical after operations cease.

- .3 Remove paint splashings on exposed surfaces that were not painted. Remove smears and spatter immediately as operations progress, using compatible solvent.
- .4 Protect freshly completed surfaces from paint droppings and dust to approval of Departmental Representative. Avoid scuffing newly applied paint.
- .5 Restore areas used for storage, cleaning, mixing and handling of paint to clean condition as approved by Departmental Representative.

END OF SECTION

1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 35 16 - Alteration & Renovation Procedures

1.2 REFERENCES

- .1 The Master Painters Institute (MPI)
 - .1 Maintenance Repainting Manual current edition, Master Painters Institute (MPI), including Identifiers, Evaluation, Systems, Preparation and Approved Product List.
- .2 Environmental Protection Agency (EPA)
 - .1 Test Method for Measuring Total Volatile Organic Compound Content of Consumer Products, Method 24 (for Surface Coatings).
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Contractor: to have a minimum of five years proven satisfactory experience. Provide a list of last three comparable jobs including, job name and location, specifying authority, and project manager.
 - .2 Qualified journeypersons as defined by local jurisdiction to be engaged in repainting work.
 - .3 Apprentices: may be employed provided they work under the direct supervision of qualified journeyperson in accordance with applicable trade regulations.
- .2 Conform to latest MPI requirements for interior repainting work including cleaning, preparation and priming.
- .3 Materials (primers, paints, coatings, varnishes, stains, lacquers, fillers, thinners and solvents) shall be in accordance with the latest edition of the MPI Approved Product List and shall be from a single manufacturer for each system used.
- .4 Paint materials such as linseed oil, shellac, reducers and turpentine shall be the highest quality product of an approved manufacturer listed in MPI Maintenance Repainting Manual and shall be compatible with other coating materials as required.
- .5 Retain purchase orders, invoices and other documents to prove conformance with noted MPI requirements when requested by Departmental Representative.
- .6 Standard of Acceptance: when viewed using final lighting source surfaces shall indicate the following:

- .1 Walls: no defects visible from a distance of 1000 mm at 90 degrees to surface.
- .2 Ceilings: no defects visible from floor at 45 degrees to surface.
- .3 Final coat to exhibit uniformity of colour and sheen across full surface area.

1.4 PERFORMANCE REQUIREMENTS

- .1 Environmental Performance Requirements:
 - .1 Provide paint products meeting MPI "Environmentally Friendly" E2 ratings based on VOC (EPA Method 24) content levels.
 - .2 Where indoor air quality (odour) is a problem, use only MPI listed materials having a minimum E2 rating.

1.5 SCHEDULING

- .1 Submit work schedule for various stages of painting to Departmental Representative for review.
- .2 Paint occupied facilities in accordance with approved schedule. Schedule operations to approval of Departmental Representative such that painted surfaces will have dried and cured sufficiently before occupants are affected.
- .3 Obtain written authorization from Departmental Representative for changes in work schedule.
- .4 Schedule repainting operations to prevent disruption by other trades if applicable and by occupants in and about building.

1.6 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide product data and manufacturer's installation/application instructions for each paint and coating product to be used in accordance with the requirements of Section 01 33 00 - Submittal Procedures.
- .2 Provide samples in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Submit full range colour sample chips for review and selection. Indicate where colour availability is restricted.
- .3 Closeout Submittals:
 - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
 - .1 Submit records of products used. List products in relation to finish system and include following:
 - .1 Product name, type and use (i.e. materials and location).
 - .2 Manufacturer's product number.
 - .3 Colour code numbers.
 - .4 MPI Environmentally Friendly classification system rating.
 - .5 Manufacturer's Material Safety Data Sheets (MSDS).

1.7 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements, supplemented as follows:
 - .1 Deliver and store materials in original containers, sealed, with labels intact.
 - .2 Labels to indicate:
 - .1 Manufacturer's name and address.
 - .2 Type of paint or coating.
 - .3 Compliance with applicable standard.
 - .4 Colour number in accordance with established colour schedule.
 - .3 Remove damaged, opened and rejected materials from site.
 - .4 Store and handle in accordance with manufacturer's recommendations.
 - .5 Store materials and equipment in secure, dry, well-ventilated area with temperature range between 7 degrees C to 30 degrees C. Store materials and supplies away from heat generating devices and sensitive products above minimum temperature as recommended by manufacturer.
 - .6 Keep areas used for storage, cleaning and preparation, clean and orderly to approval of Departmental Representative. After completion of operations, return areas to clean condition to approval of Departmental Representative.
 - .7 Remove paint materials from storage in quantities required for same day use.
 - .8 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling storage, and disposal of hazardous materials.
 - .9 Fire Safety Requirements:
 - .1 Provide one 9 kg Type ABC fire extinguisher adjacent to storage area.
 - .2 Store oily rags, waste products, empty containers and materials subject to spontaneous combustion in ULC approved, sealed containers and remove from site daily.
 - .3 Handle, store, use and dispose of flammable and combustible materials in accordance with National Fire Code of Canada.

1.8 SITE CONDITIONS

- .1 Heating, Ventilation and Lighting:
 - .1 Do not perform repainting work unless adequate and continuous ventilation and sufficient heating facilities are in place to maintain ambient air and substrate temperatures above 10 degrees C for 24 hours before, during and after paint application and until paint has cured sufficiently.
 - .2 Ventilate enclosed spaces in accordance with Section 01 51 00. Where required, provide continuous ventilation for seven days after completion of application of paint.
 - .3 Co-ordinate use of existing ventilation system with General Contractor and Departmental Representative and ensure its operation during and after application of paint as required.
 - .4 Provide temporary ventilating and heating equipment where permanent facilities are not available or supplemental ventilating and heating equipment if ventilation and heating from existing system is inadequate to meet minimum requirements. Use of gas-fired appliances is not permitted.

-
- .5 Do not perform painting work unless minimum lighting level of 323 Lux is provided on surfaces to be painted.
 - .2 Temperature, Humidity and Substrate Moisture Content Levels:
 - .1 Unless specifically pre-approved by specifying body, Paint Inspection Agency and, applied product manufacturer, do not perform repainting work when:
 - .1 Ambient air and substrate temperatures are below 10 degrees C.
 - .2 Substrate temperature is over 32 degrees C unless paint is specifically formulated for application at high temperatures.
 - .3 Relative humidity within area to be repainted is above 85%.
 - .2 Conduct moisture tests using properly calibrated electronic Moisture Meter, except use simple "cover patch test" on concrete floors to be repainted.
 - .3 Do not perform repainting work when maximum moisture content of substrate exceeds:
 - .1 12% for concrete and masonry (clay and concrete brick/block).
 - .2 12% for plaster and gypsum board.
 - .4 Test painted concrete, masonry and plaster surfaces for alkalinity as required.
 - .3 Surface and Environmental Conditions:
 - .1 Apply paint finish in areas where dust is no longer being generated by related construction operations or when ventilation conditions are such that airborne particles will not affect quality of finished surface.
 - .2 Apply paint to adequately prepared surfaces and to surfaces within moisture limits noted herein.
 - .3 Apply paint when previous coat of paint is dry or adequately cured, unless otherwise pre-approved by specific coating manufacturer.
 - .4 Apply paint in occupied facilities in unoccupied rooms or areas. Schedule operations to approval of the Departmental Representative such that painted surfaces will have dried and cured sufficiently before occupants are affected.

1.9 MAINTENANCE

- .1 Extra Materials:
 - .1 Submit maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
 - .2 Submit one - four litre can of each type and colour of finish coating. Identify type and colour in relation to established colour schedule and finish system.

2 Products

2.1 MATERIALS

- .1 Paint materials listed in latest edition of MPI Approved Product List (APL) are acceptable for use on this project.

- .2 Where required by authorities having jurisdiction, paints and coatings to provide a fire resistant rating.
- .3 Paint materials for repaint systems to be products of single manufacturer.
- .4 Only qualified products with MPI "Environmentally Friendly" E2 rating are acceptable for use on this project.
- .5 Use only MPI listed L rated materials.
- .6 Paints and coatings must not be formulated or manufactured with formaldehyde, halogenated solvents, mercury, lead, cadmium, hexavalent chromium or their compounds.

2.2 COLOURS

- .1 Colours as indicated in the Finish Schedule, or as otherwise selected by the Departmental Representative.
- .2 First coat in two coat (Premium) repaint system to be tinted slightly lighter colour than top coat to show visible difference between coats.

2.3 MIXING AND TINTING

- .1 Perform colour tinting operations prior to delivery of paint to site. On-site tinting of painting materials is allowed with Departmental Representative's written permission.
- .2 Mix paste, powder or catalyzed paint mixes in accordance with manufacturer's written instructions.
- .3 Where thinner is used, addition not to exceed paint manufacturer's recommendations. Do not use kerosene or such organic solvents to thin water-based paints.
- .4 Thin paint for spraying in accordance with paint manufacturer' instructions. If directions are not on container, obtain instructions in writing from manufacturer and provide copy of instructions to Departmental Representative.
- .5 Re-mix paint in containers prior to and during application to ensure break-up of lumps, complete dispersion of settled pigment, and colour and gloss uniformity.

2.4 GLOSS/SHEEN RATINGS

- .1 Paint gloss defined as sheen rating of applied paint, in accordance with following MPI gloss / sheen standard values:

Gloss Level Category	Units @ 60 Degrees	Units @ 85 Degrees
G1 - matte finish	0 to 5	maximum 10
G2 - velvet finish	0 to 10	10 to 35
G3 - eggshell finish	10 to 25	10 to 35
G4 - satin finish	20 to 35	minimum 35

G5 - semi-gloss finish	35 to 70	
G6 - gloss finish	70 to 85	
G7 - high gloss finish	85	

- .2 Gloss level ratings of repainted surfaces shall be as specified herein.

2.5 INTERIOR PAINTING SYSTEMS

- .1 RIN 4.2 - Concrete Masonry Units: (Concrete Block).
- .1 RIN 4.2G- W.B. Light Industrial Coating; G3 gloss level.
- .2 RIN 5.1 - Structural Steel and Metal Fabrications.
- .1 RIN 5.1F - Aliphatic Polyurethane G5 gloss level.
- .3 RIN 5.3 - Galvanized Metal: (High Contact/High Traffic Areas (Doors, Frames, Railings, Pipes, and Handrails). Low Contact/Low traffic areas (Overhead Decking, Pipes, and Ducts).
- .1 RIN 5.3H - 2 Component Polyurethane; G5 gloss level.
- .4 RIN 9.2 - Plaster and Gypsum Board: (gypsum wallboard, drywall, and "sheet rock type material".
- .1 RIN 9.2L - W.B. Light Industrial Coating, G3 gloss level.
- .5 RIN 10.1 - Canvas and Cotton Coverings (Pipe and Duct Coverings).
- .1 RIN 10.1A - Latex G3 gloss level.

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 EXAMINATION

- .1 Interior repainting work: inspected by MPI Accredited Paint Inspection Agency (inspector) acceptable to specifying authority and local Painting Contractor's Association. Painting contractor to notify Paint Inspection Agency a minimum of one week prior to commencement of work and provide a copy of project repainting specification and Finish Schedule (as well as plans and elevation drawings).
- .2 Interior surfaces requiring repainting: inspected by both painting contractor and Paint Inspection Agency who will notify Departmental Representative in writing of defects or problems, prior to commencing repainting work, or after surface preparation if unseen substrate damage is discovered.

-
- .3 Where an assessed degree of surface degradation of DSD-1 to DSD-3 before preparation of surfaces for repainting is revealed to be DSD-4 after preparation, repair or replacement of such unforeseen defects discovered are to be corrected, as mutually agreed, before repainting is started.
 - .4 Where "special" repainting or recoating system applications (i.e. elastomeric coatings) or non-MPI listed products or systems are to be used, paint or coating manufacturer to provide as part of work, certification of surfaces and conditions for specific paint or coating system application as well as on site supervision, inspection and approval of their paint or coating system application as required at no additional cost to Departmental Representative.

3.3 PREPARATION

- .1 Perform preparation and operations for interior painting in accordance with MPI Maintenance Repainting Manual requirements except where otherwise specified.
- .2 Apply paint materials in accordance with paint manufacturer's written application instructions.
- .3 Clean and prepare interior surfaces to be repainted in accordance with MPI Maintenance Repainting Manual requirements. Refer to MPI Manual in regard to specific requirements and as follows:
 - .1 Remove dust, dirt, and surface debris by vacuuming, wiping with dry, clean cloths or compressed air.
 - .2 Wash surfaces with a biodegradable detergent and bleach where applicable and clean warm water using stiff bristle brush to remove dirt, oil and surface contaminants.
 - .3 Rinse scrubbed surfaces with clean water until foreign matter is flushed from surface.
 - .4 Allow surfaces to drain completely and to dry thoroughly. Allow sufficient drying time and test surfaces using an electronic moisture meter before commencing work.
 - .5 Use water-based cleaners in place of organic solvents where surfaces will be repainted using water based paints.
 - .6 Many water-based paints cannot be removed with water once dried. Minimize use of kerosene or such organic solvents to clean up water-based paints.
- .4 Clean metal surfaces to be repainted by removing rust, dirt, oil, grease and foreign substances in accordance with MPI requirements. Remove such contaminants from surfaces, pockets and corners to be repainted by brushing with clean brushes, blowing with clean dry compressed air, or brushing/vacuum cleaning as required.
- .5 Prevent contamination of cleaned surfaces by salts, acids, alkalis, other corrosive chemicals, grease, oil and solvents before priming and between applications of remaining coats. Touch-up, spot prime, and apply primer, paint, or pre-treatment as soon as possible after cleaning and before deterioration occurs.

- .6 Do not apply paint until prepared surfaces have been accepted by Departmental Representative.
- .7 Sand and dust between coats as required to provide adequate adhesion for next coat and to remove defects visible from distance up to 1000 mm.

3.4 EXISTING CONDITIONS

- .1 Prior to commencing work, examine site conditions and existing interior substrates to be repainted. Report in writing to Departmental Representative and General Contractor damages, defects, or unsatisfactory or unfavourable conditions or surfaces that will adversely affect this work.
- .2 Conduct moisture testing of surfaces to be painted using properly calibrated electronic moisture meter, except test concrete floors for moisture using simple "cover patch test" and report findings to Departmental Representative and General Contractor. Maximum moisture content not to exceed specified limits.
- .3 Do not commence until such adverse conditions and defects have been corrected and surfaces and conditions are acceptable to Painting Subcontractor and Inspection Agency.
- .4 Degree of surface deterioration (DSD) to be assessed using MPI Identifiers and Assessment criteria indicated in MPI Maintenance Repainting Manual. MPI DSD ratings and descriptions are as follows:

Condition	Description
DSD-0	Sound Surface (includes visual (aesthetic) defects that do not affect film's protective properties).
DSD-1	Slightly Deteriorated Surface (indicating fading; gloss reduction, slight surface contamination, minor pin holes scratches).
DSD-2	Moderately Deteriorated Surface (small areas of peeling, flaking, slight cracking, and staining).
DSD-3	Severely Deteriorated Surface (heavy peeling, flaking, cracking, checking, scratches, scuffs, abrasion, small holes and gouges).
DSD-4	Substrate Damage (repair or replacement of surface required).

3.5 PROTECTION

- .1 Protect existing surfaces and adjacent fixtures and furnishings from paint spatters, markings and other damage by suitable non-staining covers or masking. If damaged, clean and restore such surfaces as directed by Departmental Representative.
- .2 Protect items that are permanently attached such as Fire Labels on doors and frames.
- .3 Protect factory finished products and equipment.

-
- .4 Protect general public and building occupants in and about building.
 - .5 Remove electrical cover plates, light fixtures, surface hardware on doors, bath accessories and surface mounted equipment, fittings and fastenings prior to undertaking re-painting operations. Store items and re-install after painting is completed.
 - .6 Move and cover furniture and portable equipment as necessary to carry out repainting operations. Replace as painting operations progress.
 - .7 As repainting operations progress, place "WET PAINT" signs in occupied areas to approval of Departmental Representative.

3.6 APPLICATION

- .1 Apply paint by method that is best suited for substrate being repainted using brush, roller and/or airless sprayer. Conform to manufacturer's application instructions unless specified otherwise. Methods of application as pre-approved by Departmental Representative before commencing work.
- .2 Brush and Roller Application:
 - .1 Apply paint in uniform layer using brush and/or roller of types suitable for application.
 - .2 Work paint into cracks, crevices and corners.
 - .3 Paint surfaces and corners not accessible to brush using spray, daubers and/or sheepskins. Paint surfaces and corners not accessible to roller using brush, daubers or sheepskins.
 - .4 Brush and/or roll out runs and sags, and over-lap marks. Rolled surfaces free of roller tracking and heavy stipple unless approved by Departmental Representative.
 - .5 Remove runs, sags and brush marks from finished work and repaint.
- .3 Spray Application:
 - .1 Provide and maintain equipment that is suitable for intended purpose, capable of properly atomizing paint to be applied, and equipped with suitable pressure regulators and gauges.
 - .2 Keep paint ingredients properly mixed in containers during paint application by continuous mechanical agitation frequently as necessary.
 - .3 Apply paint in uniform layer, with overlapping at edges of spray pattern.
 - .4 Back roll spray applications and brush out runs and sags immediately.
 - .5 Use brushes to work paint into cracks, crevices and places which are not adequately painted by spray.
- .4 Use dipping, sheepskins or daubers when no other method is practical in places of difficult access and when specifically authorized by Departmental Representative.
- .5 Apply paint coats in continuous manner and allow surfaces to dry and properly cure between coats for minimum time period as recommended by manufacturer. Minimum dry film thickness of coats not less than that recommended by manufacturer. Repaint thin spots or bare areas before next coat of paint is applied.

- .6 Sand and dust between coats to remove visible defects.
- .7 Repaint surfaces both above and below sight lines as specified for surrounding surfaces, including such surfaces as tops of interior cupboards and cabinets and projecting ledges.
- .8 Repaint top, bottom, and vertical edges of doors to be repainted.
- .9 Repaint inside of cupboards and cabinets as specified for outside surfaces.
- .10 Repaint closets and alcoves to match existing, unless otherwise scheduled or noted.

3.7 MECHANICAL/ELECTRICAL EQUIPMENT

- .1 Unless otherwise noted, repainting to include exposed to view / previously painted mechanical and electrical equipment and components (panels, conduits, piping, hangers, and ductwork.).
- .2 Touch up scratches and marks and repaint such mechanical and electrical equipment and components with colour, and sheen finish to match existing unless otherwise noted or scheduled.
- .3 Do not paint over name plates or instruction labels.
- .4 Leave unfinished exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment in original finish.
- .5 Keep sprinkler heads free of paint.
- .6 Do not paint interior transformers and substation equipment.
- .7 Standard of Acceptance: when viewed using natural prevailing sunlight at peak period of day (mid-day) on surface viewed, surfaces to indicate following:
 - .1 Walls: no defects visible from distance of 1000 mm at 90 degrees to surface.
 - .2 Ceilings: no defects visible from grade at 45 degrees to surface.
 - .3 Final coat to exhibit uniformity of colour and sheen across full surface area.

3.8 FIELD QUALITY CONTROL

- .1 Inspection:
 - .1 Advise Departmental Representative and Paint Inspection Agency when each surface and applied coating is ready for inspection. Do not proceed with subsequent coats until previous coat has been approved.
 - .2 Co-operate with Paint Inspection Agency and provide access to areas of work.

3.9 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning, supplemented as follows:

- .1 Remove paint where spilled, splashed, splattered or sprayed as work progresses using means and materials that are not detrimental to affected surfaces.
- .2 Keep work area free from unnecessary accumulation of tools, equipment, surplus materials and debris.
- .3 Remove combustible rubbish materials and empty paint cans each day and safely dispose of same in accordance with requirements of authorities having jurisdiction.
- .4 Clean equipment and dispose of wash water used for water borne materials, solvents used for oil based materials as well as other cleaning and protective materials (e.g. rags, drop cloths, and masking papers), paints, thinners, paint removers/strippers in accordance with safety requirements of authorities having jurisdiction and as noted herein.
- .5 Clean painting equipment in leak-proof containers that will permit particulate matter to settle out and be collected. Sediment remaining from cleaning operations to be recycled or disposed of in manner acceptable to authorities having jurisdiction.
- .6 Recycle paint and coatings in excess of repainting requirements as specified.

3.10 RESTORATION

- .1 Clean and re-install hardware items removed before undertaken painting operations.
- .2 Remove protective coverings and warning signs as soon as practical after operations cease.
- .3 Remove paint splashings on affected exposed surfaces. Remove smears and spatter immediately as operations progress, using compatible solvent.
- .4 Protect freshly completed surfaces from paint droppings and dust to approval of Departmental Representative. Avoid scuffing newly applied paint.
- .5 Restore areas used for storage, cleaning, mixing and handling of paint to clean condition as approved by Departmental Representative.

END OF SECTION

1 General

1.1 RELATED REQUIREMENTS

- .1 Section 02 41 16 - Selective Demolition.

1.2 DESCRIPTION OF WORK

- .1 Perform installation under the direct supervision of the shooting range equipment manufacturer.
- .2 All equipment specified under this section shall be provided by (1) manufacturer to insure compatibility and product performance capability.

1.3 QUALITY ASSURANCE

- .1 Shooting range equipment manufacturers must meet the following qualifications: A firm having ten (10) years experience in fabrication and installation of work of the quality and scope required on this project.
- .2 Upon request provide a list of five (5) representative completed law enforcement type shooting range equipment installations in continuous use for three (3) years, with name, address and phone number of the Departmental Representative and a brief description for each project.
- .3 The shooting range equipment supplier must have ISO 9001:2008 Quality Management System and an ISO 14001:2004 Environmental Management System. Information confirming such shall be provided upon request.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for all shooting range equipment and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit shop drawings, indicating all equipment, sizes, materials, fabrication, installation, fastening, mechanical and electrical data and connection details. Coordinate all details on shop drawings with exact locations for mechanical and electrical work.
- .4 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.
- .5 Manufacturer's Instructions: submit manufacturer's installation instructions.

1.5 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for shooting range equipment for incorporation into manual.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated and secure area. Do not use non-vented plastic or canvas shelters that could create a humidity chamber.
 - .2 Store and protect shooting range equipment from damage.
 - .3 Protect prefinished surfaces with wrapping.
 - .4 Replace defective or damaged materials with new.
- .4 Inspect equipment upon delivery for damage.

2 Products

2.1 GRANULAR BALLISTICS TRAPS

- .1 Granulate: specialty treated rubber granulate made from recycled materials, to safely stop bullets and maintain their basic original shape, thus minimizing broken up lead particles released into the atmosphere.
- .2 Provide system for all small arms including handguns, shotguns, and rifles with a maximum velocity of 3600 FPS and maximum energy of 3600 ft. lbs.
- .3 Size: foot print to be no less than 3760 mm. Overall height to be as indicated on the drawings and reviewed shop drawings.

-
- .4 Provide granular ballistics trap with a sloping front surface constructed with a stepped steel bedplate, box tube support frame and must incorporate an upper hopper bin, filled with replenishment rubber material. This upper bin consists of an angled 10 mm AR500 @ 470-500 BHN armor plate slope sheet. Provide lower trap section, bedplates, to support rubber granules. These rubber granules consist of chopped rubber and shall be predominately free of cording, threads, steel belting pieces and cotton fibers. Fired rounds will be captured by the rubber granulate with little or no fragmentation or back-splatter. The steel bedplate provides a safety barrier. The design of the trap shall be such that under normal service and maintenance, the 3.57 mm thick steel bedplate shall not be relied upon to terminate the bullets flight.
 - .5 The granular ballistics trap's steel bedplates must be in a deep stepped configuration and not a simple angled plate. The primary impact area's step depth (Measured at the Horizontal steel bed plate) shall not be less than 610 mm. This required stepped design allows for greater rubber granule and lead retention in the granular ballistics trap's primary impact areas.
 - .6 The granular ballistics traps must incorporate an internal, separately enclosed & conveyor belt faced - backup Safety Bin - with additional rubber granulate within. This back-up area shall be no less than 250 mm in depth.
 - .7 The granular ballistics trap shall allow the recovery of largely intact spent rounds.
 - .8 The granular ballistics trap shall be self-supporting and assembled entirely by mechanical fasteners. The upper holding bins must be part of the Granular ballistics traps frame support assembly and not require overhead support via chains/cables, bridging or rear wall attachment and the like. The traps upper frame shall support the Granular ballistics traps 10 mm thick - AR500 Armor plate upper slope sheet and must extend no less than 1500 mm from the rear side of the trap assembly. No on-the-job cutting or welding shall be required.
 - .9 All metal parts not otherwise finished or plated shall be primed and painted.
 - .10 Note that use of this deeper granular ballistics trap design will require relocation of the existing 25 metre target line. Anticipate the new target line at 3048 mm from the rear edge of the new granular ballistics trap. Range Equipment Provider is to retain as much target distance as possible - without being detrimental to the equipments operational and service needs.
 - .11 Granular trap to meet the following requirements:
 - .1 Stepped bed plates. In addition to the primary loose rubber material depth - the traps primary impact area must hold an additional volume of 8 cubic feet.
 - .2 10 mm thick AR500 plate facing on the traps upper replenishment bin.
 - .3 The replenishment bin - when full and level with traps top elevation - must hold a volume of 19 cubic feet of rubber granulate material.

-
- .4 Granular ballistics traps upper replenishment bin must be a solid boxed steel frame that is fastened to the traps main support frames - and not suspended via chain or cables. The entire trap must be self supporting with no required attachment to the rear wall or ceiling structure.
 - .5 Granular ballistics trap must incorporate a "back-up" safety bin at the traps rear side. This area is to hold 10 cubic feet of rubber granulate.
 - .6 Granular ballistics traps support frames must be of tube / boxed steel. Use of angle iron, lumber or other support is not acceptable.

2.2 PROTECTIVE CEILING PANELS

- .1 The ceiling system is a combination of specially designed protection panels. These panels are made to fit the range precisely and to maximize the protection. From the Firing Line - a series of combined horizontal and angled panels will be installed. The safety ceiling (SC) and panels are created by mounting a 12.7 mm Fire Rated Treated plywood panel to a Fire rated treated 38 mm x 89 mm wood frame to a 10 mm thick - AR500 steel Armor Plate panel.
- .2 The **re-directive** guards are fabricated from 10 mm thick - AR500 Armor plate steel have a bare steel frontal surface.
- .3 Provide all Suspension hardware (chains, cables, "S"-hooks & turnbuckles) as required.
- .4 Light Cove deflectors shall have a 10 mm thick AR500 frontal surface (Bare steel) and arrive pre-punched with anchor holes and related mounting hardware. Panels to have a factory applied coat of primer on all sides.
- .5 The Ceiling panel's bottom surfaces are to have an open cell foam/acoustical material attached, to reduce the sound level in the range. Provide and install a sufficient quantity of 50 mm acoustical foam/sound deadening material by the range equipment manufacturer, to cover the facing of the safety ceiling. This acoustical foam material shall be based on the Anechoic-Wedge Principle. The acoustical foam shall be Class 1 rated. (Flammability - ASTM E 84 Class 1, Flame Spread - 5, Smoke Density - 90).
- .6 Range equipment provider to also provide & install 25 mm x 610 mm x 610 mm Shredded Rubber Planks (SRP) on the underside of the existing range ceiling. Installation of 38 mm x 89 mm furring strips on 400 mm centers - up & down the length of the range - as well as a layer of 19 mm plywood. **FIRE RATED TREATED LUMBER TO BE UTILIZED.** Furring and plywood locations shall be indicated on the range equipment providers shop drawings.
- .7 Provide and install any bridging (if required) for any obstructions that interfere with the ceiling panel installation.

2.3 COMBAT WALLS

- .1 Combat Wall System: consists of 10 mm thick - AR500 Armor backing plate, wood

framed air space chamber, 12.7 mm plywood and a 25 mm rubber facing. FIRE RATED/TREATED LUMBER MUST BE USED. The steel panels arrive prefabricated & ready for installation.

- .2 Coverage to include the bullet trap sidewalls and continue continuously back to the 25 Meter primary firing line - at an elevation of 2440 mm.
- .3 The system shall be modular in design to facilitate ease of installation. The entire system shall include all framing and assembly fasteners. The panels shall be firmly secured to the wall via mastic and mechanical fasteners.

2.4 PROTECTIVE CEILING PANELS

- .1 The ceiling system is a combination of specially designed protection panels. These panels are made to fit the range precisely and to maximize the protection. From the Firing Line - a series of combined horizontal and angled panels will be installed. The safety ceiling (SC) and are created by mounting a 12.7 mm fire rated treated plywood panel to a fire rated treated 38 mm x 89 mm wood frame to a 10 mm thick - AR500 steel Armor Plate panel.
- .2 The re-directive guards are fabricated from 10 mm thick - AR500 Armor plate steel have a bare steel frontal surface.
- .3 Provide all Suspension hardware (chains, cables, "S"-hooks & turnbuckles) as required.
- .4 Light cove deflectors shall have a 10 mm thick AR500 frontal surface (Bare steel) and arrive pre-punched with anchor holes and related mounting hardware. Panels to have a factory applied coat of primer on all sides.
- .5 The ceiling panel's bottom surfaces are to have an open cell foam/acoustical material attached, to reduce the sound level in the range. Provide and install a sufficient quantity of 50 mm acoustical foam/sound deadening material by the range equipment manufacturer, to cover the facing of the safety ceiling . This acoustical foam material shall be based on the Anechoic-Wedge Principle. The acoustical foam shall be Class 1 rated. (Flammability - ASTM E 84 Class 1, Flame Spread - 5, Smoke Density - 90).
- .6 Provide and install any bridging (if required) for any obstructions that interfere with the ceiling panel installation.

2.5 GUN CLEARING TRAP

- .1 Provide Gun Clearing Trap for a safe and secure means of clearing guns during loading and unloading. Gun clearing traps shall protect both the shooter and bystanders from an accidental discharge by safely containing the bullet.
 - .1 Provide (1) Rifle Rated Gun Clearing Trap; Weapon-Clear as manufactured by MilPolice Equipment, www.MilPolice.com.
 - .2 The clearing trap shall be a self-standing/floor model that does not require a stand or special mounting hardware to secure it.

- .3 The clearing trap shall accommodate pistole and rifle rounds up to 0.50 BMG AP and meet Wiltshire Balistic Services: 48 rounds in total from 300 ft/lbs to 13334 ft/lbs.
- .4 The clearing trap shall utilize safety signage that illustrates its capabilities and limitations.

3 Execution

3.1 RANGE CLEANING/DEMOLITION WORK

- .1 Perform all demolition work in accordance with Section 02 41 16 - Selective Demolition.

3.2 INSTALLATION

- .1 The work must be completed in accordance with standard practice in equipment manufacture and in a manner acceptable to the Departmental Representative.
- .2 Install in exact accordance with manufacturer's instructions and submittals.
- .3 Provide installation by the equipment manufacturer.
- .4 Provide all wiring of control systems under the direct supervision of the equipment manufacturer.
- .5 Install all components in a rigid secure manner.
- .6 Adjust target system for proper operation.
- .7 At installation completion, provide the services of a representative of the firearms training equipment to demonstrate proper operation and maintenance training of the complete system in accordance with Section 01 79 00 - Demonstration and Training.
- .8 Manufacturer must provide a toll-free telephone number and a dedicated toll-free customer service number with access to a customer service representative. Provide follow up courtesy services/training visit from a factory trained service technician, for the target retrieval systems, within one year of installation.

3.3 CLEANING

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

END OF SECTION

1. General

1.1 Intent

- .1 Work in Division 21, will include all drawings and all sections of the specifications that form the Contract Documents, including all addenda, and including Division 00 and Division 01, whether defined in Division 21 or elsewhere, or whether defined in mechanical drawings or elsewhere.
- .2 Provide complete, fully tested and operational mechanical systems to meet requirements described herein and in complete accord with applicable codes and ordinances. Include all costs to obtain all permits and to pay for all fees and charges, including inspection charges by the authorities that issue the permits. Coordinate all related inspections. Permits, fees and inspections including:
 - .1 Sprinklers
 - .2 Fire Protection
 - .3 Third party engineering fees
- .3 Contract documents consisting of the specifications and drawings, are generally diagrammatic and approximately to scale unless detailed otherwise. They establish scope, material and installation quality and are not detailed installation instructions.
- .4 Review Contract Documents and notify the Consultant of issues or conflict that require clarification prior to submitting tender. Failure by the Contractor to secure clarification does not relieve the Contractor to comply with the intent of the design and/or the Contract Document.

1.2 Related Requirements

- .1 Refer to and comply with the following sections:

.1 General Requirements	Division 01
.2 Submittal Procedures	Section 01 33 00
.3 Delegated Design Submittals	Section 01 33 50
.4 Quality Control	Section 01 45 00
.5 Temporary Facilities and Controls	Section 01 51 00
.6 Execution Requirements	Section 01 73 00
.7 Closeout Procedures	Section 01 77 00
.8 Closeout Submittals	Section 01 78 00
.9 Demonstration and Training	Section 01 79 00
.10 Commissioning	Section 01 91 00

.11 Building Management Manual (BMM)

Section 01 91 51

1.3 Related Work Specified In Other Sections

.1 For complete Common Work requirements refer to Section 23 05 00 – Common Work Results for HVAC.

2. Products

.2 For complete Common Work requirements refer to Section 23 05 00 – Common Work Results for HVAC.

3. Execution

.3 For complete Common Work requirements refer to Section 23 05 00 – Common Work Results for HVAC.

END OF SECTION

1. General

1.1 Scope

- .1 Gate valves
- .2 Butterfly valves
- .3 Check valves

1.2 Reference Documents

- .1 American Society for Testing and Materials (ASTM):
 - .1 ASTM A126-04 Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
 - .2 ASTM B21/B21M-06 Standard Specification for Naval Brass Rod, Bar, and Shapes
 - .3 ASTM B61-08 Standard Specification for Steam or Valve Bronze Castings
 - .4 ASTM B62-09 Standard Specification for Composition Bronze or Ounce Metal Castings
 - .5 ASTM B98/B98M-08 Standard Specification for Copper-Silicon Alloy Rod, Bar and Shapes
 - .6 ASTM B139/B139M-07 Standard Specification for Phosphor Bronze Rod, Bar, and Shapes
 - .2 National Fire Protection Association (NFPA):
 - .1 NFPA 13-2013 Standard for the Installation of Sprinkler Systems
 - .2 NFPA 14-2010 Standard for the Installation of Standpipe Systems
 - .3 Manufacturers Standardization Society Standard Practices (Current Editions)
 - .1 SP-67 Butterfly Valves
 - .2 SP-70 Gray Iron Gate Valves, Flanged and Threaded Ends
-

-
- | | | |
|----|-------|---|
| .3 | SP-71 | Gray Iron Swing Check Valves, Flanged and Threaded Ends |
| .4 | SP-80 | Bronze Gate, Globe, Angle, and Check Valves |
| .5 | SP-82 | Valve Pressure Testing Methods |

1.3 Manufacturer

- .1 Provide valves of the same type by the same manufacturer throughout.
- .2 Valves shall bear the following information permanently marked on the valve body”
 - .1 Manufacturer’s name or trademark
 - .2 Pressure rating
 - .3 Flow direction
- .3 Valves for fire protection service to be ULC Listed and FM Approved.

1.4 Shop Drawings

- .1 Submit detailed shop drawings clearly indicating make, model, size, pressure rating, materials of construction and intended service.

2. Products

- .1 For complete General Duty Valve requirements refer to Section 22 05 23 – General Duty Valves for Plumbing Piping.

3. Execution

- .1 For complete General Duty Valve requirements refer to Section 22 05 23 – General Duty Valves for Plumbing Piping.

END OF SECTION

1. General

1.1 Scope

- .1 Pipe hangers and supports
- .2 Sleeving for mechanical equipment
- .3 Equipment bases and supports
- .4 Pipe anchors
- .5 Access Doors

1.2 Reference Standards

- .1 Pipe supports shall meet the requirements of ANSI B31.1 Power Piping.
- .2 Automatic sprinkler pipe supports shall meet the requirements of NFPA No.13, Standard for the Installation of Sprinkler Systems.

1.3 General Requirements

- .1 Provide hangers and supports to secure equipment in place, prevent vibration, maintain grade, and provide for expansion and contraction.
 - .2 Install supports of strength and rigidity to suit loading without unduly stressing the building. Locate adjacent to equipment to prevent undue stresses in piping and equipment. Where support is from concrete construction, avoid weakening concrete or penetrating waterproofing.
 - .3 Select hangers and supports for the service and in accordance with manufacturer's recommended maximum loading. Hangers shall have a safety factor of 5 to 1.
 - .4 Fasten supports and hangers to building structure. Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practical. When possible, set inserts in position in advance of concrete work. Drill concrete where inserts must be placed after concrete is poured.
 - .5 Where structural bearings do not exist or where inserts are not in suitable locations for proper installation of pipes, conduits and ducts, provide approved support made of steel channels or angles from which to suspend hangers. Do not use existing piping, crane rails, trolley beams, mono rails, etc, for support.
 - .6 No percussion type fastening of any kind will be permitted without prior approval.
 - .7 Provide and set sleeves or block-outs required for equipment, including openings required for placing equipment.
-

-
- .8 Provide sleeves for all piping through rated assemblies. In non-rated assemblies, provide sleeves for all domestic hot, domestic cold, and domestic recirculation piping. Sleeves to be sized to allow insulation to pass through and to project through both sides of wall.
 - .9 Provide sleeves for all piping through ceilings, floors and footings.
 - .10 Do not weld piping or equipment supports to building metal decking or building structural steel supports unless prior written approval has been obtained from the structural engineer.
 - .11 Obtain approval prior to drilling for inserts and supports for piping system. Discuss and obtain approval for hanging systems and methods with Structural Engineer.
 - .12 Obtain approval prior to using percussion type fastenings.
 - .13 Use of piping or equipment for hanger supports and use of perforated band iron, wire or chain as hangers is not permitted.

1.4 Submittals

- .1 Submit shop drawings for access doors.

2. Products

- .1 For complete hanger, support and access door requirements for fire suppression refer to Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment.

3. Execution

- .1 For complete hanger, support and access door requirements for fire suppression refer to Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment.

END OF SECTION

1. General

1.1 Scope

- .1 Painting and identification of equipment, piping and related components for the following:

- .1 Fire Protection Systems

1.2 Related Work Specified in Other Sections

- | | | |
|----|--|------------------|
| .1 | General Requirements | Division 01 |
| .2 | Interior Painting | Section 09 91 23 |
| .3 | Common Work Results for HVAC | Section 23 05 00 |
| .4 | Identification for HVAC Piping and Equipment | Section 23 05 53 |

1.3 Reference Standards

- .1 Canadian General Standards Board (CGSB)
- .1 CGSB-1-GP-12c; Color Identification and Selection
- .2 CAN/CGSB-24.3 – Identification of Piping Systems
- .2 National Fire Protection Association (NFPA)
- .1 NFPA 13-2010, Standard for the Installation of Sprinkler Systems
- .2 NFPA 14-2010, Standard for the Installation of Standpipe and Hose Systems
- .3 American Society of Mechanical Engineers (ASME)
- .1 ASME A13.1-2007, Scheme for the Identification of Piping Systems
- .4 Federal Standard 595C – Colors
- .5 WHMIS Pictograms – Workplace Hazardous Materials Information System – GHS Globally Harmonized System of Classification and Labeling Chemicals) – Pictograms

1.4 Quality Control

- .1 Coordinate color coding of piping and equipment with work of Section 09 91 23 – Interior Painting.
- .2 All painting identified in this section is to be performed by Section 09 91 23 – Interior Painting Contractor, under the direction of the Division 21 contractor.
-

-
- .3 Color code mechanical equipment and piping. Refer to Part 3 of this section.
 - .4 Submit a schedule of pipe and equipment identification methods, materials and colors to the Engineer for review.

1.5 Definitions

- .1 For the purposes of this Section, the following definitions apply:
 - .1 Concealed: Piping and equipment in trenches, shafts, furrings and suspended ceilings.
 - .2 Exposed: Piping and equipment in mechanical rooms or otherwise not “concealed”.

1.6 Equipment Protection and Clean-Up

- .1 Ensure that new and existing equipment and surfaces are carefully covered with tarping, or heavy duty plastic. Ensure that spills and splatter on finishes and equipment are cleaned up totally and promptly.

2. **Products**

Not Applicable

3. **Execution**

- .1 For complete identification requirements refer to Section 23 05 53 – Identification for HVAC Piping and Equipment.

END OF SECTION

1. General

1.1 Scope

- .1 Equipment, piping, including sprinkler heads, valves, hangers and supports, sleeves, fire department connections, and accessories.
- .2 Contractor shall be responsible for coordination of all fire alarm interlocks with Division 26.

1.2 General Requirements

- .1 Provide complete sprinkler system as required by local codes and as indicated on drawings. Size of sprinkler system based on light hazard occupancy and ordinary hazard occupancy group 1.
- .2 Provide sprinklers for areas as indicated and as required, including specialized rooms. Run piping concealed above furred ceilings and in joist to minimize obstructions. Expose only heads.
- .3 Hydraulically size sprinkler system based on the actual water supply data which must be obtained from municipal utility.

1.3 Quality Assurance

- .1 All municipal bylaws, provincial statutes and NFPA Standards governing the installation shall be strictly adhered to.
 - .2 Provide all labor and materials in accordance with the requirements of the fire marshal having jurisdiction. Comply fully with the rules and regulations stated in current National Building Code and the following NFPA Standards, those editions which are in effect locally and in the Province of Alberta.
 - .3 Guarantee that the quantities of sprinklers proposed meet the requirements of this specification. If the quantities are not within these requirements, provide additional sprinklers and their installation at no additional cost to the contract.
 - .4 Sprinkler equipment and installation shall be in accordance with the current standards and approved local Fire Commissioner.
 - .5 Equipment and installation shall meet the requirements of current edition of NFPA 13 - Standard for the Installation of Sprinkler Systems.
 - .6 Sprinkler equipment shall be installed by qualified contractors licensed and regularly engaged in installation of automatic fire sprinkler equipment.
 - .7 Refer to Section 21 05 00 – Common Work Results for Fire Suppression for welding requirements
-

1.4 Reference Standards

- .1 National Fire Protection Association (NFPA)
 - .1 NFPA 13 2013 Standard for the Installation of Sprinkler Systems
- .2 National Research Council (NRC)
 - .1 National Building Code (NBC) 2010
 - .2 National Plumbing Code of Canada (NPC) 2010

1.5 Submittals

- .1 Submit four (4) copies of the preliminary layout showing head locations, pipe sizes, and pipe route for review by the consultant. Furnish additional heads which may be required for coordinated ceiling pattern without added cost, even though number of heads may exceed minimum code requirements.
- .2 Submit to the consultant shop drawings and sprinkler hydraulic calculations bearing the approval seal of Professional Engineer specialized in Fire Protection.
- .3 Submit cut sheets of equipment and accessories related to the sprinkler system, and appurtenances for Consultant's approval.
- .4 Submit completed hydrostatic test certificates and other certification of testing as required and to the owner's Underwriter.

1.6 Related Work Specified in Other Sections

- .1 Common Work Results for Fire Suppression Section 21 05 00

1.7 Engineering Design Criteria

- .1 Design system in accordance with NFPA 13, using following parameters:
 - .1 Hazard: To suit occupancy classification based on the quantity and/or combustibility of the building contents.
 - .2 Pipe size and layout:
 - .1 Hydraulic design in accordance with NFPA standards and the Owner's Insurance Underwriter requirements, whichever is more stringent.
 - .2 Sprinkler head layout: to NFPA 13 or as directed by Authority Having Jurisdiction.
 - .3 Water Supply
-

- .1 Conduct flow and pressure test of water supply in vicinity of project to obtain criteria for bases of design in accordance with NFPA 13. Present findings to consultant.

.4 Zoning:

- .1 System zoning as indicated or in accordance with NFPA standards.

1.8 Maintenance Data and Materials

- .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 – Closeout Submittals and Section 01 91 51 – Building Management Manual (BMM).
- .2 Provide spare sprinklers and tools as indicated in 2.6 – Spare Parts Cabinet.

2. **Products**

2.1 Pipe & Fittings

Size	Material	Fittings	Joint
1. Sprinkler and standpipe and hose system piping unless otherwise noted using threaded or cut grooved mechanical coupling joints:			
100 (4") and smaller	ASTM A-53 Schedule 40, Grade A carbon steel	Standard weight cast iron to ANSI B16.4, 1206.6 kPa	Threaded, cut grooved
2. Sprinkler and standpipe and hose system piping unless otherwise noted using welded or rolled groove mechanical joints:			
25 – 100 (1" to 4")	ASTM A-53, Grade A, carbon steel, Schedule 10	Standard weight cast iron to ANSI B16.4, 1206.6 kPa, or ductile iron to ASTM A-536 with enamel coating	Welded or ULC/FM approved roll groove
50 (2") and smaller	ASTM A-795 Schedule 5, steel, minimum wall thickness 1.45mm	ULC listed/FM approved Victaulic "Press-fit" cold drawn steel with Grade 'C' Butylene 'O' rings	ULC listed/FM approved Victaulic "Press-fit" cold drawn steel with Grade 'C' Butylene 'O' rings
150 (6")	ASTM A-53, Grade A, carbon steel, min. wall thickness 3.4mm	Standard weight cast iron to ANSI B16.4, 1206.6 kPa, or ductile iron to ASTM A-536 with enamel coating	Welded or ULC/FM approved roll groove

Size	Material	Fittings	Joint
200 – 250 (8" to 10")	ASTM A-53, Grade A, carbon steel, min. wall thickness 4.78mm	Standard weight cast iron to ANSI B16.4, 1206.6 kPa, or ductile iron to ASTM A-536 with enamel coating	Welded or ULC/FM approved roll groove with EPDM gasket
<p>Note: Use of CSA/ULC labeled plastic in sprinkler system will only be allowed with specific written application to the consultant and specific return written authorization from local fire authority having jurisdiction. Include comprehensive information on products and processes with written application.</p> <p>Non-specified pipe joining and pipe fitting methods such as T-drill and Press Fit are not permitted in any piping system covered under Division 21</p>			

2.2 Unions, Flanges and Couplings

- .1 Size 50mm (2") and under: 1035 kPa (150 psi) malleable iron, bronze to iron ground joint unions for threaded ferrous piping, air tested for gas service, all bronze for copper piping.
- .2 Sizes 65mm (2½") and over: 1035 kPa (150 psi) forged steel welding neck flanges for ferrous piping, 1035 kPa (150 psi) bronze slip-on flanges for copper piping. Gaskets shall be 1.5mm (16 gauge) thick pre-formed synthetic rubber bonded asbestos.
- .3 Flange bolting: For systems up to 120°C (250°F), use carbon steel stud bolts, semi-finished, and heavy hex nuts, ASTM A307-GrB.
- .4 Rigid grooved mechanical couplings shall have an angle bolt pattern design and shall provide system support and hanging requirements in accordance with ASME B31.1. Rigid couplings shall be used in all locations unless otherwise noted. Standard of acceptance Victaulic Style 07
- .5 For grooved mechanical couplings fire protection service the gasket material shall be Grade "E" EPDM compound (green color coded stripe) conforming to ASTM D-2000 designation. Grade "E" gaskets are UL/ULC classified to ANSI/NSF 61 for -34°C to 110°C (-30°F to +230°F) operating temperature range. Any deviations from the above in the way of special lubricants or special clauses in the manufactures literature as to limitations on hot water must be brought to the attention of the engineer and may not be accepted.
- .6 Official submission of shop drawings required.

2.3 Valves, Supports and Sleeves

- .1 Valves shall conform to Section 21 05 23 – General Duty Valves for Water Based Fire Suppression Systems.

-
- .2 Pipe hangers, supports and sleeves shall conform to Section 21 05 29 – Hangers and Supports for Fire Suppression Piping and Equipment.
 - .3 Pipe and valve identification shall conform to Section 21 05 53 – Identification for Fire Suppression Piping and Equipment.

2.4 Sprinkler Heads

- .1 Temperature rating on fusible links shall suit specific hazard area and ceiling temperature with minimum margin of safety 10°C (50°F).
- .2 All sprinkler heads shall be of quick response type, and shall be designed and installed in accordance with their ULC listing. Sprinklers are to bear certification marking.
- .3 Semi-Recessed Heads: Pendant type sprinkler heads with white finish and white escutcheon.
- .4 Pendant Heads: Standard pendant heads with white finish with white escutcheon except in areas without suspended ceilings.

2.5 Supervisory Switches

- .1 General: Switches to NFPA 13 and ULC listed for fire service.
- .2 All valves that control the supply of water to automatic sprinklers shall be electrically supervised to indicate a supervisory signal on the fire alarm system.
- .3 Isolation valves supervisory switch:
 - .1 ULC listed supervisory switch one or two sets single pole double throw contacts normally open or normally closed contacts. Contacts to be rated a minimum 15.0 Amps at 125/250 VAC and 2.5 Amps at 30 VDC.
- .4 Water flow switch:
 - .1 ULC listed paddle type water flow switch with retard device with one or two sets of single pole double throw normally open or normally closed contacts. Contacts to be rated a minimum 15.0 Amps at 125/250 VAC and 2.0 Amps at 30 VDC. Cover shall incorporate tamper resistant screws.

2.6 Spare Parts Cabinet

- .1 For storage of maintenance materials, spare sprinkler heads and sprinkler wrench.
 - .2 Construct to sprinkler head manufacturers standard.
 - .3 Provide on wall near sprinkler valve, cabinet containing extra sprinkler heads of each type and a wrench suitable for each head type. Six (6) extra sprinkler heads for less than 300 sprinklers, 12 for 300 to 1000 sprinklers, and 24 for over 1000 sprinkler heads of each type.
-

3. Execution

3.1 Installation

- .1 Install, inspect and test to acceptance with NFPA 13 and local authorities.
- .2 Provide on sprinkler system take-off from water supply ULC approved double check valve assembly.
- .3 Locate sprinkler heads in ceilings in order to maintain the pattern with lights, diffusers, etc. In other areas, arrange layouts and head locations as to avoid interference with other equipment and materials. Sprinkler head locations shall be located symmetrically within each room or area but shall not exceed the manufactures ULC listed maximum spacing. Final layout to be based on architectural and mechanical shop drawing reviews.
- .4 Provide sprinkler inspector's test and flow test connections as per NFPA 13.
- .5 Install water flow indicators where indicated.
- .6 Locate zone shut-off valves visible from the floor. Do not conceal from view, locate in janitor, storage rooms, or stairwells unless approved by the Engineer.
- .7 Identify all piping and isolation valves in accordance with Section 21 05 53 – Identification for Fire Suppression Piping and Equipment.

3.2 Fire Protection System Tests

- .1 Sprinkler System: Test as required by the edition of NFPA 13 noted in the Alberta Building Code 2014 and the authorities having jurisdiction. Complete certificates for test results and submit.

3.3 Piping – Preparation

- .1 Ream pipes and tubes. Clean off scale and dirt, inside and outside, before assembly. Remove welding slag or other foreign material from piping.
- .2 Protect all steel pipes when stored on site from external conditions and ensure protective coating remains intact. If in the opinion of the engineer, deterioration of the protective coating has instigated corrosion, all rust must be removed down to bare metal and prime coated with red oxide paint.
- .3 Use Victaulic roll grooving tools to groove pipe in accordance with manufacturer's specifications. Use copper rolls for copper pipe and stainless steel rolls for stainless steel pipe as provided by Victaulic.

3.4 Piping – Connection

- .1 Make screwed joints with full cut standard taper pipe threads with approved Teflon tape or non-toxic joint compound applied to male threads only, equal to Jet-Lube V-2 multi-purpose thread sealant.
-

-
- .2 Use grooved mechanical couplings and mechanical fasteners as manufactured by Victaulic where allowed.
 - .3 Make connections to equipment, specialty components, and branch mains after isolation valves, with unions or flanges.
 - .4 Provide dielectric type connections wherever jointing dissimilar metals in open systems. Brass adapters and valves are acceptable.

3.5 Piping – Routes and Installation

- .1 Confirm requirements of main line routing with consultant prior to hydraulic design. Route piping in an orderly manner and maintain proper grades. Install to conserve headroom and interfere as little as possible with use of space. Run exposed piping parallel to walls. Group piping, wherever practical, at common elevations. Install concealed pipes close to the building structure to keep furring to a minimum.
- .2 Co-ordinate the installation of sprinkler piping with all other trades, services and structure.
- .3 Sprinkler piping is to be sloped towards the system low points in accordance with NFPA 13. Sprinkler piping to be arranged to minimize the number of auxiliary drains required to collect condensation and to drain system low points. Extend drain lines to the floor level within the reach of a floor drain with a 15m (50'-0") hose.
- .4 Equip low points with 20mm ($\frac{3}{4}$ ") drain valves and hose nipples.
- .5 Pipe the discharge from all relief valves, safety valves, vents, drains, and equipment to the nearest building drain.
- .6 Install piping to allow for expansion and contraction without unduly stressing pipe or equipment connected.
- .7 Provide clearance for proper access to valves, air vents, drains and unions.

END OF SECTION

1. General

1.1 Scope

- .1 Equipment, piping, including sprinkler heads, valves, hangers and supports, sleeves, fire department connections, and accessories.
- .2 Contractor shall be responsible for coordination of all fire alarm interlocks with Division 26.

1.2 General Requirements

- .1 Provide complete sprinkler system as required by local codes and as indicated on drawings. Size of sprinkler system based on light hazard occupancy.
- .2 Provide sprinklers for areas as indicated and as required, including specialized rooms. Run piping concealed above furred ceilings and in joist to minimize obstructions. Expose only heads.
- .3 Hydraulically size sprinkler system based on the actual water supply data which must be obtained from municipal utility.

1.3 Quality Assurance

- .1 All municipal bylaws, provincial statutes and NFPA Standards governing the installation shall be strictly adhered to.
- .2 Provide all labor and materials in accordance with the requirements of the fire marshal having jurisdiction. Comply fully with the rules and regulations stated in current National Building Code and the following NFPA Standards, those editions which are in effect locally and in the Province of Alberta.
- .3 Guarantee that the quantities of sprinklers proposed meet the requirements of this specification. If the quantities are not within these requirements, provide additional sprinklers and their installation at no additional cost to the contract.
- .4 Sprinkler equipment and installation shall be in accordance with the current standards required by IAO, Insurers Advisory Organization, Owner's Underwriters, Factory Mutual, and approved local Fire Commissioner.
- .5 Equipment and installation shall meet the requirements of current edition of NFPA 13 - Standard for the Installation of Sprinkler Systems.
- .6 Sprinkler equipment shall be installed by qualified contractors licensed and regularly engaged in installation of automatic fire sprinkler equipment.

1.4 Reference Standards

- .1 National Fire Protection Association (NFPA)
-

-
- .1 NFPA 13 Standard for the Installation of Sprinkler Systems
 - .2 National Research Council (NRC)
 - .1 Alberta Building Code (ABC) 2014
 - .2 National Building Code (NBC) 2010
 - .3 National Plumbing Code of Canada (NPC) 2010

1.5 Submittals

- .1 Submit four (4) copies of the preliminary layout showing head locations, pipe sizes, and pipe route for review by the consultant. Furnish additional heads which may be required for coordinated ceiling pattern without added cost, even though number of heads may exceed minimum code requirements.
- .2 Submit to the consultant shop drawings and sprinkler hydraulic calculations bearing the approval seal of Professional Engineer specialized in Fire Protection.
- .3 Submit cut sheets of equipment and accessories related to the sprinkler system, and appurtenances for Consultant's approval.
- .4 Submit completed hydrostatic test certificates and other certification of testing as required and to the owner's Underwriter.

1.6 Related Work Specified in Other Sections

- .1 Common Work Results for Fire Suppression Section 21 05 00
- .2 Wet Pipe Fire Suppression Sprinkler Systems Section 21 13 13

1.7 Engineering Design Criteria

- .1 Design system in accordance with NFPA 13, using following parameters:
 - .1 Hazard: To suit occupancy classification based on the quantity and/or combustibility of the building contents.
 - .2 Pipe size and layout:
 - .1 Hydraulic design in accordance with NFPA standards and the Owner's Insurance Underwriter requirements, which ever is more stringent.
 - .2 Sprinkler head layout: to NFPA 13 or as directed by Authority Having Jurisdiction.]
 - .3 Water Supply
-

- .1 Conduct flow and pressure test of water supply in vicinity of project to obtain criteria for bases of design in accordance with NFPA 13. Present findings to consultant.

.4 System Type

- .1 Provide a double-interlock preaction sprinkler system with electrical activation. Typical sequence of operation as follows:

- .1 Initiating device circuit is activated either by a detector or a manual pull station.
- .2 Fire alarm panel receives the initiating device signal and indicates first alarm.
- .3 Sprinkler head(s) are activated and air pressure is released from the piping.
- .4 Low pressure switch is activated and signal is sent to the fire alarm panel. Fire alarm panel indicates second alarm.
- .5 Fire alarm panel reverses polarity of the release circuit, solenoid valve is activated and water is released into the sprinkler piping.
- .6 Activated sprinkler head(s) discharge only in the areas where sprinklers have operated.

1.8 Maintenance Data and Materials

- .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 – Closeout Submittals and Section 01 91 51 – Building Management Manual (BMM).
- .2 Provide spare sprinklers and tools as indicated in 2.11 – Spare Parts Cabinet.

2. Products

2.1 Pipe & Fittings

Size	Material	Fittings	Joint
1. Sprinkler and standpipe and hose system piping unless otherwise noted using threaded or cut grooved mechanical coupling joints:			
100 (4") and smaller	ASTM A-53 Schedule 40, Grade A carbon steel	Standard weight cast iron to ANSI B16.4, 1206.6 kPa	Threaded, cut grooved
2. Sprinkler and standpipe and hose system piping unless otherwise noted using welded or rolled groove mechanical joints:			

Size	Material	Fittings	Joint
25 – 100 (1" to 4")	ASTM A-53, Grade A, carbon steel, Schedule 10	Standard weight cast iron to ANSI B16.4, 1206.6 kPa, or ductile iron to ASTM A-536 with enamel coating	Welded or ULC/FM approved roll groove
50 (2") and smaller	ASTM A-795 Schedule 5, steel, minimum wall thickness 1.45mm	ULC listed/FM approved Victaulic "Press-fit" cold drawn steel with Grade 'C' Butylene 'O' rings	ULC listed/FM approved Victaulic "Press-fit" cold drawn steel with Grade 'C' Butylene 'O' rings
Note: Use of CSA/ULC labeled plastic in sprinkler system will only be allowed with specific written application to the consultant and specific return written authorization from local fire authority having jurisdiction. Include comprehensive information on products and processes with written application.			

2.2 Unions, Flanges and Couplings

- .1 Size 50mm (2") and under: 1035 kPa (150 psi) malleable iron, bronze to iron ground joint unions for threaded ferrous piping, air tested for gas service, all bronze for copper piping.
- .2 Sizes 65mm (2½") and over: 1035 kPa (150 psi) forged steel welding neck flanges for ferrous piping, 1035 kPa (150 psi) bronze slip-on flanges for copper piping. Gaskets shall be 1.5mm (16 gauge) thick pre-formed synthetic rubber bonded asbestos.
- .3 Flange bolting: For systems up to 120°C (250°F), use carbon steel stud bolts, semi-finished, and heavy hex nuts, ASTM A307-GrB.
- .4 Rigid grooved mechanical couplings shall have an angle bolt pattern design and shall provide system support and hanging requirements in accordance with ASME B31.1. Rigid couplings shall be used in all locations unless otherwise noted. Standard of acceptance Victaulic Style 07
- .5 For grooved mechanical couplings fire protection service the gasket material shall be Grade "E" EPDM compound (green color coded stripe) conforming to ASTM D-2000 designation. Grade "E" gaskets are UL/ULC classified to ANSI/NSF 61 for -34°C to 110°C (-30°F to +230°F) operating temperature range. Any deviations from the above in the way of special lubricants or special clauses in the manufactures literature as to limitations on hot water must be brought to the attention of the engineer and may not be accepted.
- .6 Official submission of shop drawings required.

2.3 Valves, Supports and Sleeves

- .1 Valves shall conform to Section 21 05 23 – General Duty Valves for Water Based Fire Suppression Systems.
- .2 Pipe hangers, supports and sleeves shall conform to Section 21 05 29 – Hangers and Supports for Fire Suppression Piping and Equipment.
- .3 Pipe and valve identification shall conform to Section 21 05 53 – Identification for Fire Suppression Piping and Equipment.

2.4 Sprinkler Heads

- .1 Temperature rating on fusible links shall suit specific hazard area and ceiling temperature with minimum margin of safety 10°C (50°F).
- .2 All sprinkler heads shall be of quick response type, and shall be designed and installed in accordance with their ULC listing. Sprinklers are to bear certification marking.
- .3 Upright Heads: Standard upright, brass finish.
- .4 Sidewall Heads: Standard sidewall heads with chrome plated finish and chrome plated escutcheon.

2.5 Supervisory Switches

- .1 General: Switches to NFPA 13 and ULC listed for fire service.
 - .2 All valves that control the supply of water to automatic sprinklers shall be electrically supervised to indicate a supervisory signal on the fire alarm system.
 - .3 Isolation Valves Supervisory Switch:
 - .1 ULC listed supervisory switch one or two sets single pole double throw contacts normally open or normally closed contacts. Contacts to be rated a minimum 15.0 Amps at 125/250 VAC and 2.5 Amps at 30 VDC.
 - .4 Pressure Alarm Switch:
 - .1 ULC listed with one or two sets single pole double throw contacts normally open or normally closed contacts. Pressure switch cover shall incorporate tamper resistant screws. Contacts to be rated a minimum 15.0 Amps at 125/250 VAC and 2.5 Amps at 30 VDC.
 - .5 Low Pressure Alarm Switch:
 - .1 ULC listed with one or two sets single pole double throw contacts normally open or normally closed contacts. Pressure switch cover shall incorporate tamper resistant screws. Contacts to be rated a minimum 15.0 Amps at 125/250 VAC and 2.5 Amps at 30 VDC.
-

.6 Solenoid Valve:

- .1 Provide a 24 VDC rated solenoid valve listed for use with the electrical actuation trim provided.

2.6 Preaction Valve Release Panel

- .1 Panel shall be provided by Division 21 and installed by Division 26. The panel must be by the same manufacturer as the base building fire alarm panel.
- .2 Panel shall be housed in a wall-mounted enclosure with hinged door that is provided with a keyed lock. The panel shall be ULC approved and comply with NFPA 72.
- .3 The following circuits shall be provided:
- .1 A supervised signal initiating device circuit for manual pull stations, smoke detectors and/or heat detectors. This circuit shall be selectable to style D (class A) or style B (class B).
- .2 A supervised signal indicating device circuit that will reverse polarity when an alarm condition occurs. This circuit shall be rated ½ ampere at 24 VDC.
- .3 A separate supervised style B (class B) circuit to monitor control valve position, low air pressure in supervised preaction piping and alarm pressure switch (system has tripped).
- .4 A style B (class B) supervised solenoid release circuit that shall reverse polarity when a releasing condition occurs. This circuit shall be rated 1.0 ampere at 24VDC.
- .4 Provide visual indicators that are visible with the panel door closed as follows:
- .1 AC On – Green LED
- .2 Alarm – Red LED
- .3 System Trouble – Yellow LED
- .4 Supervisory Condition – Yellow LED
- .5 Signal Indicating device silenced – Yellow LED
- .5 Provide the following panel features:
- .1 A built in trouble buzzer.
- .2 Silence switch that silences alarm indicating devices or the trouble buzzer and resets trouble relay contacts.
- .3 Manual release switch that activates all alarm indicators, alarm and releasing circuit outputs.
-

-
- .4 Releasing circuit disable switch that prevents operation of the releasing circuit.
 - .5 A test switch that disables the latching function of the signal initiating device circuit.
 - .6 Reset switch that restores the panel to normal after the initiating device circuit has been cleared.
 - .7 One set of SPDT (form C) auxiliary alarm contacts and one set SPST (Form A) auxiliary trouble contacts, rated 2 amperes at 30 volts AC/DC.
 - .8 Provide a secondary power supply in accordance with NFPA 72. The power supply shall be a combination power supply/battery charger with standby batteries capable of operating the system for up to 24 hours under maximum quiescent load (system functioning in a non-alarm condition).
 - .9 Defects in the system which may cause failure or impair operation of the system shall cause these conditions to be annunciated as follows:
 - .10 Failure of any electrical power either primary or battery shall cause a visual and audible trouble signal on the control panel annunciator panel.
 - .11 Open circuits in any fire detector wiring or removal of any detector shall cause an audible signal and visually annunciate the specific zone where the fault is located.
 - .12 Open circuits in initiator wiring or the silencing of the alarm sounding devices shall cause an audible and visual trouble signal at the control panel and annunciator panel.

2.7 Preaction Alarm Valve

- .1 Provide a ULC approved preaction valve complete with all devices and drain valves.

2.8 Air Maintenance Device

- .1 Provide a ULC listed air maintenance device complete with isolation valves, strainer, air pressure regulator, restriction orifice and bypass.

2.9 Air Compressor

- .1 Provide electric drive, horizontal tank mounted, single stage compressor, capable of restoring normal system air pressure within 30 minutes, two (2) pole air pressure operated electric pressure switch with 2-way release or breather valve, safety valve, check valve, automatic tank drain, belt guard and controls.
 - .2 Air compressor is to be supplied with magnetic starter and the compressor motor is to be 120 volt, 1 phase, 60 Hertz.
-

2.10 Pressure Gauges

- .1 Gauges to be ULC listed.
- .2 Shall have maximum limit of not less than twice normal working pressure at point where installed.
- .3 A pressure gauge with a connection not smaller than 6mm (1/4"). shall be installed at the system main drain, at each main drain associated with a floor control valve, and on the inlet and outlet side of each pressure-reducing valve. Each gauge connection shall be equipped with a shutoff valve and provisions for draining.

2.11 Spare Parts Cabinet

- .1 For storage of maintenance materials, spare sprinkler heads and sprinkler wrench.
- .2 Construct to sprinkler head manufacturers standard.
- .3 Provide on wall near sprinkler valve, cabinet containing extra sprinkler heads of each type and a wrench suitable for each head type. Six (6) extra sprinkler heads for less than 300 sprinklers, 12 for 300 to 1000 sprinklers, and 24 for over 1000 sprinkler heads of each type.

3. Execution

3.1 Installation

- .1 Install, inspect and test to acceptance with NFPA 13 and local authorities.
 - .2 All sprinkler system isolation valves shall have fire alarm contacts that can be monitored on the building fire alarm system. Coordinate contact type and wiring with Division 26.
 - .3 Locate sprinkler heads in ceilings in order to maintain the pattern with lights, diffusers, etc. In other areas, arrange layouts and head locations as to avoid interference with other equipment and materials. Sprinkler head locations shall be located symmetrically within each room or area but shall not exceed the manufactures ULC listed maximum spacing. Final layout to be based on architectural and mechanical shop drawing reviews.
 - .4 Provide sprinkler inspector's test and flow test connections as per NFPA 13.
 - .5 Install water flow indicators where indicated.
 - .6 Locate zone shut-off valves visible from the floor. Do not conceal from view, locate in janitor, storage rooms, or stairwells unless approved by the Engineer.
 - .7 Identify all piping and isolation valves in accordance with Section 21 05 53 – Identification for Fire Suppression Piping and Equipment.
-

3.2 Fire Protection System Tests

- .1 Sprinkler System: Test as required by the edition of NFPA 13 noted in the Alberta Building Code 2014 and the authorities having jurisdiction. Complete certificates for test results and submit.

3.3 Piping – Preparation

- .1 Ream pipes and tubes. Clean off scale and dirt, inside and outside, before assembly. Remove welding slag or other foreign material from piping.
- .2 Protect all steel pipes when stored on site from external conditions and ensure protective coating remains intact. If in the opinion of the engineer, deterioration of the protective coating has instigated corrosion, all rust must be removed down to bare metal and prime coated with red oxide paint.
- .3 Use Victaulic roll grooving tools to groove pipe in accordance with manufacturer's specifications. Use copper rolls for copper pipe and stainless steel rolls for stainless steel pipe as provided by Victaulic.

3.4 Piping – Connection

- .1 Make screwed joints with full cut standard taper pipe threads with approved Teflon tape or non-toxic joint compound applied to male threads only, equal to Jet-Lube V-2 multi-purpose thread sealant.
- .2 Use grooved mechanical couplings and mechanical fasteners as manufactured by Victaulic where allowed.
- .3 Make connections to equipment, specialty components, and branch mains after isolation valves, with unions or flanges.
- .4 Provide dielectric type connections wherever jointing dissimilar metals in open systems. Brass adapters and valves are acceptable.

3.5 Piping – Routes and Installation

- .1 Confirm requirements of main line routing with consultant prior to hydraulic design. Route piping in an orderly manner and maintain proper grades. Install to conserve headroom and interfere as little as possible with use of space. Run exposed piping parallel to walls. Group piping, wherever practical, at common elevations. Install concealed pipes close to the building structure to keep furring to a minimum.
 - .2 Co-ordinate the installation of sprinkler piping with all other trades, services and structure.
 - .3 Sprinkler piping is to be sloped towards the system low points in accordance with NFPA 13. Sprinkler piping to be arranged to minimize the number of auxiliary drains required to collect condensation and to drain system low points. Extend drain lines to the floor level within the reach of a floor drain with a 15m (50'-0") hose.
-

-
- .4 Equip low points with 20mm ($\frac{3}{4}$ ") drain valves and hose nipples.
 - .5 Pipe the discharge from all relief valves, safety valves, vents, drains, and equipment to the nearest building drain.
 - .6 Install piping to allow for expansion and contraction without unduly stressing pipe or equipment connected.
 - .7 Provide clearance for proper access to valves, air vents, drains and unions.

END OF SECTION

1. General

1.1 Scope

- .1 Provide for flushing and disinfection of domestic water systems.
- .2 Isolate and bypass equipment listed in Clause 3.1.

1.2 Quality Assurance

- .1 Provide chemical treatment, chemicals and equipment by an agency that specializes in this type of work. This work shall be directed by the water treatment agency who, upon completion, shall certify that the process is satisfactory and submit a report outlining the cleaning operation and the treatment process.
- .2 Provide chemical treatment as specified herein and provide written reports. Reports shall be signed by the chemical treatment agency, mechanical contractor and commissioning agency.
- .3 Include for the costs of an independent testing agency, selected by the Owner, to take samples of domestic water, perform lab analysis of the chemical treatment levels, and submit a written report of their findings to the Owner. Should the lab results prove that standards for drinking water quality have not been met, the Contractor shall correct the deficiency and cover the costs of the independent testing agency to take additional samples and tests.
- .4 All equipment, service and chemicals shall be from one supplier.

1.3 Submittals

- .1 Submit shop drawings including proposed chemicals, quantities, procedures and analysis reports to be used on this project. Provide written operating instructions and system schematics.
- .2 Provide written reports containing log and procedure of system cleaning and degreasing, giving times, dates, conditions of water and problems and actions encountered.
- .3 Submit a written report on system operations.

1.4 Chemical Treatment Agency

- .1 Chemical treatment agency shall provide equipment, chemicals and site supervision so as to fully comply with all requirements and their intent contained within this specification section.
-

2. Products

2.1 Materials

- .1 Provide sufficient chemicals to treat domestic water systems and test the systems from the time of activation and acceptance of the building.
- .2 Chemicals used must comply with environmental and health standards applicable to the usage on this project.
- .3 Domestic Water System: Sodium hypochlorite conforms to ANSI/AWWA B301.

3. Execution

3.1 Piping General

- .1 Ensure reasonable care is exercised to prevent debris, dirt and other foreign material from entering the pipe during construction. This is to include proper protection of piping on site prior to installation, temporary caps on partial systems, and complete evacuation of moisture within systems being hydrostatically pressure tested.
- .2 Chemical treatment agency shall, in conjunction with the mechanical contractor, review connections for complete draining and venting of the systems. The mechanical contractor shall provide adequate drain connections to completely drain the systems within one hour.
- .3 Protect and/or remove control devices from systems during cleaning. All terminal control valves shall be in open position during cleaning. Particular attention is to be made to control valves which have a normally closed position.
- .4 Make systems completely operational, totally filled, thoroughly vented, and completely started.

3.2 System Cleaning

- .1 Pipes intended to carry potable water shall be disinfected before being placed in service. Disinfection procedures shall conform to AWWA C651 as hereinafter modified or expanded, and the requirements of any governing agency having jurisdiction.
 - .2 Flushing
 - .1 Before disinfecting, the mechanical contractor shall flush all foreign matter from the pipeline. He/she shall provide hoses, pumps, temporary pipes, ditches, etc., as required to dispose of flushing water without causing damage to adjacent properties. The flushing velocities shall be at least 2.5 FPS. For large diameter pipe, where it is impractical or impossible to flush the pipe at 2.5 FPS velocity, the pipeline shall be cleaned in place from the inside by brushing and sweeping, then flushing the line at a lower velocity.
 - .3 Disinfection Mixture
-

-
- .1 The mechanical contractor shall prepare the disinfection mixture with a chlorine-water solution having a free chlorine residual of 40 - 50 PPM. The disinfection mixture shall be prepared by injecting calcium or sodium hypochlorite and water into the piping and allowing it to flow at a measured rate so that water-chlorine solution is of the specified strength.
 - .2 If the calcium hypochlorite procedure is used, first mix the dry powder with water to make a thick paste, then thin to approximately a one percent solution (10,000 PPM Chlorine). If the sodium hypochlorite procedure is used, dilute the liquid with water to obtain a one percent solution.
 - .4 Point of Application
 - .1 The chlorine mixture shall be injected into the piping to be treated at the beginning of the line, and through a corporation stop or suitable tap in the top of the line. Water from the existing system or other approved sources shall be controlled so as to flow slowly into the newly installed pipe during the application of chlorine. The rate of chlorine mixture flow shall be in such proportion to the rate of water entering the pipe that the combined mixture shall contain 40-50 PPM of free available chlorine. Valves shall be manipulated so that the strong chlorine solution in the line being treated will not flow back into the line supplying the water. Check valves shall be used if deemed necessary. The water treatment representative shall analyze and record the free chlorine residual at the farthest fixtures from the injection point.
 - .5 Retention Period
 - .1 Treated water shall be retained in the pipeline long enough to destroy all nonspore-forming bacteria. With proper flushing and the specified solution strength, 24 hours is adequate. At the end of the 24-hour period, the disinfection mixture shall have a strength of at least 25 PPM of chlorine.
 - .6 The above procedure shall be repeated at the mechanical contractor's expense if the free chlorine level drops below the minimum requirements.
 - .7 All valves, fixtures and other appurtenances shall be operated during disinfection to ensure that the disinfection mixture is dispersed into all parts of the line, including dead ends, new services and similar areas that otherwise may not receive the treated water. The water treatment representative shall analyze and record the free chlorine residual at the farthest fixtures from the injection point.
 - .8 After chlorination, the water from the line shall be flushed until it meets health department requirements.
 - .9 Disposal of Disinfection Water
 - .1 Disposal of disinfecting water shall be done in an approved manner. Disinfecting water should not be allowed to flow into a waterway without adequate dilution or other satisfactory method of reducing chlorine concentrations.

END OF SECTION

1. General

1.1 Intent

- .1 Work in Division 22 will include all drawings and all sections of the specifications that form the Contract Documents, including all addenda, and including Division 00 and Division 01, whether defined in Division 22 or elsewhere, or whether defined in mechanical drawings or elsewhere.
- .2 Provide complete, fully tested and operational mechanical systems to meet requirements described herein and in complete accord with applicable codes and ordinances. Include all costs to obtain all permits and to pay for all fees and charges, including inspection charges by the authorities that issue the permits. Coordinate all related inspections. Permits, fees and inspections including:
 - .1 Water treatment
 - .2 Building plumbing
- .3 Contract documents consisting of the specifications and drawings, are generally diagrammatic and approximately to scale unless detailed otherwise. They establish scope, material and installation quality and are not detailed installation instructions.
- .4 Review Contract Documents and notify the Consultant of issues or conflict that require clarification prior to submitting tender. Failure by the Contractor to secure clarification does not relieve the Contractor to comply with the intent of the design and/or the Contract Document.

1.2 Related Requirements

- .1 Refer to and comply with the following sections:
 - .1 General Requirements Division 01
 - .2 Submittal Procedures Section 01 33 00
 - .3 Delegated Design Submittals Section 01 33 50
 - .4 Quality Control Section 01 45 00
 - .5 Temporary Utilities Section 01 51 00
 - .6 Closeout Procedures Section 01 77 00
 - .7 Closeout Submittals Section 01 78 00
 - .8 Demonstration and Training Section 01 79 00
 - .9 Commissioning Section 01 91 00
 - .10 Commissioning (Cx) Plan Section 01 91 31
 - .11 Building Management Manual Section 01 91 51
-

1.3 Related Work Specified In Other Sections

- .1 For complete common work requirements refer to Section 23 05 00 – Common Work Results for HVAC.

2. **Products**

- .1 For complete Common Work requirements refer to Section 23 05 00 – Common Work Results for HVAC.

3. **Execution**

- .1 For complete Common Work requirements refer to Section 23 05 00 – Common Work Results for HVAC.

END OF SECTION

1. General

1.1 Scope

- .1 Provide meters, gauges and taps where shown on drawings and/or specified herein.

1.2 Reference Documents

- .1 American Society of Mechanical Engineers (ASME):
 - .1 ASME Fluid Meter's Handbook: Their Theory and Application, Sixth Edition [1971].
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS):
- .3 Material Safety Data Sheets (MSDS).

1.3 Submittals

- .1 Submit shop drawings in accordance with Section 23 05 00 – Common Work Results for HVAC.
- .2 Submit shop drawings of proposed products to the engineer for review.
- .3 Submit data sheets on thermometers and pressure gauges indicating service, and temperature or pressure ranges, to the engineer for review.
- .4 Submit list of all meters, including location, service, flow and corresponding reading for flow.

1.4 Delivery & Storage

- .1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.5 Waste Management and Disposal

- .1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

2. Products

- .1 For complete meter and gauge requirements refer to Section 23 05 00 – Common Work Results for HVAC.

END OF SECTION

1. General

1.1 Scope

- .1 Ball valves
- .2 Butterfly valves
- .3 Check valves
- .4 Gate valves
- .5 Globe valves

1.2 Reference Documents

- .1 American National Standards Institute (ANSI)/American Petroleum Institute (API)
 - .1 ANSI/API 609 Lug- and Water-Type Butterfly Valves.
 - .2 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME).
 - .1 ANSI/ASME B1.20.1 Pipe Threads, General Purpose (Inch)
 - .2 ANSI/ASME B16.1 Cast Iron Pipe Flanges and Flanged Fittings
 - .3 ANSI/ASME B16.5 Pipe Flanges and Flanged Fittings
 - .4 ANSI/ASME B16.11 Forged Fittings, Socket-Welding and Threaded
 - .5 ANSI/ASME B16.25 Buttwelding Ends
 - .6 ANSI/ASME B16.34 Valves - Flanged, Threaded and Welding Ends
 - .3 American Society for Testing and Materials (ASTM):
 - .1 ASTM A126-04 Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
 - .2 ASTM B21/B21M-06 Standard Specification for Naval Brass Rod, Bar, and Shapes
 - .3 ASTM B61-08 Standard Specification for Steam or Valve Bronze Castings
 - .4 ASTM B62-09 Standard Specification for Composition Bronze or Ounce Metal Castings
-

-
- | | | |
|----|---|---|
| .5 | ASTM B98/B98M-08 | Standard Specification for Copper-Silicon Alloy Rod, Bar and Shapes |
| .6 | ASTM B139/B139M-07 | Standard Specification for Phosphor Bronze Rod, Bar, and Shapes |
| .4 | National Plumbing Code of Canada 2010 | |
| .5 | National Fire Protection Association (NFPA): | |
| .1 | NFPA 13-2010 | Standard for the Installation of Sprinkler Systems |
| .2 | NFPA 14-2007 | Standard for the Installation of Standpipe Systems |
| .6 | Manufacturers Standardization Society Standard Practices (Current Editions) | |
| .1 | SP-67 | Butterfly Valves |
| .2 | SP-70 | Gray Iron Gate Valves, Flanged and Threaded Ends |
| .3 | SP-71 | Gray Iron Swing Check Valves, Flanged and Threaded Ends |
| .4 | SP-80 | Bronze Gate, Globe, Angle, and Check Valves |
| .5 | SP-82 | Valve Pressure Testing Methods |
| .6 | SP-110 | Ball Valves, Threaded Socket-Welding, Solder Joint, Grooved and Flared Ends |

1.3 Manufacturer

- .1 Provide valves of the same type by the same manufacturer throughout.
- .2 Valves shall bear the following information permanently marked on the valve body”
 - .1 Manufacturer’s name or trademark
 - .2 Pressure rating
 - .3 Flow direction
- .3 Valves for fire protection service to be ULC Listed and FM Approved.

1.4 Shop Drawings

- .1 Submit detailed shop drawings clearly indicating, at a minimum, the following:
-

-
- .1 Manufacturer
 - .2 Model
 - .3 Size
 - .4 Pressure rating
 - .5 Materials of construction
 - .6 Intended service

2. Products

- .1 For complete General Duty Valve requirements refer to Section 23 05 23 – General Duty Valves for HVAC Piping.

2.2 Acceptable Manufacturers

- .1 Ball Valves : Crane, Jenking, Kitz, Legend, Nibco, MAS, Milwaukee, Toyo
- .2 Butterfly Valves :Apollo, Centerline, Jenkins, Keystone, Victaulic
- .3 Check Valves – Swing : Crane, Jenkins, Kitz, Milwaukee, Moygro, Mueller, Nibco, Toyo, Victaulic
- .4 Gate Valves : Crane, Jenkins, Kitz, Legend, Nibco, Milwaukee, Toyo, Victaulic
- .5 Globe Valves : Crane, Jenkins, Kitz, Legend, Nibco, Milwaukee, Toyo

2.3 Fire Protection System

- .1 Gate Valves
 - .1 Up to 50mm (2"):
 - .1 Bronze body, threaded ends, Outside Screw and Yoke (O.S.Y.), rising stem, screw-over or screw-in bonnet, solid wedge,
 - .2 Rating: 1205 kPa (175 psi) water
 - .3 ULC Listed & FM Approved.
 - .2 65mm (2½") and Over:
 - .1 Cast iron body, flanged ends, O.S.Y., rising stem, bronze trim, solid wedge, wheel handle
-

-
- .2 Rating 1205 kPa (175 psi) water
 - .3 ULC Listed & FM Approved.
 - .2 Butterfly Valves:
 - .1 Lug-Wafer:
 - .1 Cast iron body, bronze disc, BUNA-N liner
 - .2 Rating: 1380 kPa (200 psi) at 68°C (155°F)
 - .3 ULC Listed and FM Approved
 - .2 Lug Style:
 - .1 Ductile iron body, EPDM molded-in seat liner, ductile iron disc, stainless steel stem with copper bushings
 - .2 Rating: 250 PSI WWP
 - .3 Valve shall accept internal supervisory switches
 - .4 ULC Listed and FM Approved
 - .3 Grooved:
 - .1 Ductile iron, EPDM encapsulated ductile iron disc, stainless steel stem with metal bushings
 - .2 Rating: 300 psi WWP
 - .3 Valve shall accept internal supervisory switches
 - .4 ULC Listed and FM Approved
 - .3 Swing Check Valves
 - .1 Up to 50mm (2"):
 - .1 Bronze body threaded ends, screw-in cap, renewable composition disc
 - .2 Rating 2070 kPa (300 psi) W.O.G.
 - .2 65mm (2½") and Over:
 - .1 Cast iron body, flanged ends, bolted cover, regrind-renew bronze disc and seat ring
 - .2 Rating 1205 kPa (175 psi) water
-

.3 Underwriters listed

.4 All operable valves are to be complete with supervisory switches.

2.4 Domestic Cold Water System

.1 Ball Valves

.1 Up to 50mm (2"):

.1 Two piece bronze body, full standard port, chrome plated, solid bronze ball, threaded or solder ends, TFE seat and packing, level handle;

.2 Rating: 4134 kPa (600 psi) non-shock W.O.G.

.3 Lead free

.2 Globe Valves

.1 Up to 50mm (2"):

.1 Bronze body, screw over bonnet, threaded ends

.2 Rating 1035kPa (150psi) steam, solder ends; rating 2070 kPa (300 psi) water.

.3 Lead free

.3 Swing Check Valves

.1 Up to 50mm (2"):

.1 Bronze body screw-in cap, renewable no. 125 composition disc, threaded ends

.2 Rating: 860 kPa (125 psi) steam.

.3 Lead free

2.5 Domestic Hot Water System

.1 Valves to be used in the hot water section of the system shall be exactly as specified in the cold water section with one exception, that all composition disc valves shall be fitted with discs suitable for hot water, rated for 2756 kPa (400 psi) at 94°C (200°F).

3. Execution

3.1 Installation and Application

- .1 Install valves with stem upright or horizontal. Under no circumstances shall the stems be installed inverted.
- .2 Align valve for easy access and identification when several service lines are installed together.
- .3 Install valves for shut-off and isolating service, to isolate all equipment, parts of systems, or vertical risers.

END OF SECTION

1. General

1.1 Scope

- .1 Pipe hangers and supports
- .2 Pipe anchors
- .3 Access Doors

1.2 Reference Standards

- .1 Pipe supports shall meet the requirements of ANSI B31.1 Power Piping.

1.3 General Requirements

- .1 Provide hangers and supports to secure equipment in place, prevent vibration, maintain grade, and provide for expansion and contraction.
 - .2 Install supports of strength and rigidity to suit loading without unduly stressing the building. Locate adjacent to equipment to prevent undue stresses in piping and equipment. Where support is from concrete construction, avoid weakening concrete or penetrating waterproofing.
 - .3 Select hangers and supports for the service and in accordance with manufacturer's recommended maximum loading. Hangers shall have a safety factor of 5 to 1.
 - .4 Fasten supports and hangers to building structure. Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practical. When possible, set inserts in position in advance of concrete work. Drill concrete where inserts must be placed after concrete is poured.
 - .5 Where structural bearings do not exist or where inserts are not in suitable locations for proper installation of pipes, conduits and ducts, provide approved support made of steel channels or angles from which to suspend hangers. Do not use existing piping, crane rails, trolley beams, mono rails, etc, for support.
 - .6 No percussion type fastening of any kind will be permitted without prior approval.
 - .7 Provide and set sleeves or block-outs required for equipment, including openings required for placing equipment.
 - .8 Provide sleeves for all piping through rated assemblies. In non-rated assemblies, provide sleeves for all domestic hot, domestic cold, and domestic recirculation piping. Sleeves to be sized to allow insulation to pass through and to project through both sides of wall.
 - .9 Provide sleeves for all piping through ceilings, floors and footings.
-

- .10 Do not weld piping or equipment supports to building metal decking or building structural steel supports unless prior written approval has been obtained from the structural engineer.
- .11 Obtain approval prior to drilling for inserts and supports for piping system. Discuss and obtain approval for hanging systems and methods with Structural Engineer.
- .12 Obtain approval prior to using percussion type fastenings.
- .13 Use of piping or equipment for hanger supports and use of perforated band iron, wire or chain as hangers is not permitted.

1.4 Submittals

- .1 Submit shop drawings for access doors.

1.5 Delivery & Storage

- .1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.6 Waste Management and Disposal

- .1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

2. Products

- .1 For complete hanger, and support requirements for plumbing refer to Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment.

3. Execution

- .1 For complete hanger, support and access door requirements for plumbing refer to Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment.

END OF SECTION

1. General

1.1 Scope

- .1 Painting and identification of equipment, piping and related components for the following:

- .1 Plumbing Systems

1.2 Reference Standards

- .1 Canadian General Standards Board (CGSB)

- .1 CGSB-1-GP-12c; Color Identification and Selection

- .2 CAN/CGSB-24.3 – Identification of Piping Systems

- .2 American Society of Mechanical Engineers (ASME)

- .1 ASME A13.1-2007, Scheme for the Identification of Piping Systems

- .3 Federal Standard 595C – Colors

- .4 WHMIS Pictograms – Workplace Hazardous Materials Information System – GHS Globally Harmonized System of Classification and Labeling Chemicals) – Pictograms.

1.3 Delivery & Storage

- .1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.4 Waste Management and Disposal

- .1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.5 Related Work Specified in Other Sections

- | | | |
|----|--|------------------|
| .1 | Submittals | Division 01 |
| .2 | Interior Painting | Section 09 91 23 |
| .3 | Common Work Results for HVAC | Section 23 05 00 |
| .4 | Identification for HVAC Piping and Equipment | Section 23 05 53 |

1.6 Quality Control

- .1 Coordinate color coding of piping and equipment with work of Section 09 91 23 – Interior Painting.
-

-
- .2 All painting identified in this section is to be performed by Section 09 91 23 – Interior Painting Contractor, under the direction of the Division 22 contractor.
 - .3 Color code mechanical equipment and piping. Refer to Part 3 of this section.
 - .4 Submit a schedule of pipe and equipment identification methods, materials and colors to the Engineer for review.

1.7 Definitions

- .1 For the purposes of this Section, the following definitions apply:
 - .1 Concealed: Piping and equipment in trenches, shafts, furrings and suspended ceilings.
 - .2 Exposed: Piping and equipment in mechanical rooms or otherwise not “concealed”.

1.8 Equipment Protection and Clean-Up

- .1 Ensure that new and existing equipment and surfaces are carefully covered with tarping, or heavy duty plastic. Ensure that spills and splatter on finishes and equipment are cleaned up totally and promptly.

2. Products

Not Applicable

3. Execution

- .1 For plumbing piping and equipment identification requirements refer to Section 23 05 53 – Identification for HVAC Piping and Equipment.

END OF SECTION

1. General**1.1 Scope**

- .1 Domestic water systems (hot, cold, recirculation), ambient to 82°C (180°F)
- .2 Adhesives, tie wires, tapes
- .3 Recovery materials

1.2 Reference Documents

- .1 American Society for Testing and Materials (ASTM)
 - 1. ASTM B209M Specification for Aluminum and Aluminum Alloy Sheet and Plate
 - 2. ASTM C335 Steady State Heat Transfer Properties of Pipe Insulation
 - 3. ASTM C411 Hot-Surface Performance of High Temperature Thermal Insulation
 - 4. ASTM C423 Standard Method for Sound Absorption and Sound Absorption Coefficients by Reverberation Room Method
 - 5. ASTM C449 Mineral Fiber Hydraulic Setting Thermal Insulating and Finishing Cement
 - 6. ASTM C533 Calcium Silicate Block and Pipe Thermal Insulation
 - 7. ASTM C534 Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
 - 8. ASTM C547 Mineral Fiber Pipe Insulation
 - 9. ASTM C553 Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
 - 10. ASTM C612 Mineral Fiber Block and Board Thermal Insulation
 - 11. ASTM C921 Practice for Determining the Properties of Jacketing Materials for Thermal Insulation
 - 12. ASTM C1071 Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)
 - 13. ASTM G21 Standard of Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi
-

.2 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

1. ASHRAE Standard 90.1 Energy Standard for Buildings except Low Rise Residential Buildings

.3 Canadian General Standards Board (CGSB):

1. CAN/CGSB-51.2 Thermal Insulation, Calcium Silicate for Piping, Machinery and Boilers
2. CAN/CGSB-51.9 Mineral Fiber Thermal Insulation for Piping and Round Ducting
3. CAN/CGSB-51.10 Mineral Fibre Board Thermal Insulation
4. CAN/CGSB-51.11 Mineral Fibre Thermal Insulation Blanket
5. CAN/CGSB-51.12-M86 Thermal Insulating and Finishing Cement
6. CAN/CGSB-51.53 Poly (Vinyl Chloride) Jacketing Sheet for Insulated Pipes, Vessels and Round Ducts
7. CGSB 51-GP-52Ma Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation

.4 National Fire Protection Association (NFPA):

1. NFPA 255 Standard Method of Test of Surface Burning Characteristics of Building Materials

.5 Thermal Insulation Association of Canada (TIAC)

- .1 Mechanical Insulation Best Practices Guide.

.6 Underwriters Laboratories Canada (ULC)

1. CAN/ULC-S102 Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies
2. CAN/ULC-S701 Thermal Insulation, Polystyrene, Boards and Pipe

2. Products

- .1 For complete plumbing insulation requirements refer to Section 23 07 00 – HVAC Insulation.

3. Execution

- .1 For complete plumbing insulation requirements refer to Section 23 07 00 – HVAC Insulation.
-

GOVERNMENT OF CANADA

Existing Building Renovation

Alberta, Canada

Project No.: 144202775.215

Section 22 07 00

PLUMBING INSULATION

Page **3** of **3**

END OF SECTION

1. General**1.1 Quality Assurance**

- .1 Use highest quality piping confirming to the appropriate ASTM and CSA specifications.
- .2 Use tradesmen licensed by the provincial authorities for the particular service.
- .3 Use fully qualified welders licensed by the provincial authorities and weld in accordance with the requirements of the Boiler Inspection Branch.
- .4 The codes and standards herein referred to shall be those editions currently in effect or accepted by the authorities in the area of jurisdiction.
- .5 Comply with the National Plumbing Code of Canada – 2010, Provincial Codes and Municipal Codes.
- .6 Non specified pipe joining and pipe fitting methods such as T-drill and Press Fit are not permitted in any piping system covered under Division 22.

1.2 Reference Standards

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers International (ASME).
 - .1 ANSI/ASME B16.15 Cast Bronze Threaded Fittings, Classes 125 and 250.
 - .2 ANSI/ASME B16.18 Cast Copper Alloy Solder Joint Pressure Fittings.
 - .3 ANSI/ASME B16.22 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
 - .4 ANSI/ASME B16.24 Cast Copper Alloy Pipe Flanges and Flanged Fittings, Class 150, 300, 400, 600, 900, 1500 and 2500.
 - .2 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A307 Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .2 ASTM B88M Standard Specification for Seamless Copper Water Tube (Metric).
 - .3 ASTM F492 Standard Specification for Polypropylene and Polypropylene (PP) Plastic-Lined Ferrous Metal Pipe and Fittings.
-

- .3 American Water Works Association (AWWA).
 - .1 AWWA C111 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- .4 Department of Justice Canada (Jus).
 - .1 Canadian Environmental Protection Act, 1999, c. 33 (CEPA).
- .5 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
 - .1 Material Safety Data Sheets (MSDS).
- .6 National Research Council (NRC)/Institute for Research in Construction.
 - .1 National Plumbing Code of Canada (NPC) 2010

1.3 Delivery & Storage

- .1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.4 Waste Management and Disposal

- .1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

2. **Products**

2.1 Acceptable Manufacturers

- .1 Pipe and Fittings: Crane, Grinnell, Ladish, Taylor Forge.
- .2 Plastic Pipe and Fittings: Building Products Orion, Emco, Dorn-X, Scepter, Canplas.

2.2 Pipe and Fittings

Size	Material	Fitting	Joint
1. Domestic Water, Inside Building, Above Ground:			
All Sizes	ASTM B88 Type L, hard temper, copper tube	ANSI B16.22 capillary joint, cast brass or wrought copper	95-5 solder or brazed
2. Domestic Hot Water Recirculation, Inside Building, Above Ground:			
All Sizes	ASTM B88 Type K, soft copper tube	ANSI B16.22 capillary joint, cast brass or wrought copper	95-5 solder or brazed

2.3 Unions, Flanges, and Couplings

- .1 All other services, size 50mm and under: 1034 kPa malleable iron, bronze to iron ground joint unions for threaded ferrous piping, all bronze for copper piping. Unions to ANSI B16.3.

2.4 Solder

- .1 Generally, use 95-5 solder for pressure service, 50-50 solder for gravity drainage service.

2.5 Miscellaneous

- .1 Use factory fabricated butt weld fittings for welded steel pipes.
- .2 Use long radius elbows for steel and cast iron water piping.

3. Execution

3.1 Piping General

- .1 Install piping approximately as shown, with all lines being carried parallel to building walls, as close to the structure as possible, or as detailed on the drawings.
 - .2 Align and support all piping properly, under no circumstances may any piping load be transferred to the equipment. Make all equipment connections so as to allow disassembly of the piping for equipment removal and maintenance.
 - .3 Install piping to allow for expansion and contraction without unduly stressing pipe or connected equipment.
 - .4 Provide clearance for proper installation of insulation and for access to valves, air vents, drains and unions.
 - .5 Use only eccentric reducing fittings. Top flat for water.
 - .6 Do not use direct welded or screwed connections to valves, equipment or other apparatus. Make all connections with an accessible mechanical connection of a style consistent with the connecting pipe joints. For grooved pipe system, use rigid couplings to prevent valve rotation.
 - .7 Sleeve all pipe passing through partitions, walls and floors.
 - .8 Provide non-conducting type dielectric connections wherever jointing dissimilar metals.
 - .9 Ensure no contact between copper and ferrous metal.
 - .10 Provide drain valves at main shut-off valves, low points of piping and apparatus, and at the bottom of all risers.
-

-
- .11 Keep open ends of pipe free from scale and dirt. Whenever work is suspended during construction, protect the open ends by using temporary plugs, burlap or other means approved by the consultant.
 - .12 Do not run piping carrying liquids over electrical switchboards, elevator controllers or electrical motor starters. Where this is unavoidable, provide 1.2mm gauge aluminum pans under piping. Each drip pan shall have a drain piped to discharge over nearest available open drain. This does not apply in Mechanical Rooms.
 - .13 Provide for isolation of systems by section.
 - .14 Make connections to equipment, specialty components, and branch mains after isolation valves, with unions or flanges.
 - .15 Use insulating plastic spacers for copper pipe installation in metal studs.
 - .16 Ensure piping location does not subject piping to frost damage under flow or no-flow conditions.

3.2 Solder and Brazed Connections

- .1 Remove burrs and chips and ream or file the pipe ends out to size or bore. In the case of soft copper tubing, ensure that reaming restores tubing to full diameter before jointing to fitting.
- .2 Assemble joints without binding. Brazing material or solder shall penetrate fully and fill the joint completely.

3.3 Route and Grades

- .1 Route piping in orderly manner and maintain proper grades. Install to conserve headroom and interfere as little as possible with use of space. Run exposed piping parallel to walls. Group piping wherever practical at common elevations. Install concealed pipes close to the building structure to keep furring to a minimum.
- .2 Slope water piping 0.2% and provide hose bibb drains at low points.
- .3 Provide air collection chambers with manual air vent at all high points of system. Collection chambers to be 25mm (1") dia or line size whichever is greater and 150mm (6") high minimum. Square tees may only be used to assist with complete venting and draining.

3.4 Installation

- .1 Water piping shall be complete from service connection to all fixtures, equipment, outlets, etc. Sizes of pipes shall be as shown or as specified.
 - .2 Exercise care in the laying of soft copper tubing that it does not bear or is in contact with rocks and that directional changes are gradual to ensure tubing will not be kinked or collapsed.
-

-
- .3 All brass and copper pipe and tubing shall be free from cuts, dents or other surface damage at the time of final inspection. Remove damaged pipe or tubing and replace with new pipe or tubing.
 - .4 Take branches from water supply mains from the top, bottom, or side, using crossover fittings where required by structural or operating conditions.
 - .5 Install piping to allow for expansion and contraction without unduly stressing pipe or equipment connected.
 - .6 Provide clearance for proper installation of insulation and for access to valves, air vents, drains and unions.

3.5 Plumbing Systems and Piped Utility Tests

- .1 Refer to Section 23 05 00 – Common Work Results for HVAC for system testing and startup requirements.
- .2 All domestic water piping shall be tested in accordance with the current National Plumbing Code of Canada, 2010 and under the requirements of the Local Plumbing Inspection Branch.
- .3 If approved, hydrostatic tests may be substituted with air or smoke tests when there is a danger of freezing.
- .4 Test interior domestic water piping system. Completely fill and hydraulically test with a pressure of at least 1035 kPa (346 ft W.G.) at system low point, maintain the pressure for four (4) hours after all air has been expelled with all outlets tightly closed. Isolate system components not designed for this test pressure.
- .5 Test site water service from connection to utility water supply to building in the manner prescribed by the local water supply utility, but no less than the performance described below:
 - .1 Hydrostatically test for a period of not less than one (1) hour, at a pressure of the greater of 1-1/2 times the maximum operating pressure of 1035 kPa (346 ft W.G.).
 - .2 During the hydrostatic test, all exposed pipes, fittings, valves, hydrants and joints will be examined for visible leaks. Repair joints and remove defective components and then repeat test.
 - .3 Conduct a leakage test after the hydrostatic test. Subject the pipe to normal operating pressure for at least a two (2) hour period. The measured leakage shall not exceed the number of liters per hour as determined by the formula:

$$L = ND(P)$$

Where L is the allowable leakage, N is the number of joints in the length of pipeline tested, D is the nominal diameter of the pipe in mm and P is the normal operating pressure in kPa. No leakage is permitted on welded piping.

- .6 Test emergency fixtures as per ANSI standard Z358.1 (current edition). Test that the tempered water discharge temperature is 23.9°C (75°F).

END OF SECTION

1. General

1.1 Scope

- .1 Water hammer arrestors
- .2 Backflow preventers
- .3 Vacuum breakers
- .4 Trap primers

1.2 General Requirements

- .1 Provide materials, equipment and labor to install plumbing as required by Provincial and Local Codes as specified herein.
- .2 Provide water connections to equipment furnished in other sections of this specification and by the Owner. Refer to Section 23 05 00 – Common Work Results for HVAC.
- .3 Provide and include charges for connections to Municipal and Utility Company services, including costs to maintain temporary water supply pending acceptable water quality tests, where applicable.
- .4 Every plumbing fixture is to be equipped with separate water line fixture stops at water connections to fixtures.

1.3 Standard References

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A126 Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
 - .2 ASTM B62 Specification for Composition Bronze or Ounce Metal Castings.
 - .2 Canadian Standards Association (CSA International)
 - .1 CSA-B64 Series Backflow Preventers and Vacuum Breakers.
 - .2 CSA-B79 Floor, Area and Shower Drains, and Cleanouts for Residential Construction.
 - .3 CSA-B356 Water Pressure Reducing Valves for Domestic Water Supply Systems.
 - .3 National Research Council (NRC)/Institute for Research in Construction.
-

.1 National Plumbing Code of Canada (NPC) 2010

.4 Plumbing and Drainage Institute (PDI)

.1 PDI-WH201 Water Hammer Arresters Standard.

1.4 Delivery & Storage

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.5 Waste Management and Disposal

.1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.6 Submittals

.1 Provide shop drawings for the equipment noted below. Clearly identify model number and any options selected.

2. Products

2.1 Acceptable Manufacturers

1. Water Hammer Arrestors : Jay R. Smith, Watts, Zurn.

2. Vacuum Breakers : Febco, Watts.

3. Trap Primers : Jay R. Smith, Watts, Zurn

2.2 Water Hammer Arrestors

.1 Fit water supply to each fixture or group of fixtures with an air chamber. Provide air chambers same size as supply line or 20mm (¾”) minimum, and minimum 450mm (18”) long.

.2 Provide stainless steel bellows or piston type water hammer arrestors on water lines connected to solenoid valves, flush valves and to fixture or group of fixtures complete with accessible isolation valve. Water hammer arrestors to be Zurn Z-1700 (bellows) or Z-1705 (piston) or equal.

Standard of Acceptance: Zurn Z-1700 (bellows)

Standard of Acceptance: Zurn Z-1705 (piston)

2.3 Vacuum Breaker Assemblies

.1 Provide pressure type vacuum breaker assembly complete with shut-off valves before and after check valves and test cocks. Assembly shall consist of one (1) positive sealing check valve and one (1) atmospheric vent disk with stainless steel or bronze seats

complete with shut-off valves before and after check valves and test cocks. Assembly shall meet AWWA requirements and CSA B64 standards.

Standard of Acceptance: Watts No. 800M4QT

- .2 Provide atmospheric type vacuum breaker assembly complete with shut-off valve before assembly. Assembly shall consist of one (1) free floating poppet to seal the atmospheric vent under flow conditions.

Standard of Acceptance: Watts No. 288A

Standard of Acceptance: Watts No. 388ASC (for bottom inlet and outlet)

- .3 Provide hose connection type vacuum breaker assembly, consisting of a check valve disc assembly to be vandal proof and drainable.

Standard of Acceptance: Watts No. 8A

Standard of Acceptance: Watts No. NF8 (use for freezing conditions)

2.4 Trap Seal Primers

- .1 For single floor drains the trap primer shall be automatically activated complete with vacuum breaker; connected to nearest cold water line and piped to traps. Provide access door for concealed installations.

Standard of Acceptance: Zurn 1022

3. Execution

3.1 Installation

- .1 Install approved backflow preventer or vacuum breaker assemblies on water lines where contamination of domestic water may occur.
- .2 Install trap primers on all floor drains.
- .3 Double checks can be in horizontal or vertical, depending on manufacturer's installation instructions.
- .4 Do not run any wet piping through electrical machine rooms or other similar rooms.
- .5 Coordinate fixture carrier requirements with architectural features and drawing requirements.

3.2 Vacuum Breakers

- .1 Install vacuum breaker on all hose bibbs and where shown on drawings.
- .2 Provide air gaps on all atmospheric drains such as drains from coils, blowdowns, tanks, equipment, riser drains, and relief valve discharge.

END OF SECTION

1. General**1.1 Quality Assurance**

- .1 Use highest quality piping confirming to the appropriate ASTM and CSA specifications.
- .2 Use tradesmen licensed by the provincial authorities for the particular service.
- .3 The codes and standards herein referred to shall be those editions currently in effect or accepted by the authorities in the area of jurisdiction.
- .4 Comply with the National Plumbing Code of Canada – 2010, Provincial Codes and Municipal Codes.

1.2 Reference Standards

- .1 American Society for Testing and Materials International, (ASTM)
 - .1 ASTM B32 Specification for Solder Metal.
 - .2 ASTM B306 Specification for Copper Drainage Tube (DWV).
 - .3 ASTM C564 Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
 - .4 ASTM D2235 Specification for Solvent Cement for Acrylonitrille-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
 - .5 ASTM D2564 Specifications for Solvent Cements for Poly(Vinyl-Chloride) (PVC) Plastic Piping Systems.
 - .2 Canadian Standards Association (CSA International)
 - .1 CSA B67 Lead Service Pipe, Waste Pipe, Traps, Bends and Accessories.
 - .2 CAN/CSA-B70 Cast Iron Soil Pipe, Fittings and Means of Joining.
 - .3 CAN/CSA-B125 Plumbing Fittings.
 - .4 CSA-Series B1800 Plastic Nonpressure Pipe Compendium.
 - .5 CSA-B181.2 PVC Drain, Waste and Vent Pipe and Pipe Fittings.
-

.6 CSA-B182.1 Plastic Drain and Sewer Pipe and Pipe Fittings.

.3 National Research Council (NRC)

.1 National Plumbing Code of Canada (NPC) 2010

1.3 Delivery & Storage

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.4 Waste Management and Disposal

.1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

2. **Products**

2.1 Acceptable Manufacturers

.1 Pipe and Fittings: Crane, Grinnell, Ladish, Taylor Forge.

.2 Plastic Pipe and Fittings: Building Products Orion, IPEX, Emco, Domn-X, Scepter, Canplas.

2.2 Pipe and fittings

Size	Material	Fittings	Joint
1. Sanitary, Waste and Vent Piping Above Grade (Inside Building):			
65 (2½") and smaller	ASTM B306 DWV grade hard temper copper tube	ANSI B16.29 cast brass or wrought copper	Soldered 50-50
75 (3") and larger	CSA.B70,27580 kPa crushing strength, cast iron with varnish asphalt base	Cast iron, CSA B70, factory applied corrosion resistant coating inside and out	Mechanical joint, Hub & Spigot
2. Sanitary, Waste and Vent Piping Below Grade (Inside Building):			
All sizes	CSA.B70, 27580 kPa crushing strength, cast iron with varnish asphalt base	Cast iron, CSA B70, with a heavy bituminous coating	Mechanical joint, Hub & Spigot
150 (6") and smaller	ABS-DWV to CSA B181.1 - 1973	ABS	Solvent cement

Size	Material	Fittings	Joint
150 (6") and smaller	PVC, DWV to CSA B181.2 - 1973	PVC	PVC solvent cement, solvent weld

2.3 Solder

- .1 Generally, use 95-5 solder for pressure service, 50-50 solder for gravity drainage service.

2.4 Couplings

- .1 Hubless couplings shall be composed of a stainless steel shield, clamp assembly and elastomeric sealing sleeves to CSA-B602 and CAN/ULC-S102.

3. **Execution****3.1** Piping General

- .1 Make joints for plain end pipe with gasket and clamp type mechanical fastener.
- .2 Clamp cast iron water pipe at fittings with 20mm (¾") rods and properly anchor and support.
- .3 Install piping approximately as shown, with all lines being carried parallel to building walls, as close to the structure as possible, or as detailed on the drawings.
- .4 Align and support all piping properly, under no circumstances may any piping load be transferred to the equipment. Make all equipment connections so as to allow disassembly of the piping for equipment removal and maintenance.
- .5 Install piping to allow for expansion and contraction without unduly stressing pipe or connected equipment.
- .6 Provide clearance for proper installation of insulation and for access to valves, air vents, drains and unions.
- .7 Use only eccentric reducing fittings.
- .8 Sleeve all pipe passing through partitions, walls and floors.
- .9 Provide non-conducting type dielectric connections wherever jointing dissimilar metals.
- .10 Ensure no contact between copper and ferrous metal.
- .11 Keep open ends of pipe free from scale and dirt. Whenever work is suspended during construction, protect the open ends by using temporary plugs, burlap or other means approved by the consultant.
- .12 Ensure piping location does not subject piping to frost damage under flow or no-flow conditions.
-

-
- .13 Install and support piping so that strain and weight does not bear on cast iron fittings or apparatus.
 - .14 Mechanical contractor is to provide pictures of underground services to the mechanical engineer a minimum of one (1) week prior to the services being backfilled.
 - .15 Underground piping installed below structural slabs is to be supported by pipe hangers hung from the structure.

3.2 Solder and Brazed Connections

- .1 Remove burrs and chips and ream or file the pipe ends out to size or bore. In the case of soft copper tubing, ensure that reaming restores tubing to full diameter before jointing to fitting.
- .2 Assemble joints without binding. Brazing material or solder shall penetrate fully and fill the joint completely.

3.3 Route and Grades

- .1 Route piping in orderly manner and maintain proper grades. Install to conserve headroom and interfere as little as possible with use of space. Run exposed piping parallel to walls. Group piping wherever practical at common elevations. Install concealed pipes close to the building structure to keep furring to a minimum.
- .2 Grade horizontal drainage and vent piping 2% minimum.

3.4 Installation

- .1 Run pipes in straight lines and have a uniform grade between elevations noted. No branch drain shall have a lesser grade than that indicated for the main drain to which it is connected. Where elevations are not given, pipes shall have a uniform grade of 6.5mm per 300mm, except that where such grade on overhead pipes would reduce the headroom materially, the grade may be reduced to not less than 3.2mm per 300mm, if so directed by the consultant. All overhead pipes must be kept as close to ceilings as possible, unless otherwise indicated or noted.
- .2 Do not use double hubs, straight crosses, double T's or double TY's in any soil or waste pipe below any fixture. Do not install a branch fitting other than the full Y and an eight bend on any soil or waste pipe running in a horizontal plane. Quarter bends placed on their sides shall not be permitted. Do not use inverted joints below any fixture.

3.5 Plumbing Systems and Piped Utility Tests

- .1 Refer to Section 22 05 00 – Common Work Results for Plumbing for system testing and startup requirements.
 - .2 All drainage piping shall be tested in accordance with the National Plumbing Code of Canada, 2010 and under the requirements of the Local Plumbing Inspection Branch.
-

- .3 If approved, hydrostatic tests may be substituted with air or smoke tests when there is a danger of freezing.
- .4 Test drainage system by filling with water to produce a pressure of 30 kPa (10 ft. W.G.) minimum and 75 kPa (25 ft. W.G.) maximum. Check for proper grade and obstruction by ball test.

END OF SECTION

1. General

1.1 Scope

- .1 Cleanouts
- .2 Floor drains
- .3 Sediment interceptors

1.2 General Requirements

- .1 Provide materials, equipment and labor to install plumbing as required by Provincial and Local Codes as specified herein.
- .2 Provide and include charges for connections to Municipal and Utility Company services.

1.3 Standard References

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A126 Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
 - .2 ASTM B62 Specification for Composition Bronze or Ounce Metal Castings.
- .2 Canadian Standards Association (CSA International)
 - .1 CSA-B79 Floor, Area and Shower Drains, and Cleanouts for Residential Construction.
- .3 National Research Council (NRC)/Institute for Research in Construction.
 - .1 National Plumbing Code of Canada (NPC) 2010

1.4 Delivery & Storage

- .1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.5 Waste Management and Disposal

- .1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.6 Submittals

- .1 Provide shop drawings for the equipment noted below. Clearly identify model number and any options selected.
-

2. Products**2.1 Acceptable Manufacturers**

1. Cleanouts : Jay R. Smith, Mifab, Zurn, Watts.
2. Floor Drains : Jay R. Smith, Mifab, Zurn, Watts.
3. Sediment Inteceptors : Jay R. Smith, Mifab, Zurn, Watts.

2.2 Cleanouts and Cleanout Access Covers

- .1 Supply and install cleanout on all drains at all changes in direction, at the ends of all horizontal runs, at the base of every stack where drains leave the building; where shown on the drawings; 7.6m (25 ft) apart in horizontal drainage lines of 50mm (2") and 65mm (2-1/2") nominal diameter; 15.2m (50 ft) apart in horizontal lines of 75mm (3") or 100mm (4") nominal diameter and not more than 26m (85 ft) for larger pipe sizes and as called for in the National Plumbing Code.
 - .2 All cleanouts shall be full size for pipes up to 100mm (4") diameter and 100mm (4") size of larger pipes. Cleanouts shall be extended to a finished wall or floor.
 - .3 Provide caulked or threaded type extended to finished floor or wall surface. Ensure ample clearance at cleanout for rodding of drainage system. The piping shall be extended beyond the room for cleanout installation. Where cleanouts occur in carpeted areas, they shall be extended to the finished walls unless the Consultant gives special permission for them to terminate in the carpeted floor.
 - .4 Cleanouts for copper pipe shall be cast brass with raised shoulder on plug and gasket.
 - .5 Cleanouts for cast iron pipe shall be steel plug type.
 - .6 Covers for cleanouts shall be as follows:
 - .1 Unfinished areas, such as concrete floors in equipment rooms and flush type cleanouts in outside areas:

Standard of Acceptance: Zurn ZZN-1612 with cover suitable for heavy traffic.
 - .2 Slab on grade finished in ceramic tile; cleanout to be complete with nickel bronze frame and cover:

Standard of Acceptance: Zurn ZN-1400-Z
 - .3 Upper floors finished in ceramic tile; cleanout to be complete with nickel bronze frame and cover:

Standard of Acceptance: Zurn ZN-1400-Z
-

- .4 Floors finished in lino or other such thin material; cleanout to be complete with nickel bronze frame and cover:

Standard of Acceptance: Zurn ZN-1400-TX (square)

Standard of Acceptance: Zurn ZN-1400-X (round)

- .7 All barriers for cleanout plugs shall be securely anchored so that they do not rotate when the plug is being removed.

2.3 Floor Drains

- .1 Flow Characteristics: Full open flow unless noted otherwise. Check all construction details prior to ordering drains and ensure the drains are suitable for the construction.
- .2 Refer to Plumbing Fixture Schedule on drawings for floor drain types.

2.4 Sediment Interceptors

- .1 Construct sediment interceptor from epoxy coated steel and shall have a gasketed epoxy coated steel skid-proof cover.
- .2 Set interceptors as shown on drawings. Provide extensions for recessed interceptors as necessary.
- .3 Refer to Plumbing Fixture Schedule on drawings for capacities and sizes.

3. Execution

3.1 Installation

- .1 Lubricate cleanout plugs with mixture of graphite and linseed oil. Prior to building turnover, remove cleanout plugs, re-lubricate and re-install using only enough force to ensure permanent leakproof joint.
- .2 Install trap primers on all floor drains. Refer to Section 22 11 19 – Domestic Water Piping Specialties. Primers shall be installed in an area accessible for easy maintenance.
- .3 Plumbing vents shall be located minimum 5m (16'-0") from air intakes.
- .4 Do not run any wet piping through electrical machine rooms or other similar rooms.
- .5 Provide dielectric fittings in all dissimilar metal connections.
- .6 Coordinate type of floor drains specified with building construction details.

END OF SECTION

1. General**1.1 Quality Assurance**

- .1 All compressed air piping systems shall be installed to the approval of the Authority Having Jurisdiction.

2. Products**2.1 Pipe**

	Service	Size	Material	Fittings	Joint
.1	Compressed Air	50 (2") and under	Type 'L' hard copper, ASTM B88M	Wrought copper or cast brass	95-5 Solder

2.2 Unions, Flanges, and Couplings

- .1 Size 50mm (2") and under: 1035kPa (150 psi) malleable iron, bronze to iron ground joint unions for threaded ferrous piping, air tested for gas service, all bronze for copper piping. Unions to ANSI B16.3.
- .2 Unions to be 4137 kPa (600 psi) malleable iron with brass-to-iron ground seat. Unions to be to ANSI B16.3.
- .3 Couplings to be threaded, to ANIS B16.11.

3. Execution**3.1 Preparation**

- .1 Ream pipes and tubes. Clean off scale and dirt, inside and outside, before assembly. Remove welding slag or other foreign material from piping.
- .2 Provide dielectric type connections wherever jointing dissimilar metals in open systems. Brass adapters and valves are acceptable.
- .3 Use insulating plastic spacers for copper pipe installation in metal studs.

3.2 Route and Grades

- .1 Route piping in orderly manner and maintain proper grades. Install to conserve headroom and interfere as little as possible with use of space. Run exposed piping parallel to walls. Group piping wherever practical at common elevations. Install concealed pipes close to the building structure to keep furring to a minimum.
- .2 Slope air piping 0.2% and provide valved and capped drains at low points.
-

3.3 Installation

- .1 Assemble joints without binding. Solder shall penetrate fully and fill the joint completely.
- .2 Install unions to permit removal or replacement of equipment.
- .3 Make branch connections from top of main.
- .4 Install compressed air trap at bottom of each riser and at low points in minas, complete with hose end drain and valve. Valves must be at readily accessible locations, serviced from the floor or mezzanine. Distance between drain points to be 30 meters (100 feet) maximum.
- .5 Install piping to allow for expansion and contraction without unduly stressing pipe or equipment connected.
- .6 Provide clearance for access to valves, drains and unions.
- .7 Blow out all piping to clean interior thoroughly of all oil and foreign matter.
- .8 Testing:
 - .1 Pressure test for 4 hours minimum to 2068 kPa (300 psi) with outlets closed and with compressor isolated from system. Pressure drop not to exceed 10 kPa (1.5 psi)

END OF SECTION

1. GENERAL

1.1 Work Included

- .1 Compressed air valves & accessories.

1.2 Quality Assurance

- .1 All compressed air systems shall be installed to the approval of the Authority Having Jurisdiction.

1.3 Submittals

- .1 Provide shop drawings for all valves and accessories.
- .2 Comply with the requirements of Section 23 05 00 – Common Work Results for HVAC.

2. PRODUCTS

2.1 Pressure Regulator

- .1 Factory assembled heavy-duty with mounting bracket and low pressure side relief valve.
- .2 Maximum inlet pressure: As specified on drawings.
- .3 Operating temperature: -18°C (-0.4°F) to +52°C (126°F).
- .4 Pressure range in regulator: As specified on drawings.

2.2 Ball Valves

- .1 Three piece design or top entry for ease of in-line maintenance.
 - .1 To ASTM A181, Class 70 carbon steel body screwed ends, stainless steel ball and associated trim suitable for compressed air application.
 - .2 To withstand 2068 kPa (300 psi) maximum pressure.
- .2 Acceptable Materials: Worcester Valve Fig. 444466TT-SE, Jamesbury, MAS G-3 all 316 stainless steel.

2.3 Couplers/Connectors

- .1 Industrial interchange series, full-bore.
 - .2 Maximum inlet pressure: 2068 kPa (300 psi).
 - .3 Valve seat: Molded nylon.
-

.4 Body: Zinc plated steel.

.5 Threads: NPT.

.6 Acceptable Materials: ARO.

2.4 Check Valves

.1 50mm (2") and under, screwed.

.1 To MSS SP-80, Class 300, 2068 kPa (300 psi) steam, 3447 kPa (500 psi) WOG, bronze body, bronze swing disk, screw-in cap, re-grindable seat.

2.5 Flexible Piping

.1 Premium quality compressed air hose suitable for maximum working pressure of 2068 kPaG (300 psig). Nitrile tube with spiral reinforcement and PVC nitrile cover.

.2 Provide two-section/two-bolt or two-section/four-bolt clamp type restrained hose end adapters to standard male NPT ends, suitable for air service.

3. EXECUTION

3.1 Main Air Pressure Regulators

.1 Install at air compressor stations where indicated.

3.2 Compressed Air Piping Installation

.1 Install flexible connection at connection to air compressors.

.2 Install shut-off valves at outlets, major branch lines and elsewhere as indicated.

.3 Install quick-coupler chucks and pressure gauges on drop pipes as indicated.

END OF SECTION

1. General

1.1 Scope

- .1 Reciprocating air compressor
- .2 Air receiver and accessories

1.2 Quality Assurance

- .1 Air receivers shall meet requirements of ASME code for Unfired Pressure Vessels and carry ASME approval stamp.

1.3 Submittals

- .1 Submit shop drawings for air compressor, receiver, dryer and all other related accessories. Shop drawings to indicate construction, capacity, operating pressure, electrical, controls, dimensions.
- .2 Submit Provincial Inspector's certificate for air receiver for inclusion in Operating and Maintenance Manuals.

2. Products

2.1 Acceptable Manufacturers

- 1. Reciprocating Air Compressors : Atlas-Copco, DeVilbiss, Eagle, Ingersoll Rand

2.2 Type

- .1 Provide tank mounted simplex compressor unit consisting of open drip proof motor, compressor, air receiver, refrigerated air dryer and operating controls. Duplex units to consist of two complete compressor/motor units mounted on common receiver.

2.3 Compressor

- .1 Provide 1 stage air cooled compressor(s) with replaceable dry cartridge type intake air filter, V-belt drive and belt guard.
 - .2 Provide automatic compressor unloading device for load free motor starting.
 - .3 Mount motor and compressor on one-piece welded steel base with provision for V-belt adjustments.
 - .4 Provide compressor with low oil pressure protection to automatically shut down compressor on low pressure.
 - .5 Provide line size isolation valve and check valve on compressor discharge.
-

2.4 Receiver

- .1 Provide ASME vertical receiver complete with welded support feet and spring type vibration isolators.
- .2 Provide tank mounted fittings including pressure switch, pressure gauge, safety valve, air outlet valve, flexible braided hose connection to tank, automatic condensate trap and drain cock.
- .3 Receiver finish to be enamel coated.

2.5 Compressor Controls

- .1 Pressure switch shall operate to cut out at 690 kPa (100 psi) with a minimum differential of 140 kPa (20 psi).

3. **Execution**

3.1 Installation

- .1 Install compressor unit on neoprene isolation pad.
- .2 Connect condensate drains to nearest floor drain.

3.2 Performance

- .1 Refer to Air Compressor Schedule on drawings.

END OF SECTION

1. General

1.1 Scope

- .1 Emergency eye/face wash units
- .2 Emergency mixing valves

1.2 General Requirements

- .1 Provide new fixtures, CSA approved, free from flaws and blemishes with finished surfaces clear, smooth and bright.
- .2 Provide CSA approved plumbing fittings. Visible parts of fixture brass and accessories shall be heavily chrome plated.
- .3 Fixtures shall be product of one manufacturer. Fittings of same type shall be product of one manufacturer.
- .4 Protect fixtures against use and damage during construction.

1.3 Job Conditions

- .1 Check millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation. Advise consultant of discrepancies prior to ordering fixtures or trim.

1.4 Submittals

- .1 Submit shop drawings for review.

2. Products

2.1 Acceptable Manufacturers

- 1. Emergency Eye/Face Wash Units : Bradley, Encon, Haws
- 2. Emergency Mixing Valves : Bradley, Haws, Leonard

2.2 Emergency Eye / Face Wash Units

- .1 Refer to Plumbing Fixture Schedule for emergency eye/face wash unit types.

2.3 Emergency Mixing Valves

- .1 Refer to Plumbing Fixture Schedule for emergency mixing valve types.
-

3. Execution

3.1 Installation

- .1 Install each fixture with its own trap, easily removable for servicing and cleaning. At completion thoroughly clean plumbing fixtures and equipment.
- .2 Provide chrome plated rigid or flexible supplies to fixtures with screw driver stops, reducers and escutcheons.
- .3 Provide pressure reducing valves on water lines to fixtures which are not rated for the system operating pressures.
- .4 All trim and plumbing fixtures shall be located as per the Architectural Details.

END OF SECTION

1. General

1.1 Scope

- .1 This contractor shall be responsible for and ensure that all ductwork is internally clean when handed over to the Owner. This responsibility includes the entire system, from outdoor air intakes to air terminals and from air terminal to relief outlets. It includes all ductwork, lined and unlined, all plenums and all equipment within or connected to ducts and plenums.
- .2 The surfaces shall be considered clean when all foreign materials capable of particulating and visible to the naked eye are removed.
- .3 The Contractor shall initiate quality control measures during the fabrication and installation of all ductwork to clean/keep clean all ductwork, so that ductwork cleaning may not be required at the completion of the work. Consultant shall review cleanliness of ductwork, and at the sole discretion and direction of the Consultant, the ductwork cleaning requirements of this section may be required, reduced or eliminated. However, if the ductwork does require cleaning, it shall be done as per the requirements of this section, and shall be at no additional cost to the Owner.

1.2 Definitions

- .1 Clean: No visible particulates or deposition in air systems after vacuum techniques have been completed.
- .2 Air Systems: Includes central equipment; supply, return, exhaust fans, coils, dampers, turning vanes, grilles, diffusers, high, medium and low pressure ductwork (supply, return and exhaust) that is associated with an air handling system.

1.3 Quality Assurance

- .1 Ductwork cleaning firms shall be specialists in this field.
- .2 The HVAC system cleaning sub-trade shall be a certified member of the National Air Duct Cleaners Association (NADCA) or equivalent.
- .3 The Owner may hire an independent agency to review duct cleaning procedures prior to starting work and perform spot checks to confirm that duct system cleaning has been effectively executed.

1.4 Related Work Specified in Other Sections

- .1 Common Work Results for HVAC Section 23 05 00
 - .2 Metal Ducts Section 23 31 13
 - .3 Air Duct Accessories Section 23 33 13
-

1.5 Waste Management and Disposal

- .1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.6 Approved Agencies

- .1 Contractor to submit proposed agency for Consultant and Owner approval.

1.7 Submittals

- .1 Submit certification of NADCA membership (or equivalent).
- .2 Submit list of five (5) recent projects of similar magnitude.
- .3 Submit the name of the superintendent-in-charge of the work and list his project experience.
- .4 Submit an outline of the work scope for each ductwork system for review prior to starting work, including lighting strategy and procedures, cleaning procedures, equipment, materials, and schedule.
- .5 Submit a certificate of completion for each ductwork system that cleaning has been completed as defined in the specifications.

2. **Products**

Not Applicable

3. **Execution**

3.1 Preparation

- .1 All ductwork shall be wiped clean prior to installation.
 - .2 Oil film on sheet metal shall be removed before shipment to Work Site. Finished ductwork shall be stood vertically for 72 hours to allow oil remnants to drains as indicated by SMACNA. Ducts shall be inspected for oil remnants prior to shipping to site.
 - .3 Close all dampers immediately following installation thus checking the operation and retarding movement of contaminants through the system.
 - .4 Seal all openings at the end of each day and at such other time as site conditions dictate.
 - .5 Floor openings to be capped with sheet metal or floor grilles plus 0.15 mm (6 mils) thick poly sheet.
 - .6 Other openings to be covered with 0.15 mm (6 mils) thick poly sheet taped so as to be air tight.
-

3.2 Installing Access Doors

- .1 Provide and locate access doors and install as follows:
 - .1 At 12.0m (36 ft) intervals in vertical ducts.
 - .2 Horizontal ducts at intervals of 6m (18 ft).
 - .3 At the base of all duct risers.
 - .4 Both sides of turning vanes in all ducts.
 - .5 At each fire damper location.
 - .6 At each side of all coils except where an access is provided.
 - .7 At all locations of internally duct mounted equipment or devices including balancing dampers, automatic dampers, damper motors, duct mounted smoke detectors and heat detectors, and controls, except where access is provided.
 - .8 Where required to facilitate duct cleaning.

3.3 Cleaning

- .1 On completion of the duct and plenum installation and prior to the installation of air terminals and prior to balancing of the air systems, but not until the areas are substantially clean (floors have been swept and vacuumed) and all "dirty" construction has been completed, employ an approved Cleaning Agency to vacuum clean the following:
 - .1 All air handling units.
 - .2 All plenums.
 - .3 All supply and return air ducts.
 - .4 All exhaust air ducts.
 - .2 All components within each system shall be thoroughly cleaned and shall include but not be limited to the following: coils, fans and motors, silencers, air terminals and mixing boxes / air terminal boxes.
 - .3 When connecting to existing supply ductwork, clean existing supply ducts upstream from connection back to the filters. Clean existing supply ductwork downstream from new connections to outlets.
 - .4 Cleaning shall generally be by high capacity power vacuum. High-pressure compressed air, wire brushing and/or non-toxic solvent cleaning shall be used where dirt or scale cannot be removed otherwise.
 - .5 Install temporary filters as follows:
-

-
- .1 Behind all grilles and diffusers.
 - .2 In front of all duct coils.
 - .3 At inlet of all terminal high velocity units to protect pitot openings.
 - .6 The Cleaning Contractor shall be responsible for removing and replacing filter media. This contractor will remove the temporary filters and replace with new after cleaning the systems.
 - .7 The Cleaning Contractor shall mark balancing damper positions before cleaning and return them to their original position when cleaning is completed unless the system is still to be balanced.
 - .8 Reinstall any grilles, registers and diffusers, which may have been removed for cleaning purposes.
 - .9 After the duct systems have been cleaned they shall be resealed if they are not being used. Provide filter media on the return air terminals, in a ducted return system, if the return air fans are run after cleaning has been completed. Where the ceiling is being used as a return air plenum, provide filter media on the return air opening at the shaft.
 - .10 The Cleaning Agency shall perform a full inspection of the duct interior. Utilizing a fibre optic borescope with dedicated light source, inspect interior ductwork surfaces, and ductwork accessories including terminal units, mixing boxes / air valves, ductwork liners, duct-mounted coils, filters, dampers, humidifiers and all other appurtenances within the ductwork system.
 - .11 Spot checks will be made by the Consultant during the cleaning process to verify that the required standard is being met. When substantial performance is claimed, final spot checks will be made to verify that the ducts are clean. Make available for the use of the Consultant a fibre optic borescope with dedicated light source. If any ducts are found to be unclean, then they shall be recleaned.
 - .12 Ducts serving very clean areas served with 85% NBS or HEPA filters shall be reviewed by the Consultant utilizing the equivalent of a white glove wipe technique.
 - .13 Submit a report from the cleaning agency that certifies all specified air systems have been cleaned

3.4 Inspection

- .1 Ductwork cleanliness will be inspected using a periscope built of 75mm (3") diameter tube, mirrors and flashlight.
- .2 Ductwork found to be dirty shall be re-cleaned at contractor's expense.
- .3 Ductwork cleanliness shall be inspected by the mechanical engineer.

END OF SECTION

1. General**1.1 Intent**

- .1 Work in Division 22 and 23 will include all drawings and all sections of the specifications that form the Contract Documents, including all addenda, and including Division 00 and Division 01, whether defined in Division 22 and 23 or elsewhere, or whether defined in mechanical drawings or elsewhere.
- .2 Provide complete, fully tested and operational mechanical systems to meet requirements described herein and in complete accord with applicable codes and ordinances. Include all costs to obtain all permits and to pay for all fees and charges, including inspection charges by the authorities that issue the permits. Coordinate all related inspections. Permits, fees and inspections including:
 - .1 Ventilation
 - .2 Building HVAC
 - .3 Building plumbing
- .3 Contract documents consisting of the specifications and drawings, are generally diagrammatic and approximately to scale unless detailed otherwise. They establish scope, material and installation quality and are not detailed installation instructions.
- .4 Review Contract Documents and notify the Consultant of issues or conflict that require clarification prior to submitting tender. Failure by the Contractor to secure clarification does not relieve the Contractor to comply with the intent of the design and/or the Contract Document.

1.2 Related Requirements

- .1 Refer to and comply with the following sections:
 - .1 General Requirements Division 01
 - .2 Submittal Procedures Section 01 33 00
 - .3 Delegated Design Submittals Section 01 33 50
 - .4 Quality Control Section 01 45 00
 - .5 Temporary Utilities Section 01 51 00
 - .6 Closeout Procedures Section 01 77 00
 - .7 Closeout Submittals Section 01 78 00
 - .8 Demonstration and Training Section 01 79 00
 - .9 Commissioning Section 01 91 00
 - .10 General Commissioning (Cx) Requirements Section 01 91 13
 - .11 Building Management Manual Section 01 91 51
-

1.3 Related Work Specified in Other Sections

- | | | |
|----|---|-------------|
| .1 | Bidding Requirements and General Conditions of Contract | Division 01 |
| .2 | Electric Motor Power Characteristics | Division 26 |

1.4 Codes, Regulations, Permits, Fees and Inspections

- | | |
|----|--|
| .1 | Conform to the latest edition and supplements of the following for all materials and installations: |
| .1 | National Building Code (NBC) 2010 |
| .2 | Alberta Building Code (ABC) 2014, as amended by local bylaws and Provincial Statutes. |
| .3 | National Fire Protection Association. |
| .4 | Codes, Standards, Bylaws, Statutes and Manufacturer's Association Specifications or instructions mentioned in Division 22 and 23 sections, refer to latest revisions thereof at time of calling of bids, unless specifically designated otherwise. |
| .5 | In no instance shall the standard established by the drawings and specifications be reduced by code or otherwise. |
| .6 | Where conflict or discrepancies between Codes, Standards, Bylaws, Statutes, Specifications, Drawings, etc., exist, the most stringent requirement shall apply. |
| .7 | Furnish all notices, obtain all necessary permits related to Division 22 and 23 work. |

1.5 Installation Requirements

- | | |
|----|--|
| .1 | Provide labor, material and tools required to install, test and place into operation, a complete mechanical system. Provide additional material for modifications required to correct minor job confliction. |
| .2 | Install material and equipment generally in locations and routes shown, close to building structure with minimum interference with other services or free space. Remove and replace improperly installed equipment as determined by the Engineer. Field verify all dimensions, clearances, maintenance clearances, equipment handling requirements, invert elevations, and other similar measurements prior to any fabrication and installation. Notify the Consultant of any discrepancies that require resolution. |
| .3 | Confirm invert elevations and locations of connection to utilities before any excavation work is started. |
| .4 | Install piping and ductwork only in concealed spaces, unless otherwise approved. |
-

-
- .5 Remove and replace improperly installed mechanical work, or work that requires modifications due to coordination issues or conflicts.
 - .6 Review architectural drawings and confirm that plumbing fixtures defined on Architectural Drawings are consistent with plumbing fixtures defined on mechanical drawings. Mechanical work shall include supply and installation for all fixtures defined in the contract documents.
 - .7 Refer to Architectural Drawings and Structural Drawings for sections, details, dimensions and information such as fire separations, expansion joints, roof construction, wall construction that has impact on the mechanical installation.
 - .8 Examine contract documents prepared by all disciplines and confirm that work can be installed as defined. No allowance will be made for changes unless the consultant has been notified in writing prior to tender close.
 - .9 Follow manufacturer's recommended installation details and procedures for equipment, supplemented by details given herein and on plans subject to approval of the consultant.
 - .10 Locate distribution systems, access doors, equipment and materials for maximum usable space to satisfaction of consultant.
 - .11 Install equipment in a manner to facilitate maintenance and ease of repair or replacement. Provide for adequate access and sufficient clearances.
 - .12 Equipment used shall not exceed space limitations in any dimension. Replace any equipment or apparatus which does not meet this Specification at no cost. Assume full responsibility for the expense of redesign and adjustment to other parts of the building when proposing the use of acceptable equal or alternate equipment. It is the contractor's responsibility to confirm all quantities. Dimensions, performance and accessories required for all equipment, including matching "standard" and operational accessories between "equal" and "acceptable" products/suppliers/manufacturers.
 - .13 Prepare dimensioned drawings showing sleeving, recesses, furring and openings to coordinate mechanical work with other trades.
 - .14 Prepare dimensioned drawings for congested areas such as mechanical rooms, shafts, corridors and spaces that require special attention to complete the installation.

1.6 Equipment Connections

- .1 Connect to equipment specified in other Sections and to equipment supplied and installed by other Contractors or by the Owner. Refer to below and Division 11 for owner supplied equipment and equipment furnished by other divisions.
 - .2 Provide rough-in for and make all connections to equipment supplied by Owner or other trades for this work, including:
 - .3 Refer to and comply with the following sections:
-

-
- | | | |
|-----|--|----------------------|
| .1 | Plumbing Insulation | Section 22 07 00 |
| .2 | Domestic Water Piping | Section 22 11 16 |
| .3 | Domestic Water Piping Specialties | Section 22 11 19 |
| .4 | Sanitary Waste and Vent Piping | Section 22 13 16 |
| .5 | Identification for HVAC Piping and Equipment | Section 23 05 53 |
| .6 | Testing, Adjusting and Balancing for HVAC | Section 23 05 93 |
| .7 | HVAC Insulation | Section 23 07 00 |
| .8 | Controls | Section 23 09 Series |
| .9 | Metal Ducts | Section 23 31 13 |
| .10 | Air Duct Accessories | Section 23 33 00 |
- .4 Uncrate equipment, assemble, move into place and install. After installation is complete; start-up and test the equipment.
- .5 Make all piping (water, gas, etc.) connections to all the owner and General Contractor supplied equipment. Include all valves, vents, unions, flanges and traps.
- .6 Prior to commencing installation of rough-in for the equipment, coordinate with the final reviewed equipment shop drawings and with the manufacturer. Revise rough-in as necessary to meet requirements of actual equipment purchased.
- .7 Arrange ducting and piping connections to allow for equipment removal.
- .8 All equipment provided by others, which require mechanical connections, shall become the responsibility of the Division 23 contractor with respect to mechanical connections only.

1.7 Provisions for Maintenance

- .1 Install piping in racks with clearance in between pipes equal to the pipe diameter. Where piping is stacked, provide a minimum 300mm (12") clearance in between stacks.
- .2 Install maintainable components such as valves, motors, traps, air vents, dampers, filters, and coils in a manner to facilitate proper access for maintenance.
- .3 Install major equipment components such as pumps, fans, dry coolers, chillers at floor level unless indicated otherwise. Install piping connections with isolating valves located to allow component removal with minimal system drainage.
- .4 Locate flanges/unions to allow equipment removal without interruption to piping work.
- .5 Allow adequate space for removal of equipment and components from the mechanical room space.
- .6 Install "Pete's Plugs" gauges and metering equipment in readily accessible and visual locations.
-

-
- .7 Provide extensions to grease cups, lubrication fittings for bearings, etc. to outside of fan cabinets.
 - .8 Provide maintenance platforms, ladders, safety rails to Occupational Health and Safety Standards to accommodate equipment and components not easily accessed from the floor.
 - .9 Provide lifting lugs attached to the building structure above motors and equipment that weight in excess of 50 kg (110 lb).
 - .10 Allow minimum clearance in front of electrical components, such as motor control centers, starters, VFDs, control panels in accordance with applicable codes.

1.8 Warranty

- .1 Comply with warranty requirements defined in Division 01.
- .2 Furnish a written guarantee stating that all work executed in this contract will be free from defective workmanship and materials for a period of one (1) year from the date of substantial performance of work. The Contractor shall repair and replace any work which fails or becomes defective during the term of the guarantee/warranty, providing the operating and maintenance instructions have been complied with. The period of guarantee specified shall not, in any way, supplant any other guarantees of a longer period provided by Manufacturers or as called for in the project documents.

1.9 Owner Requirements During Warranty

- .1 Unless specified otherwise the Owner shall be responsible for all routine maintenance requirements as required in the manufacturer's instructions.
- .2 The Owner shall be responsible for supplying replaceable components such as filters and belts during the warranty period.

1.10 Materials

- .1 Materials and equipment installed shall be new, full weight and of quality specified. Use same brand or manufacturer and model for each specific application.
 - .2 Each major component of equipment shall bear manufacturer's name, address, catalog and serial number in a conspicuous place.
 - .3 Provide statically and dynamically balanced rotating equipment for minimum vibration and low operating noise levels. Provide balancing certificates if requested by the consultant.
 - .4 Replace materials or workmanship below specified quality and relocate work wrongly placed to satisfaction of the Engineer and at no cost to the Owner.
 - .5 Install materials and equipment in a quality manner providing good workmanship by competent tradesmen. At the request of the consultant, provide certificates proving competency of specialists employed. Certificates shall be from recognized, related
-

governing associations. The owner and his representatives reserve the right to terminate any specific person's employment on this project for failure to prove adequate qualifications and/or workmanship.

- .6 If shop drawings are rejected technically after 3 submissions, the Contractor at no additional expense to the Owner shall revert the specified product and manufacturer for this project.

1.11 Availability of Equipment and Materials

- .1 Make known in writing to the Engineer ten (10) days prior to the tender closing date any materials specified that are required to complete the work which are not currently available or will not be available for use as called for herein. Failing to do so, it will be assumed that the most expensive alternate has been included in the tender price.
- .2 If requested after contract award, provide within 24 hours a list of equipment and manufacturers to be used on this project. This list shall not be deviated from unless delivery, performance, or dimension issues require a change to be reviewed by the Consultant.

1.12 Alternate Materials and Equipment

- .1 Comply with the requirements of Division 01.
- .2 The price submitted for this contract shall be based on the use of materials and equipment as specified or as contained within the acceptable equivalent manufacturers listed in each section.
- .3 Requests for approval for tendering purposes of equivalent materials or equipment shall be submitted in duplicate, to the Engineer no later than ten (10) working days prior to the closing date of tender for mechanical trade, complete with all applicable technical data, including performance curves and physical details. Approval of requests shall only be given by addendum and consistent with all requirements defined in Division 01.
- .4 The Contractor shall, in his quotation, indicate the degree of approval obtained from the Engineer. In the event that the product has been approved as an "Alternate Only", this shall be stated in the quotation and the difference from the base bid price indicated.
- .5 Approved equivalents and/or alternatives to specified products shall be equal in performance and materials to the specified product in every respect, operate as intended, meet the space, capacity, and noise requirements outlined. . Equipment which is not equal will be replaced with the specified equipment at no cost to the Owner.
- .6 The Contractor shall be fully responsible for all costs for work or materials required by the trades or other contractors to accommodate use of other than specified materials or equipment.
- .7 Manufacturers/suppliers which are noted in individual sections as "Acceptable Manufacturers" are automatically approved for bidding and are not required to follow the
-

approval process. All other manufacturers/suppliers must follow the approval process. "Approved Manufacturers" must meet all requirements of specified equipment.

1.13 Metric Conversion

- .1 All units in this division are expressed in SI units. Soft metric conversions are used throughout.
- .2 Submit all shop drawings and maintenance manuals in SI units.
- .3 On all submittals use the same SI units as stated in the specification.
- .4 Equivalent Nominal Diameters of Pipes - Metric and Imperial
 - .1 Where pipes are specified with metric dimensions and only Imperial sized pipes are available, provide equivalent nominal Imperial sized pipe as indicated in the table, and provide adapters to ensure compatible connections to all metric sized fittings, equipment and piping.
 - .2 When CSA approved SI Metric pipes are available and are provided, the contractor shall provide adapters to ensure compatible connections between the SI Metric pipes and all new and existing pipes, fittings, and equipment.
 - .3 Record accurately on "as-built" drawings the type of pipe (i.e., Metric or Imperial) installed.

Equivalent Nominal Diameters of Pipes

mm	inches	mm	inches	mm	inches
3	1/8	65	2-1/2	375	15
6	1/4	75	3	450	18
10	3/8	100	4	500	20
15	1/2	125	5	600	24
20	3/4	150	6	750	30
25	1	200	8		
30	1-1/4	250	10		
40	1-1/2	300	12		
50	2				

- .5 Metric Duct Sizes
 - .1 The metric duct sizes are expressed as 25mm = 1inch.

1.14 Drawings And Specifications

- .1 Refer to architectural drawings for building dimensional data and construction details.

-
- .2 Drawings and specifications are complementary each to the other, and what is called for by one shall be binding as if called for by both. Any item omitted from one but which is mentioned or reasonably implied in the other shall be considered as properly and sufficiently specified.
 - .3 Should any discrepancy appear between drawings and specifications which leaves the Contractor in doubt as to the true intent and meaning of the plans and specifications, obtain a ruling from the Engineer in writing or by Addendum, before submitting tender. If this is not done, it will be assumed that the most expensive alternate has been included.
 - .4 Where errors or discrepancies appear in catalogue numbers, provide the material in accordance with the system requirements and to the standard of the specifications.
 - .5 Prior to construction start, examine all contract documents, including all drawings and specifications, and work of other trades to ensure that work can be satisfactorily carried out without changes to building.
 - .6 The scope of work in this division shall include all work defined in the Contract Documents, including work which may exceed the minimum requirements of codes and standards that are referenced in the Contract Documents.

1.15 Examination Of Site

- .1 Before submitting tender, visit and examine the site and note all characteristics and features affecting the work. Report discrepancies to the Engineer seven (7) days prior to tender closing. No allowances will be made for any difficulties encountered or any expenses incurred because of any conditions of the site or item existing, thereon, which are visible or known to exist at the time of tender. Failure to advise Engineer of discrepancies will assume contractor accepts documents as presented without potential of additional costs.

1.16 Equipment Delivery, Storage and Cleanup

- .1 Arrange, and coordinate, storage space with the General Contractor. Materials and equipment shall be stored in a safe, dry location and shall be protected against weather, damage and theft.
 - .2 Materials to be delivered to site in original factory packaging with manufacturer's labeling including name and address.
 - .3 Protect equipment and materials in storage on site during and after installation until final acceptance. Leave factory covers in place. Take special precautions to prevent entry of foreign material into working parts of piping and duct systems.
 - .4 Protect equipment with polyethylene covers and crates.
 - .5 Operate, drain and flush out bearings and refill with new change of oil, before final acceptance.
-

-
- .6 Thoroughly clean piping, ducts and equipment of dirt, cuttings and other foreign substances.
 - .7 Protect bearings and shafts during installation. Grease shafts and sheaves to prevent corrosion. Supply and install necessary extended nipples for lubrication purposes.
 - .8 Ensure that existing equipment to be turned over to the Owner or reused is carefully dismantled and not damaged or lost. Do not reuse existing materials and equipment unless specifically indicated.
 - .9 Existing equipment that is to remain in place, and be reused, is to be protected from physical damage including freezing.

1.17 Waste Management and Disposal

- .1 Separate and recycle waste materials in accordance with Section 01 52 00 – Construction Facilities.
- .2 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.

1.18 Coordination of Work

- .1 Cooperate and coordinate with other trades on the project. Phase work in sequence with the General Contractor.
 - .2 Make reference to electrical, mechanical, structural and architectural drawings when setting out work. Consult with respective Divisions in setting out locations for ductwork, equipment, and piping, so that conflicts are avoided and symmetrical even spacing is maintained. Provide coordination drawings showing the work of all trades and contractors involved, in areas of potential conflict or congestion, as requested by Engineer at no additional cost.
 - .3 Where dimensional details are required, work with the applicable architectural and structural drawings.
 - .4 Full size and detailed drawings shall take precedence over scale measurements from drawings.
 - .5 Prepare and submit drawings showing sleeving, recesses, and formed work in concrete.
 - .6 Prepare and submit drawings for all shafts, duct openings, roof openings and similar requirements.
 - .7 Coordinate with the Construction Manager and Electrical Trade all requirements for electrical services to mechanical components and equipment. Motor voltages will be defined in Division 26.
-

-
- .8 Using shop drawing data, prepare a comprehensive list to define all specific electrical requirements needed by the Division 22 and 23 work to complete the installation. Coordinate with Electrical Trade.
 - .9 Prepare and submit drawings to the Construction Manager and structural Consultant defining mechanical system support loads and support details. Include definition of pipe and/or loads on structural elements and anchor arrangements.

1.19 Coordination with Division 26 (Electrical) Work

- .1 Provide motors or mechanical equipment with voltage and phase characteristics as defined in Division 26.
 - .2 Comply with the requirements in Section 23 05 13 – Common Motor Requirements for HVAC Equipment.
 - .3 Prior to ordering any motor driven mechanical equipment, meet with the electrical trade and confirm all electrical interface requirements with mechanical components.
 - .4 Division 22 and 23 (Mechanical) Trade shall:
 - .1 Submit a list of all motor specifications and electrical connections to mechanical equipment, outlets, components, panels and point source requirements. Maintain list up-to-date and make available for site review.
 - .2 Include final motor list in O&M Manuals.
 - .3 Supply and install all low voltage (24 V) control devices, temperature control systems including direct digital central systems defined in Section 23 09 (Series), Controls.
 - .4 Supply and set in place all variable frequency drives that are defined in Section 23 05 04, including start-up and commission.
 - .5 Supply and install 110 V wiring interface with control devices on packaged equipment, such as liquid level controllers and multi-speed controllers.
 - .6 Supply and install all low and live voltage wiring associated with automatic control systems defined in Sections 23 09 (Series), Controls.
 - .7 Provide CSA labeling on all mechanical equipment with electrical components.
 - .8 Provide all on-site interconnecting wiring for connecting loose electrical components supplied with mechanical equipment.
 - .5 Division 26 (Electrical) Trade will:
 - .1 Supply and install all electrical components which are required, but not part of Division 22 and 23 supplied packaged equipment.
-

- .2 Provide wiring interface from distribution equipment to variable frequency drives (VFDs) and from VFDs to motors.
- .3 Extend power wiring from electrical centers to packaged equipment that contains electrical components.
- .6 Refer to Division 26.

1.20 **Cutting and Patching**

- .1 Provide inserts, holes and sleeves, cutting and fitting required for mechanical work. Relocate improperly located holes and sleeves.
- .2 Provide inserts or drill for expansion bolts, hanger rods, brackets, and supports.
- .3 Obtain written approval from Engineer before drilling, coring, cutting or burning structural members. Ensure post tensioned or pre-stressed strands are located accurately and avoid with an adequate margin of safety.
- .4 Cutting practices shall be limited to neat openings created through recognized drilling or coring practices.
- .5 Use only National Building Code approved and rated process and materials for filling of voids. All processes and materials are subject to the approval of the Fire Commissioner. Maintain integrity of fire separation.
- .6 Patch and make good building where damaged from equipment installation, improperly located holes etc. Work to be performed by the trade or contractor responsible for that type of work.

1.21 **Temporary Heat**

- .1 Refer to Section 01 50 00 – Temporary Facilities and Controls.
- .2 The building systems shall not be utilized for temporary heat. The contractor may provide a proposed temporary heat agreement to the Owner for review. However, the agreement may or may not be accepted, and as a minimum, the following requirements would have to be met:
 - .1 The agreement shall include payment schedule for utilities, spare parts listing and confirmation of warranty.
 - .2 Thoroughly clean and overhaul permanent equipment used during the construction period, and replace worn or damaged parts before final inspection at the sole discretion of the Consultant.
 - .3 Use of permanent systems for temporary heat shall not modify terms of warranty. Equipment Manufacturers shall certify that equipment is in "new" condition at start of warranty period.

-
- .4 Operate heating systems under conditions which ensure no temporary or permanent damage. No water systems shall operate without proper water treatment or blow-down. Operate fans at proper resistance with filters installed. Change filters at regular intervals. Operate with proper safety devices and controls installed and fully operational. Operate systems only with treated water as specified.
 - .5 Air systems may not be used for temporary heating.
 - .6 Radiant panels may not be used for temporary heating.
 - .7 When permanent systems are used for temporary heat, provide alarm indicating system failure. Connect alarm to independent alarm company monitoring system.
 - .8 Where pumps are used for temporary heating, replace mechanical seals, regardless of condition, with new mechanical seals, prior to Total Performance.
 - .9 Avoid thermal shock to heating system during planning, construction and operation of temporary heating system.

1.22 Temporary or Trial Usage

- .1 Temporary or trial usage requested by the Owner of mechanical equipment supplied under contract shall not represent acceptance. Operate and maintain all equipment and systems during trial usage.
- .2 Repair or otherwise rectify damage caused by defective materials or workmanship during temporary or trial usage.
- .3 For all ventilation systems, the operation of the system shall be pre-tested by running the units in their designed maximum fresh air, maximum exhaust air mode once all distribution ductwork is installed. Inspect filters bi-monthly; change filters if pressure drop exceeds manufacturer's recommended operating limit.

1.23 Welding

- .1 Use fully qualified welders licensed by the provincial authorities.
 - .2 For field welding, comply with the procedures of CSA W117.2-M87 "Code for Welding and Cutting (Requirements for Welding Operators)".
 - .3 Welding materials, fabrication standards and labour qualifications must conform to ANSI/ASME B31.1, ANSI B16.25, ASME Section IX, and the Provincial Board of Labour Regulations.
 - .4 Use pressure welders for work on systems containing pressure in excess of 103.4 kPa (15 psig).
 - .5 Weld in accordance with the requirements of the Provincial Boiler Inspection Branch.
-

-
- .6 Submit a statement describing welding procedures proposed for the review of the consultant before commencing work.
 - .7 Before proceeding with the welded joining on the entire piping system, prepare not more than ten sample joints for the on-site review by the consultant. The consultant may request the cutting out of one or more welding joints for close visual examination or x-ray test. Once the consultant has reviewed the samples, the remaining pipe welding joints shall be to the standard accepted.
 - .8 Welded joints shall be free of defects including: elongated slag, isolated slag, porosity, incomplete penetration, lack of fusion, burn-through, cracks, arc burn, internal concavity, hollow beads, internal undercuts, and external undercuts.

1.24 Weld Tests

- .1 Unless otherwise stated, the quality and interpretation of the radiography performed under this specification shall conform to CSA Standard Z183, Oil Piping and Z184, Gas Piping ANSI ASME B31.1 Pressure Piping, B31.3 Refinery Piping and UW51, UW52 Pressure Vessel Codes and all related standards.
 - .2 All welded joints on piping, regardless of service, but including as a minimum, natural gas, heating, chilled water and condenser water, low and high pressure steam and condensate shall be subjected to radiographic inspection with costs borne under the mechanical construction contract.
 - .3 Equivalency of weld quality testing may be granted to the contractor on the following basis at the consultant's discretion:
 - .1 The contractor submits, to the consultant, and obtains approval of a corporate quality control procedures manual for welding practices.
 - .2 5% of welds, as a minimum, shall be radiographed on all welded services.
 - .3 A minimum of two (2) welds shall be radiographed on all services where there are fewer than twenty (20) welds on the service.
 - .4 If defects are recorded which, in the opinion of the consultant, are serious, the consultant may request further radiograph testing of welds to a maximum of 100% of all welded joints at his discretion. The contractor shall bear all related costs of these extra testing procedures as an acknowledgement of maintenance of project quality requirements.
 - .4 A senior radiographer with Canadian Government Standard Board Level 2 qualifications shall be in the field supervising the radiographic operations under contract.
 - .5 Prior to beginning work, the following requirements shall be fulfilled:
 - .1 The radiographic contractor shall supply the consultant with written evidence of each radiographer's certification in accordance with "Welds and Weldments" CGSB 48-G04, latest edition.
-

-
- .2 The radiographer shall be required to satisfactorily make two (2) qualification radiographs, which will include exposing and processing the radiographs and interpreting the radiographs in accordance with applicable code. One (1) copy of the qualification radiograph shall be kept by the consultant and shall be used as a standard against which the quality of production radiographs can be checked.
 - .6 The radiographer shall be responsible for the protection and personal monitoring of every man working with or near radiation in accordance with the regulations of the Department of Health and Welfare, Radiation Protection Division. When crank-out type Isotope camera is used, the area affected by radiation shall be surveyed and limits of hazard posted.
 - .7 Submit all certified test reports to the consultant.

1.25 Testing of Soldered Copper Joints

- .1 The Engineer, at any time, may select up to five (5) sample soldered copper joints from installed pipe for review. Samples provided shall be split longitudinally for visual review.
- .2 If the submitted samples do not pass a visual inspection to the satisfaction of the Engineer, the contractor shall arrange and pay for radiographic testing of the samples to verify quality of workmanship.
- .3 Rejection of a sample will require re-test of adjacent joints at the contractor's expense.
- .4 Failure of more than 75% of the above removed samples will necessitate removal and replacement of all joints completed up to the time of test, at contractor's expense.

1.26 Stray Currents

- .1 All wet lines shall be tested for stray currents at total contract performance.
- .2 Isolate and correct stray currents to minimize electrolytic action potential.

1.27 Shop Drawings

- .1 Submit shop drawings and product data in accordance with Division 1 to consultant for approval prior to ordering material. Shop drawings are to be submitted electronically (PDF) and electronic copies will be provided in return with consultant comments and review stamp. Identify materials and equipment by manufacturer, trade name, and model number. Include copies of applicable brochure or catalogue material. Space must be left on the shop drawing to accommodate the Engineers review stamp. Where equipment is identified by name or number on the drawings or specification, clearly mark each shop drawing with the identical name and/or number.
 - .2 Prior to submission to the Engineer, the Contractor shall review all shop drawings. By this review, the Contractor certifies that he has determined and verified the following:
 - .1 Measurements are verified with field installation space requirements.
-

-
- .2 “Handing” of equipment for access and maintenance is correct.
 - .3 Access for maintenance requirements is defined.
 - .4 Field connections for wiring, controls, piping and ductwork connections are defined.
 - .5 Electrical service connections and characteristics are defined.
 - .6 Work required by other trades is defined.
 - .7 Vendor’s catalogue numbers are correct and consistent with the system performance criteria.
 - .8 Shop drawings meet all requirements of the contract documents.
-
- .3 The Contractor's review of each shop drawing shall be indicated by stamp, date and signature of a responsible person.
 - .4 Identify materials and equipment by manufacturer, trade name, and model number. Include copies of applicable brochure or catalogue material. Do not assume applicable catalogues are available in the Engineers office. Maintenance and operating manuals are not suitable submittal material. Where equipment is identified by name or number on the drawings or specification, clearly mark each shop drawing with the identical name and/or number.
 - .5 Clearly mark each sheet of submittal material (using arrows, underlining, or circling) to show differences from what is specified, particularly sizes, types, model numbers, rating, capacities, and options actually being proposed. Cross out non-applicable material. Specifically note on the submittal specified features such as special tank linings, pump seals, materials or painting.
 - .6 The shop drawings shall be complete with detailed wiring schematics, clearly showing the external electrical connections for power, control and communication. If generic wiring schematics are provided, they shall be marked up with the terminations and wiring requirements that are applicable and available only to this project. If wiring requirements and details are shown for optional equipment and/or devices, the optional equipment and/or devices shall be provided as part of the project.
 - .7 Where optional devices, equipment or features are indicated on the data sheets, the options shall be included as part of the project unless specifically marked up as not being provided for the project.
 - .8 Include dimensional and technical data sufficient to check if equipment meets requirements. Include wiring, piping, service connection data and motor sizes.
 - .9 Submittals shall be made in BOTH metric and English units.
 - .10 Installed materials and equipment shall meet specified requirements regardless of whether or not shop drawings are reviewed by the Engineer.
-

-
- .11 The shop drawing review by the Engineer will provide the following certification: "This review by Stantec is for general conformance with the design concept of Stantec's design of the Mechanical component(s) only and does not mean that Stantec has verified or approves the shop drawings(s). The contractor remains solely responsible for the shop drawings(s) and this review by Stantec does not relieve the Contractor of the Contractor's responsibility for errors or omissions in the shop drawings(s) or for meeting all requirements of the contract documents. This review does not mean that Stantec approve the detailed design inherent in the shop drawing, responsibility for which shall remain with the Contractor submitting same, nor does this review mean that Stantec accepts any deviation of the shop drawings(s) from the contract document. The Contractor is responsible for confirming all dimensions and correlating them at the job site, for all construction means, methods and techniques, and for coordination of construction work of all trades, including coordination of all shop drawings."

1.28 Record Drawings

- .1 Comply with Division 01:
- | | | |
|----|---------------------|------------------|
| .1 | Closeout Procedures | Section 01 77 00 |
| .2 | Closeout Submittals | Section 01 78 00 |
- .2 The contractor shall keep, on site, available to the Engineer at all times and particularly for each regularly scheduled site meeting, a complete set of prints, edge bound, that are to be updated daily showing any and all deviations and changes from the Contract Drawings. This set of drawings is to be used only for this purpose, and must not be used as the daily general reference set. Make record drawings available for reference and inspection at all times.
- .3 Provide record drawings which identify location of smoke and fire dampers, major control lines, access doors, tagged valves, and actual room names or numbers. As well, deviations that are to be recorded shall include, in general, items that are significant or are hidden from view and items of major importance to future operations and maintenance, and to future alterations and additions including cleanouts and isolation valves.
- .4 Include on drawings, all addenda and construction contract changes.
- .5 Identify each drawing in lower right-hand corner in letters at least 12mm high as follows: "RECORD DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED", signature of contractor and date.
- .6 The cost of producing and plotting the AutoCAD record drawings shall be included in the tender price. Periodic checks will be carried out to verify that the record drawings are being kept up to date.
- .7 At substantial completion, transfer all deviations, including those called up by addenda, revisions, clarifications, shop drawings, and change orders, to AutoCAD 2010 files. Drafting quality layers, symbols, etc. shall be identical to original drawings. Prior to substantial performance, turn over a CD containing AutoCAD 2010 drawing files and one (1) complete set of hardcopy record drawings.
-

-
- .8 Each “record” drawing shall bear the Contractor’s identification, the date of record and the notation “We hereby certify that these drawings represent the “Work Record of Construction”. The Contractor’s signature and company seal shall be placed below that notation.
 - .9 Enter dimensions from building line to all buried services, including coordinates of manholes, catch basins, tanks, outside shut-off valves, and other similar elements.
 - .10 Service connections to water and sewer lines entering a building shall be recorded as to horizontal dimension from a convenient building element with suitable depth elevations relating to main floor level and sea level datum.
 - .11 Sewer and water lines which are placed beneath floor slabs shall be located such that each point of entry, change in direction, and irregularity is located by dimension from column grid lines on the record drawings. Depth below slabs shall be given.

1.29 HVAC Systems Testing and Startup

- .1 Conduct system startup and testing of systems.
 - .2 Quality Assurances
 - .1 Test equipment and material where required by specification or authority having jurisdiction to demonstrate its proper and safe operation.
 - .2 Test procedures in accordance with applicable portions of ASME, ASHRAE, SMACNA and other recognized test codes.
 - .3 Perform tests on site to the satisfaction of the Engineer. Tests are to be witnessed by the Consultant and the authorities having jurisdiction. Attendance at tests shall be at the discretion of the Consultant.
 - .4 Piping or equipment shall not be concealed or covered until installation is inspected and approved by the Engineer. Provide written notice to the Engineer at least three (3) days in advance of tests or concealing of piping.
 - .5 Coordinate with engineer at start of the project, those tests that will require witnessing by the Engineer.
 - .6 Submit sample test certificate forms for review two (2) weeks prior to any testing on site.
 - .7 Should a test fail, make repairs and retest until the results are satisfactory to the Consultant and authority having jurisdiction.
 - .3 Liability
 - .1 Take charge of plant during tests, assume responsibility for damages in the event of injury to personnel, building or equipment and bear costs for liability, repairs and restoration in this connection.
-

.4 Submittals

- .1 Obtain certificates of approval and acceptance, complying with rules and regulations from authorities having jurisdiction. Submit copies to be included in Operating and Maintenance Manuals.
- .2 Perform tests as specified. Include test certificates in Operating and Maintenance Manuals. Itemize each test as to the time performed and personnel responsible. Submit written report to the consultant within 48 hours after the tests have occurred.

.5 Execution

- .1 Provide equipment, materials and labor for tests and pay expenses. Use test instruments from approved laboratory or manufacturer and furnish certificate showing degree of accuracy and date of calibration. Install permanent gauges and thermometers used for tests just prior to tests to avoid possible changes in calibration.
- .2 Carry out tests for 8 hour period and maintain pressure with no appreciable pressure drop. Where leakage occurs, repair and re-test and pay necessary costs for re-witnessing.
- .3 During heating and cooling, steam and condensate piping system tests, check linear expansion at elbows, U-bends, expansion joints and offsets, for proper clearance. Restrain manufactured expansion joints during hydrostatic tests in accordance with manufacturer's recommendations.
- .4 When using water as test medium for system not regularly using water, evacuate and dehydrate the piping and certify the lines are dry following tests. Use agency specializing in this type of work.
- .5 Should tests indicate defective work or variance with specified requirements, make changes immediately to correct the defects. Correct leaks by remaking joints in screwed fittings, cutting out and rewelding welded joints, remaking joints in copper lines. Do not caulk.
- .6 Conduct all tests as work is completed and conditions permit, or on portions of systems as directed by consultant.
- .7 Visually check joints during tests for leakage of water test media or in systems with air or nitrogen tests check joints with soap bubble test.

1.30 HVAC Equipment Testing and Startup

- .1 Conduct performance testing of equipment and arrange for manufacturer's startup of equipment.
 - .2 Quality Assurance
-

-
- .1 Use factory trained representatives and submit manufacturer's check sheets for starting all systems and equipment.
 - .2 Prior to starting, testing, balancing, adjusting, and cleaning processes, verify with Engineer any tests required to be witnessed. Provide sufficient notice to Engineer prior to commencement of procedures.
 - .3 Engineer shall be allowed to witness any testing, adjusting, starting, balancing, and cleaning procedures.
 - .4 Assume all costs associated with starting and testing, including the supply of testing or cleaning medium.
 - .5 Prior to starting equipment or systems, secure and review manufacturer's installation, operation, and starting instructions. Read in conjunction with procedures defined herein.
 - .6 Use manufacturer's or supplier's starting personnel where required to ensure integrity of manufacturer's warranty.
 - .7 Compare installations to published manufacturer's data and record discrepancies. Items potentially detrimental to equipment performance shall be corrected prior to equipment starting.
 - .8 Some processes involved in starting procedures defined in this section may be duplications of authorities verification. To facilitate expedient completion of project, arrange for authorities to assist or witness these procedures.
 - .9 All starting, testing, and procedures shall be in accordance with applicable portions of ASME, ASHRAE, AABC, CSA, NFPA, SMACNA, ASTM, ASPE and as required and outlined in these specifications.
 - .10 Personnel involved in starting, testing, balancing and adjusting procedures shall be experienced in the design and operation of mechanical equipment and systems being checked and shall be able to interpret results of the readings and tests.
 - .11 Assume all liabilities associated with starting, testing and balancing procedures.

1.31 Demonstration and Owner's Instruction for HVAC Systems

- .1 Arrange for demonstration of HVAC equipment and systems operations.
 - .2 Arrange for instruction seminars for Owner's personnel.
 - .3 Comply with the requirements of Section 01 79 00 – Demonstration and Training.
 - .4 Quality Assurance
 - .1 The mechanical contractor shall arrange for sub-trades and manufacturer's representatives to be available for demonstrations and seminars.
-

1.32 Operation and Maintenance Manuals

- .1 Secure and assemble all necessary literature describing the operation and maintenance of all equipment provided. Complete and transmit documentation for review to Engineer at project milestones.
- .2 Quality Assurance
 - .1 Work specified shall be performed by an Independent Agency specializing in this type of work.
- .3 Approved Agencies
 - .1 The contractor is to submit a proposed agency for Consultant and Owner approval.

1.33 Certificate of Substantial Performance

- .1 Comply with Division 01:
 - .1 Cleaning Section 01 74 11
 - .2 Closeout Procedures Section 01 77 00
 - .3 Closeout Submittals Section 01 78 00
 - .4 Demonstration and Training Section 01 79 00
 - .5 Commissioning Section 01 91 00
 - .6 Commissioning (Cx) Plan Section 01 91 31
 - .7 Building Management Manual (BMM) Section 01 91 51
 - .2 In addition to the requirements of Division 00 and Division 01, and prior to application for a "Certificate of Substantial Performance" of the work, the contractor shall certify the following in writing to the Consultant:
 - .1 The systems are installed and suitable for operation for the purpose intended.
 - .2 Plumbing, heating, and ventilation systems are capable of operation with safety devices and alarm controls functional and automatic controls in operation and the Owners personnel have had their initial training programs.
 - .3 All equipment within mechanical rooms is installed.
 - .4 All thermal and acoustic insulation is installed.
 - .5 All static pressure tests are complete.
 - .6 All access doors are suitably located, and equipment easily accessible.
 - .7 All piping is installed, painted and clearly identified complete with flow arrows.
-

-
- .8 Systems are chemically cleaned, flushed, and water treatment initiated.
 - .9 Temporary filters are installed and fan plenums cleaned.
 - .10 All equipment is checked for operation, alignment amperage draw and rotation.
 - .11 Rough balance of air and water systems is completed and the reports have been submitted for review.
 - .12 All equipment is lubricated as per manufacturer's data.
 - .13 All valves are tagged and all equipment identified. Painting of equipment is completed and escutcheons are installed.
 - .14 All fans and equipment are installed and electrical connections made.
 - .15 All fire stop flaps, fire dampers, and smoke dampers are installed and checked for operation.
 - .16 All ducted supply/return/exhaust grilles are installed.
 - .17 All supply air, return air, exhaust air, fresh air, and combustion air ductwork is installed and cleaned.
 - .18 All plumbing fixtures are installed, solidly supported and in operation. Domestic water lines are flushed and disinfected.
 - .19 The building automation system seven (7) day acceptance test has been successfully completed.
 - .20 Noise and vibration control devices and flexible connections inspected by manufacturer's representative and written report submitted.
 - .21 All necessary tests and start-up procedures on equipment have been made, including those required by authorities.
 - .22 All contractor system start-up and test sheets have been completed and submitted for review.
 - .23 Warranty forms have been mailed to manufacturer. Provide copy of original warranty for equipment which has warranty period longer than one (1) year.
 - .24 Following information has been submitted:
 - .1 Final draft of O & M Manuals.
 - .2 Final certificates from authorities having jurisdiction.
 - .3 System cleaning reports.
 - .4 Reports from manufacturer on noise and vibration control devices.
-

-
- .5 Completed record drawings.
 - .3 Identify any systems which cannot be installed and/or placed in operation for reasons beyond the normal control of the contractors and submit a statement of the value of the remaining work required to complete the project.
 - .4 Within ten (10) days of receipt of a written application for a "Certificate of Substantial Performance", the Engineer shall visit the site.
 - .5 If, after the Engineer's site visit the application for a "Certificate of Substantial Performance" is not approved, the contractor shall reapply in accordance with the Engineer's site visit report and pay for costs of re-inspection services.

1.34 Certificate of Total Performance

- .1 Comply with the requirements of Division 00 and Division 01.
 - .2 Prior to application for a statement of "Total Performance", the Contractor shall certify the following in writing to the Engineer:
 - .1 All items noted in previous site visit reports including that performed for Substantial Performance have been completed.
 - .2 All controls have been calibrated and set.
 - .3 Equipment cleaned inside, outside and lubricated.
 - .4 All equipment has been aligned by qualified millwrights.
 - .5 Plumbing fixtures and brass have been cleaned.
 - .6 Warranty forms are mailed to manufacturer. (Provide copy of original warranty for equipment which has a warranty period of longer than one year).
 - .7 Temporary filters are removed and permanent filters are installed.
 - .8 Completed and accepted Operating and Maintenance (O & M) Manuals have been submitted to Owner.
 - .9 Completed and accepted final air and water Balancing Reports have been included in the O & M Manuals.
 - .10 The Owner has received instructions in the operation and maintenance of the system.
 - .3 Within ten (10) days after receipt of a written application for a "Certificate of Total Performance", the Engineer shall visit the site.
 - .4 The Engineer shall provide one (1) visit for the purpose of reviewing the application for a "Certificate of Total Performance". Subsequent visit(s) if required, shall be at the expense of the contractor.
-

1.35 Contract Price Breakdown

- .1 Submit a breakdown of the contract price using the following form within thirty (30) days of contract award and well before first progress claim for review and approval by Engineer.
- .2 Progress claims shall be submitted using this contract price breakdown.

	MATERIAL	LABOUR
1. Bonding		
2. Supervision		
3. Project Overheads: Shack, Telephone, etc.		
4. Documentation		
5. System Demonstration and Owners Instruction		
6. Materials Testing		
7. Equipment Testing and Start-Up (Commissioning)		
8. Balancing		
9. Pre-operational Cleaning and Chemical Treatment		
10. Plumbing		
• Fixtures		
• Piping & Valves		
• Miscellaneous Equipment (List)		
11. Ventilation & Air Conditioning		
• Make-up Air Units		
• Fans		
• Grilles & Diffusers		
• Ducts and Dampers		
• Miscellaneous Equipment (List)		
12. Insulation		
• Piping Insulation		
• Duct Insulation		
• Equipment Insulation		
13. Compressed Air System		
• Air Compressors		
• Piping		
• Miscellaneous Equipment (List)		

- Meters and Gauges
14. Duct Cleaning
15. Controls

MATERIAL	LABOUR

TOTAL (TO EQUAL CONTRACT PRICE)**2. Products****2.1 Operating and Maintenance Manuals****.1 Comply with Division 01:**

- | | | |
|----|----------------------------|------------------|
| .1 | Closeout Procedures | Section 01 77 00 |
| .2 | Closeout Submittals | Section 01 78 00 |
| .3 | Building Management Manual | Section 01 91 51 |

.2 Binders

- .1 Provide four (4) sets of Operations and Maintenance Manuals.
- .2 Each set of manuals shall include as many binders as required to accommodate the project information.
- .3 Binders shall be 216mm (8½") x 280mm (11"), three (3) post, expanding spine type, with metal piano hinges and bound with heavy fabric.
- .4 Maximum binder thickness when filled shall not exceed 100mm (4"), including a space allowance for 10% additional data.
- .5 Binder color shall be blue, Ontario buckram fabric, color #OBV460.
- .6 Project title and identification shall be silk screened on the front cover and spine. All lettering and borders shall be white.
- .7 Binder spine identification to include Volume #, Set #, Title Description, Facility Name and Facility Location. Title of the project is to be as per title on drawings cover sheet.
- .8 Contractor to submit proof of cover layout for review prior to ordering binders.
- .9 In addition to the hard copies, an electronic version of the Operating and Maintenance manuals are to be provided in PDF on a CD.

.3 Tabs

- .1 The divider tabs shall be laminated mylar plastic and colored according to division and section.
- .2 Plastic tabs with typewritten card inserts will not be accepted.
- .3 Each tab to include tab number and title printed on the tab.
- .4 The coloring for tabs for individual sections is as follows:

Green:	Air Systems
Brown:	Control Systems
Yellow:	Miscellaneous Systems
Purple:	Plumbing Systems

.4 Manual Divisions

- .1 Organize each manual into the following divisions.
 - .1 Operation Division
 - .2 Maintenance Division
 - .3 Contract Documentation Division

.5 Operations Division

- .1 The operations division shall have all data organized into sections according to the system category with individual divider tabs as follows:
 - .1 AIR - Air Systems
 - .2 CTL - Control Systems
 - .3 MIS - Miscellaneous Systems
 - .4 PLG - Plumbing Systems
- .2 Organize data for each system category (section) into individual sub-systems. Provide an index for each system category and a divider tab for each individual system.
- .3 For each individual sub-system include the following:
 - .1 System Description - Provide details of system type, composition, areas served, location in the building, design criteria and function of major components. All equipment arranged to operate together as one system shall be considered part of that system description. Design criteria shall, at minimum, include the following:

-
- .1 Occupied space conditions
 - .2 Outdoor ambient conditions
 - .3 Air circulation rate
 - .4 Exhaust air rate
 - .5 Minimum outside air
 - .6 Building pressurization
- .2 System Schematics - Provide a system schematic showing all components comprising the central system. Identify each component using DDC system mnemonic and generic name designation. Use this equipment designation in all references to the equipment throughout the manual.
- .1 System schematics shall include at a minimum:
 - .1 Ventilation systems
 - .2 Compressed air system
 - .3 Operating Instructions - Provide, in "operator" layman language, the specific instructions for start-up, shutdown and seasonal change over of each system component. Include exact type and specific location of each switch and device to be used in the system operation. Identify safety devices and interlocks that must be satisfied in order for the equipment to start. Also, list conditions to be fulfilled before attempting equipment start-up, i.e. valves position correct, glycol mixture concentration proper, piping filled with fluid, filters/strainers in place, etc.
 - .4 Equipment Identification - Provide data for each system component on equipment identification forms equal to the standard forms obtained from the design consultant.
 - .1 The consultant shall provide one sample reproducible copy of a form for use by the contractor. New forms produced by the contractor shall follow the same format as the sample form and contain all required information.
 - .5 Maintenance Division
 - .1 Organize data into the following sections with divider tabs:
 - .1 Maintenance Tasks and Schedules
 - .2 Spare Parts
 - .3 Suppliers and Contractors
-

-
- .4 Tags and Directories
 - .2 Maintenance Tasks and Schedules - Organize data according to the system category, with further breakdown into individual systems as used in the operations division of the manual. Provide section index and divider tabs for each system category. Summarize maintenance tasks from manufacturers maintenance brochures, for each component of each system in the following format:
 - .1 Daily
 - .2 Weekly
 - .3 Monthly
 - .4 Semiannually
 - .5 Annually
 - .6 When Required.
 - .3 Spare Part List - Organize data according to the system category, with further breakdown into individual systems as used in the operations division of the manual. Provide section index and divider tabs for each system category. Summarize from manufacturers maintenance brochures the recommended spare parts for each component of each system.
 - .4 Suppliers and Contractor List - Provide summary of Suppliers and Contractors for each components of each system. List name, address and telephone number of each.
 - .5 Tags and Directories - Provide a copy of the Mechanical Drawing, List, Valve Tag List, Piping Identification Schedule and all other directories as specified in the contract documents.
 - .6 Contract Documentation Division
 - .1 Organize all data required by the construction contract into sections, with divider tabs, as follows:
 - .1 Drawings List
 - .2 Shop Drawings and Product Data
 - .3 Certifications
 - .4 Warranties and Bonds
 - .5 Maintenance Brochures
-

.6 Reports

- .2 Shop Drawings and Product Data - Provide final copies of all shop drawings and product data required by the contract documents. Include section index and divider tabs. Maximum of twenty-five (25) sheets or one (1) system shop drawing per tab.
- .3 Certifications - Provide copies of Contractor Certifications for the performance of product and systems. Include copies of all pressure tests for piping and ductwork systems, equipment alignment certificates, local authority inspection reviews, backflow prevention certification, and fire protection certifications. Include section index and divider tabs with maximum of twenty-five sheets (25) or one report per tab.
- .4 Warranties and Bonds - Include one copy each of the Contractor's warranty, manufacturers' warranties longer than one year, the bond, and any service contract provided by the contractor. Provided section index.
- .5 Maintenance Brochures - Include copies of all manufacturers' printed maintenance brochures pertaining to each product, equipment or system. provide section index and divider tabs. Maximum of twenty-five (25) sheets or one system brochure per tab.
- .6 Reports - Include copies of all reports relating to the testing, adjusting and balancing of equipment and systems, water treatment reports and manufacturer's start-up reports, as required by the contract specification sections.

.7 Submissions and Approvals

.1 First Draft Submission

- .1 Contractor shall submit a draft copy of the operations and maintenance manuals for format review at the 50% construction completion stage.
 - .2 The draft submission is to be bound in 3 ring loose leaf type binders and shall include the following information:
 - .1 A table of contents for the complete manual.
 - .2 Index of each division of the manual.
 - .3 Index of each section of the operations and maintenance divisions.
-

.4 A sample operations division write-up for a typical system, including sample schematic.

.5 A sample maintenance division write-up for the same typical system.

.6 Sample proof of binder covers and spines.

.3 On completion of review of the first draft submission the consultant will return the copy of the manual with review comments for resubmission.

.2 Provisional Edition

.1 The contractor shall submit two (2) copies of the provisional edition of the manual at the 75% construction completion stage.

.2 The provisional edition shall be complete in all respects, except for reports and certificates to be produced during the facility start-up phase. This manual shall have the same physical format, including divider tabs and indices, as the final edition of the manual. This provisional edition may be bound in standard three-ring loose leaf binders.

.3 One copy of the provisional edition shall be kept on site as an interim reference for all parties engaged in the facility start-up phase, and shall be used to familiarize and train the operating staff.

.4 The second copy shall be returned to the contractor with review comments.

.5 The contractor shall update contents of the site copy of the provisional edition manual as new information is generated during the facility start-up phase.

.3 Final Edition

.1 Prior to final acceptance the contractor shall submit four (4) copies of the final edition of the manual.

.2 This final edition shall include all outstanding project information and conform to all requirements listed in this document.

3. Execution

3.1 Demonstrations – General

- .1 Mechanical Trade shall arrange for presentation and demonstration of HVAC equipment and systems by appropriate specialists and shall ensure that required manufacturer's representatives are in attendance.
- .2 Coordinate demonstration and instruction agenda and schedule with the Owner and Engineer.
- .3 Coordinate demonstration and instruction agenda and schedule for work performed outside the contract with the owner and engineer.
- .4 Provide personnel when necessary to ensure proper detailed training is provided for all mechanical systems.
- .5 Do not commence the instructional period until all mechanical systems are complete and proven operational.
- .6 Include in the operating and maintenance manuals all instructions and information given to owner's staff and instructions and information given by equipment manufacturer's representatives.

3.2 Demonstrations – Equipment & Systems

- .1 Demonstrate specific starting and stopping and general maintenance requirements for each major piece of equipment. Ensure all labeling and identification is completed.
 - .2 Demonstrate the following systems, in the form of instruction seminars and contractor-guided tour of the facility.
 - .1 Air Systems
 - .2 Control Systems
 - .3 Balancing
 - .4 Plumbing Systems
 - .3 Demonstrate the following pieces of equipment.
 - .1 Fans/Makeup Air Units
 - .4 Refer to sample mechanical system agenda schedules in section 3.3 following for identifying the proposed sequence of demonstrations. Sequence of demonstration and duration of training seminars to suit project. Submit agenda for review by Engineer one month prior to demonstration.
 - .5 Answer all questions raised by Owner at demonstrations; if unable to satisfactorily answer questions immediately, provide written response within three (3) days.
-

-
- .6 Provide sign off sheets for each session. Sign off sheets to have attendees, date, subject, presentation by and comments. Attach the sign off sheets to the agenda and submit a copy to the engineer following training seminars.

3.3 Mechanical Systems Agenda (Sample)

Mechanical Systems Agenda

Topic: Heating System

Day: 1. Start Time: 8:00 am

2. Meeting Place: _____

Approximate Duration: 7.5 hours

Agenda: 1. 8:00am – Classroom Presentation

2. Contractor / Supplier: _____

Lunch Break: 12:00pm to 1:00pm

Agenda: 1. 1:00pm – Site Walkthrough

2. 4:00pm – Final Questions and Sign-off Log Sheet

Personnel to be in Attendance:

1. Mechanical Contractor and Sub-Trades (as required)

2. Maintenance Staff

Presentation Format:

Classroom:

Introduction:

1. Pass out hand-outs of system description
2. Reference to equipment operation brochures as required
3. Detailed system overview by Mechanical Trade, Sub-Trades and Suppliers
4. Review of system installations by the Mechanical Trades using record drawings

Site Tour:

1. Mechanical Trade to outline location of main piping runs, isolation valves, service access points.
 2. Review service procedures for heating boiler and circulation pumps.
 3. Terminal hot water heating units to be reviewed for service and operation.
-

4. Coils, expansion tanks and accessories to be reviewed for service and operation.
5. Equipment to be reviewed and dismantled as required to demonstrate servicing.
6. Gas Fired equipment to be reviewed and dismantled as required to demonstrate servicing and operation.
7. Provide written instructions on how to start and stop all equipment and demonstrate using instructions during tour.

3.4 HVAC Equipment Testing and Startup – General

- .1 Conduct performance tests to demonstrate equipment and systems meet specified requirements after mechanical installations are completed and pressure tested. Conduct tests as soon as conditions permit. Make changes, repairs, and adjustments required prior to operating tests.
- .2 Meet with Division 26 manufacturers, suppliers, and other specialists as required to ensure all phases of work are properly coordinated prior to commencement of each particular testing procedure. Establish all necessary manpower requirements.
- .3 Gas fired appliances rated in excess of 17 kW (400 MBH) shall be subjected to an operational test established by the Gas Protection Branch and shall pass this test before being approved for operation.
- .4 Operate and test motors and speed switches for correct wiring and sequences and direction of rotation. Check and record overload heaters in motor starters.
- .5 Confirm voltages and operating amperages at full load.
- .6 Tests to be maintained for a period of eight (8) hours minimum for each system. Test for air and water flow and temperature and humidity to demonstrate compliance with design requirements.
- .7 During test, make adjustments to bring equipment up to the required standards with respect to performance, vibration, noise, etc.
- .8 Conduct final operating tests in presence of the owner. Vary loads to illustrate start-up and shut down sequence and simulate emergency conditions for safety shut downs, with automatic and manual reset. Repair and test defects until satisfactory. Make final adjustments to suit exact building conditions.
- .9 Provide services of one job mechanic, ladders, tools and associated equipment required to assist in final tests. Owner's personnel may witness all tests.
- .10 Lubricate bearings, adjust and/or replace and set direct and 'V' belt drives for proper alignment and tension.
- .11 Calibrate and adjust thermostats, thermometers and gauges. Control valves shall operate freely.

-
- .12 Operate and test motors for correct wiring and sequences. Check overload heaters in motor starters are within the constraints of Division 26 requirements. Replace heaters if required to suit as installed condition.
 - .13 Remove and clean strainers.
 - .14 Fasten loose and rattling pieces of equipment. Pumps and other equipment shall operate quietly.
 - .15 Failure to follow instructions pertaining to correct starting procedures may result in re-evaluation of equipment by an Independent Testing Agency selected by Owner at Contractor's expense. Should results reveal equipment has not been properly started, equipment may be rejected, removed from site, and replaced. Replacement equipment shall also be subject to full starting procedures, using same procedures specified on the originally installed equipment.

3.5 HVAC Equipment Testing and Startup – Procedures

- .1 Procedure shall be identified in the following five (5) distinct phases:
 - .1 Pre-Starting: Visual inspection.
 - .2 Starting: Actual starting procedure.
 - .3 Post-Starting: Operational testing, adjusting or balancing, and equipment run-in phase.
 - .4 Pre-Interim Acceptance of the Work: Final cleaning, re-testing, balancing and adjusting, and necessary maintenance.
 - .5 Post-Interim Acceptance of the Work: Repeat tests and fine-tuning resulting from corrective action of deficiency clean-up.
- .2 Check specified and shop drawing data against installed data.
- .3 Check the installation is as defined by contract documents and as per manufacturer's recommendations including manufacturer's installation check sheets.
- .4 Include for the costs of an independent testing agency, selected by the Owner, to take samples of all chemically treated hydronic systems, perform lab analysis of the chemical treatment levels, and submit a written report of their findings to the Owner. Should chemical treatment levels not meet the requirements of the specifications, the Contractor shall adjust treatment levels accordingly and cover the costs of the independent testing agency to take additional samples and tests.

3.6 HVAC Equipment Testing and Startup – Contractor Testing Responsibilities

- .1 The contractor shall be required to provide the following tests as part of his construction contract. For each test, a test form is to be filled out, witnessed, kept on site for the
-

consultant to verify at any time during construction and then they are to be included in the final submission of the contractor O & M manuals.

.1 Plumbing Systems

.1 Piping

- .1 Test as per the requirements of the National Plumbing Code 2010.

.2 Air Compressors

.3 Air Systems

.1 Fans

- .1 Check radiated and discharge sound power levels
- .2 Determine rpm, air flow rates, static pressure and record on the fan curves
- .3 Conduct fan performance test for total system volume on main air supply and exhaust units
- .4 Conduct smoke control test to meet occupancy requirements

.2 HEPA Filters

- .1 Test as per standard 209B, 209D and DOP

.3 Air Outlets

- .1 Take sound readings at specified air flows at outlets

.4 Fire Dampers

- .1 Test each damper to ensure proper blade movement and damper closure
- .2 Verify damper accessibility for changing of the fusible links

.5 Ductwork

- .1 Low pressure supply, return and exhaust ductwork is to be pressure tested as per requirements of Section 23 31 13.
- .2 Medium and high pressure supply, return and exhaust ductwork is to be pressure tested as per requirements of Section 23 31 13.

.4 DDC Control System

.1 General

- .1 Conduct system 7 day performance test to prove communication, loop tuning and control sequences

.2 Variable Frequency Drives

- .1 Test as per the requirements of Section 23 05 04 – Variable Frequency Drives for HVAC Equipment.

END OF SECTION

1. General

1.1 Scope

- .1 This section includes the supply, installation, start-up, testing and commissioning for variable frequency drives (VFD) controllers, including but not limited to: associated enclosures, input and output filters, warranty, local and remote control.
- .2 The VFD and all specified components, including internal wiring between those components, must be installed and integrated into one common enclosure, supplied, factory tested, and commissioned by the VFD supplier. The integrated VFD assembly shall be ready for field installation and require only the connection of the incoming power cables, the motor load cables, and the control wiring for start-up, and the commissioning of the VFDs.
- .3 The VFD supplier must coordinate with the installation contractor with respect to delivery dates, technical support for the installation, equipment start-up, and the commissioning of the VFDs.
- .4 All drives and ancillary components specified in this section to be supplied by one manufacturer to assure a properly coordinated system.
- .5 Design all equipment using modularized solid state equipment to allow easy maintenance and replacement.

1.2 Submittals

- .1 Comply with the requirements of Section 23 05 00 – Common Work Results for HVAC.
 - .2 Provide the following shop drawing information:
 - .1 Catalog and technical data.
 - .2 Outline dimensions, shipping section dimensions, weight, and foundation requirements for all assemblies.
 - .3 Physical details of the cabinets, a wiring diagram, and a ladder diagram showing both internal connections and terminals for field wiring, showing function and identification of all terminals requiring field connections. Separate diagrams are required for each VFD size. Generic diagrams are not acceptable.
 - .4 Component fabrication drawings consisting of detailed circuit schematics, indicating all components in the VFD package, including line and load reactor impedance ratings and/or filter design type, VFD current, HP and voltage rating.
 - .5 Bolt and lug torque schedule for all power and control wiring termination points.
 - .6 Vendor's start-up sheets for the drive.
-

-
- .3 Upon delivery, provide as-built shop drawings for each unit. A copy of the as-built shop drawings shall be provided for each drive in addition to one set of drawings for each copy of the O&M Manuals. (See info in the project specifications and drawings for quantities in addition to that indicated herein, the quantities shall be the maximum indicated plus 1 copy for each drive).
- .4 Supply four (4) copies of Operation and Maintenance manual containing data for each VFD. Data shall include:
- .1 Troubleshooting charts for all device faults.
 - .2 An instruction manual for: programming and the hardware provided with the equipment at time of shipment.
 - .3 Manufacturer's start-up check sheet(s) with list(s) that outline all of the completed tasks. Check-sheets are to contain actual start-up data and shall list all settings and parameters present in the drive unit as commissioned.
 - .4 VFD field-test measurement results. All data provided shall be that from the last testing conducted on the drive. If original testing was redone, then the new data shall be provided in addition to the original data. Original tests must then be marked "Superseded. For Information Only". All test data shall be dated and signed".
 - .5 Settings sheets to record all VFD configuration options and selections for VFD set-up. Settings sheets are to contain actual start-up data and shall list all settings and parameters present in the drive unit as commissioned.
 - .6 Include a list of authorized recommended spare parts, service depots, spare parts list.
- .5 Provide copies of the VFD programming / troubleshooting software, as well as any connection cables required, to Owner. Provide one set of software and cabling, for each size of drive, for each O&M manual provided.

1.3 Delivery & Storage

- .1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.4 Waste Management and Disposal

- .1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.5 Related work specified in other sections

- .1 Common Work Results for HVAC Section 23 05 00
- .2 Common Motor Requirements for HVAC Equipment Section 23 05 13
-

-
- | | | |
|----|---|------------------|
| .3 | Testing, Adjusting and Balancing for HVAC Systems | Section 23 05 93 |
| .4 | Electrical | Division 26 |

1.6 Standards

- .1 VFD units shall be ULC listed and CSA (or cUL) certified.
- .2 VFD units shall comply with applicable requirements of the latest standards of CSA, ANSI, IEEE 519, NEMA MG1 and the Canadian Electrical Code.

1.7 Intended operation

- .1 The VFD shall be designed to operate standard squirrel cage induction motors with a 1.0 service factor meeting NEMA MG1 Part 31. Refer to Section 23 05 03 – Electric Motors – 600V or less.
- .2 The VFDs shall control one of more fan motor(s) or pump motor(s) as listed in the drawing schedules.
- .3 The VFD shall communicate with, and be controlled by, the building automation system (BAS) which will provide Run Command and an Operating Speed reference to the VFD. VFD Run Status, Operating Speed, Load Amps, Power and Alarm or Fault data shall be communicated back to the BAS. The VFD shall also be capable of operating in PID Mode with the Run Command and PID Set Point communicated by the BAS. A process monitoring transmitter (supplied by the controls contractor) will be connected directly to the VFD. Refer to Controls, Sections 23 09 Series.
- .4 Communication with the BMS shall be BACnet MSTP over EIA-485.

1.8 Factory Testing

- .1 Prior to shipment, all VFD units are to be shop-tested at the factor or at the VFDs OEM/integrator's facilities. Testing shall include, but will not be limited to, a complete functional test to fully prove out the VFD and all the local and remote control functions and required parameter settings. Phase-loss protection for each of the 3 phases of the VFD shall be proven as part of the factory testing.
- .2 Provide factory-certified copies of production test results to the Engineer prior to shipment of the equipment.

1.9 Harmonic Guidelines

- .1 All VFD installations shall meet IEEE-519-1992 harmonic guidelines.
 - .2 Following award of contract, and prior to submitting shop drawings, the VFD vendor shall review the electrical system design and MCC locations and advise if filtering, in addition to the specified line reactors, is required.
-

1.10 Warranty

- .1 The VFD supplier shall provide warranty coverage for a minimum period of twelve (12) months commencing upon the date of substantial completion. Refer to Division 0 and Division 1.
- .2 The Vendor shall be responsible to bring a Factory Representative back to reset, repair, and re-commission the VFD if problems arise with the normal operation of that VFD during the warranty period.

1.11 Maintenance

- .1 VFD supplier is to include a preventative maintenance program (PMP) for a one year period. The PMP is to be broken down to daily, weekly, monthly and annual service periods. Each service period is to include all manufacturer recommended maintenance tasks which should be completed in each period. A maintenance checklist is to be cross referenced to the maintenance period and maintenance task.

1.12 Training

- .1 Provide an on-site, half day training seminar for maintenance and service personnel.
- .2 The VFD supplier shall detail an agenda for the training to be provided and to present it to the Engineer for review and adjustment. Refer to Section 23 05 06 – Demonstration and Owner’s Instruction for HVAC Systems.
- .3 The Vendor shall comply with the Engineers requests for modification of the content to suit its needs within the four (4) hour time allowance. The training agenda shall be provided four (4) weeks prior to the drive start-up, and the VFD Supplier shall schedule the timing & location of the seminar at a time and location suitable to the Engineer.
- .4 Refer to and comply with Section 20 05 06, Systems Demonstration and Owner’s Instruction.

2. **Products**

2.1 Section Includes:

- .1 Approved VFD Suppliers and Product
 - .2 Vendor Requirements – Service and Support
 - .3 General VFD Requirements
 - .4 Environmental Capabilities
 - .5 Input Power
 - .6 Output Power
-

-
- .7 Equipment Protection
 - .8 Approved Filter Manufacturers
 - .9 Integrated VFD Equipment Enclosure
 - .10 BACnet
 - .11 PID Control
 - .12 Control and Operational Features
 - .13 Drive Control (Hand operation)
 - .14 Drive Controls (Auto Operation)
 - .15 Isolated Bypass Operation
 - .16 Drive Parameter Settings
 - .17 Diagnostics
 - .18 Drives Connected to Emergency Power System
 - .19 Wiring and Identification

2.2 Acceptable Products

- .1 Variable Frequency Drive (VFD) as supplied by:
 - .1 ABB
 - .2 Cutler Hammer
 - .3 Danfoss
 - .4 General Electric
 - .5 Siemens
 - .6 TECO-Westinghouse
 - .7 Mitsubishi (MGI)

2.3 vendor requirements – Service and Support

- .1 The drive vendor must provide a factory-trained sales force locally available for applications assistance and to answer maintenance questions.
-

-
- .2 The vendor must have a distributor organization, which locally stocks standard drives, modification kits, and spare parts.
 - .3 The vendor must have factory-trained service representatives within the local Edmonton area. The factory representatives must be trained in the maintenance and troubleshooting of the equipment as specified herein.
 - .4 Vendor must provide regularly scheduled maintenance and training schools in Canada on the equipment supplied

2.4 General VFD Requirements

- .1 All units shall be ULc or CSA approved.
- .2 VFD unit shall comply with applicable requirements of the latest standards of CSA, ANSI, IEEE, NEMA, and the Canadian Electrical Code.
- .3 Unless otherwise noted, all horsepower/kW ratings are to be based on a Variable Torque load.
- .4 VFD shall be provided with a CSA (NEMA) Type 1 enclosure.
- .5 The VFD shall be rated for continuous duty while operating a NEMA design induction motor of the sizes and operating voltages as shown in the applicable schedules and indicated on the drawings.
- .6 The VFDs shall have a current rating at least 10% in excess of the motor full load amp rating. When subject to the range of ambient conditions, the VFD to be capable of delivering 110% of rated output current for up to one minute for variable torque loads
- .7 The VFD shall have a fixed bridge type converter (PWM) utilizing Insulated Gate Bipolar Transistor (IGBT) technology.
- .8 VFD operation to be fully digital with microprocessor control of frequency, voltage, and current.
- .9 Efficiency of VFD controller shall not be less than 97.5% at 60 Hz output at 100% rated load.

2.5 Environmental Capabilities

- .1 The drive shall operate without mechanical or electrical damage under any combination of conditions as follows:
 - .1 Ambient temperature: 0° to 40°C (32°F to 105°F)
 - .2 Humidity: 5 to 95% (non condensing)
 - .3 Vibration: up to 0.5 G
-

-
- .4 Altitude: 0 to 1200m (0 ft to 3940 ft); For altitudes above 1200m (3960 ft), the equipment must be properly de-rated such that the higher altitude rating is greater than the required output.
 - .5 The VFD unit may require fan-assisted cooling to ensure adequate heat dissipation. Such a system shall be installed in a manner that does not degrade the enclosure rating. Provide alarm status and shut-down for the VFD, on excessive temperature rise in the enclosure, for VFDs that utilize forced air fans for enclosure cooling.

2.6 Input Power

- .1 Input voltage shall be as indicated on motor schedules and drawings, line voltage variation ($\pm 10\%$), 3 phase, 60 Hz, grounded power supply without high or low line tripping. Confirm voltage before ordering.
 - .2 The VFD must be capable of operating under the following conditions without high or low line tripping: 3 phase, 60Hz, alternating current, grounded power supply, line voltage as shown (240,480, 600) $\pm 10\%$. Speed stability shall be $\pm 1\%$.
 - .3 Permit power line interruptions for high inertia loads such as fans and centrifuges for at least 2.0 seconds without the VFD shutting down on a fault providing an extended power loss ride-through. If the drive trips on undervoltage, the drive will activate the Automatic Restart. See "Rotating Start" clause 2.13.17.
 - .4 The VFD shall present a displacement power factor of 0.98 or better to the AC line over 10% to 100% speed range. Full load effective power factor shall be 96% or better.
 - .5 The VFD must operate satisfactorily when connected to a bus supplying other solid state power conversion equipment which may be causing up to 5% total harmonic voltage distortion and communication notches up to 36,500 volt microseconds.
 - .6 Normal power distribution is subject to voltage surges and sags as a normal condition of operation. Design and supply with each VFD the required inverter protection such that the VFD will not be stressed or damaged, in the following conditions:
 - .1 Line surges of up to 115% of rated voltage for up to 10 cycles. Based on 347/600 Volt systems.
 - .2 Line voltage sags down to 85% of rated voltage of up to 1 second duration.
 - .7 Provide a 5% impedance line reactor at in the drive input to protect electronic components from transient voltage conditions and to reduce harmonic current distortion.
 - .8 The VFD must not be sensitive to supplied power that has one phase grounded (Delta – with balanced voltages) or referenced to earth ground (Wye).
 - .9 The VFD must not be sensitive to incoming phase sequence.
-

-
- .10 VFDs shall be of the 6-pulse PWM- type complete with an external AC line reactor to reduce harmonic current distortion.

2.7 Output Power

- .1 The VFD shall produce a 3 phase output for motor loads.
- .2 Pulse-Width Modulating (PWM) circuitry must consist of a full wave diode bridge converter to convert incoming fixed voltage and frequency to a fixed DC voltage. The Pulse Width Modulation strategy shall incorporate a microprocessor to handle all Logic functions as well as the complex, sine-coded PWM generating algorithms that control output stage switching.
- .3 Generate the inverter output by IGBT power transistors only.
- .4 The VFD output waveform to be the PWM or Vector type waveform producing smooth torque at low frequencies and low motor current harmonics.
- .5 Harmonic loading shall not exceed the maximums acceptable for motor operation with a service factor of 1.0.
- .6 The VFD output voltage shall be user-adjustable to deliver voltage from 0 V to full voltage at 60 Hz.
- .7 The VFD shall be provided with user-adjustable settings to provide a frequency range of 0 to 120 Hz.
- .8 Unless otherwise specified, the VFD output voltage to be adjustable from 0 to full voltage reaching full voltage at 60 Hz.
- .9 Provide selectable constant V/Hz ratio PWM or variable V/Hz for Variable Torque loads.
- .10 The VFD must maintain capability for 100% of rated output current continuously, regardless of change in ambient conditions throughout its listed ambient conditions range.
- .11 PWM carrier frequency shall be user-selectable.
- .12 Manufacturer to indicate, at time of tender, the anticipated levels of electrical noise and heat generated. In any case, the Audible noise levels to be less than 85 dbA at 1 m out from any point on the VFD cabinet under normal operating condition, with the drive at full load.
- .13 Radio Frequency Interference (RFI) must be limited to levels specified in applicable standards. Equipment must be designed that use of radio communication equipment adjacent to VFD units is permissible. In addition, the VFD must not be susceptible to interference from radio equipment operated adjacent to it.
-

2.8 Equipment Protection

- .1 Protective devices to be incorporated are:
- .1 Three-pole fused disconnect switch to provide over-current protection with fuses rated at not more than 150% of drive input current rating, except if the VFD is specifically marked with a recommended rating for its over-current protection, then the VFD marking shall take precedence.
 - .2 The operation of the disconnect switch shall be interlocked with the VFD enclosure door. It shall not be possible to open the door without the disconnect being in the open position. A manual means to defeat this interlock for maintenance purposes shall be included, and the external operator handle for the switch must have lock-out capability.
 - .3 The symmetrical short-circuit interrupting rating shall be verified for every installation, and be coordinated with the VFDs electronic protection circuits. VFD supplier is responsible to obtain SSCIR information from the designer or design documents for the VFDs being constructed for the project.
 - .4 Integral electronic motor overload protection adjustable up to 150% of motor rating for 60 seconds.
 - .5 Ground fault protection.
 - .6 Over-voltage/over-current DC bus monitor/protection.
 - .7 Under-voltage protection, 85% of rated input voltage.
 - .8 Loss of phase and phase unbalance protection.
 - .9 Inverter over-temperature protection.
 - .10 Motor overload protection, adjustable 80 to 115% of FLA of motor.
 - .11 Where bypass contactors are utilized or where the VFD serves several motors, provide external dial adjustable motor overload protection relays with inherent single-phase protection. The current range of the overload block shall be selected to place the full-load current of the motor at approximately the centre of the dial scale for the supplied overload relay.
- .2 Include provision for adequate grounding within the equipment in addition to that provided to safeguard against electrostatic discharge damage.

2.9 Approved Filter Manufacturers

- .1 All applications with non-VFD or VFD rated motors shall require output dv/dt filters. The following manufacturers of filters are acceptable.
-

.1 TCI

.2 MTE

2.10 Integrated VFD Equipment Enclosure

- .1 The integrated VFD assembly, including all components shall be provided as a ventilated CSA (NEMA) Type 1 enclosure, with a hinged, gasketed door and a drip-shield constructed to project over the door and sized to protect all ventilation openings in the top of the enclosure (if any) from dripping water. It shall be suitable for wall or free-standing installation.
- .2 Supply full-length painted 100mm steel channels for floor-mounted VFD enclosures.
- .3 Where house-keeping pads are provided, the channel bases are not required. Where a drive is placed on top of a housekeeping pad, base construction shall be such that the door of the VFD will not drag on the house-keeping pad.
- .4 Forced air cooled enclosures shall have filters on all air inlet openings.
- .5 The backspan to be galvanized metal, non-painted, 16 gauge for EMC bonding requirements. Provide a minimum of 2 lugs for bonding conductors (sized per CEC). Lugs shall be bolted to the galvanized metal back-pan.
- .6 Door shall be grounded with multi-conductor or braided ground strap connecting the door to the grounding system in the enclosure interior.

2.11 BACnet

- .1 The VFD shall communicate with a building automation system (BAS) network by digital communication using the BACnet MSTP protocol (ANSI/ASHRAE Standard 135-2004) over EIA-485.

2.12 PID Control

- .1 Provide process controller circuitry incorporating a PID algorithm to control the frequency output of the VFD.
- .2 Input for the process controller shall be one of the analog input signals specified below (clause 2.13.1).
- .3 Set-point shall be reset, as selectable parameter, either by using the digital communication network or by using the second analog input signal.

2.13 Control and Operational Features

- .1 Provide two analog inputs that are both capable of receiving an input signal, user-selectable as either 4-20 mA or 0-10 Vdc. Provide individual optically isolated inputs for each analog signal.
-

-
- .2 Process Signal Inverter: Provide programmable control to allow speed of drive to vary inversely with input analog signal.
 - .3 Provide two analog outputs, individually isolated, either 0-10 Vdc or 4-20 mA, which can be programmed to be proportional to any two of the following:
 - .1 Output frequency
 - .2 Output power
 - .3 Output current
 - .4 Provide input for external switch to be used as a proof-of-open interlock for associated damper or valve.
 - .5 Provide a dry contact (output) for interlocking external devices such as signal to open a damper or valve of associated the equipment.
 - .6 Provide dry-contact output to signal VFD fault.
 - .7 The VFD shall be capable of operating with its output open-circuited (no motor connected), with no fault or damage, for start-up and testing purposes. The drive must be capable of running without a motor connected.
 - .8 All VFD set-up operations and adjustments to be digital and stored in a non-volatile memory (EEPROM).
 - .9 Local communications port: Provide a local interface to upload, download, and read drive parameter settings, through the use of a notebook computer. Include Windows based software for computer on CD-ROM(s) with all associated operating instructions. Software information shall be provided with the O&M manuals.
 - .10 Provide offset and gain programmable functions to set operating range.
 - .11 The VFD shall employ a programmable rate of acceleration and deceleration, either linear or S-curve. The VFD shall “coast” to a stop or new lower speed, if selected by the user.
 - .12 Speed Droop: Provide a speed droop feature that reduces the speed of the drive on transient overloads. The drive is to return to set speed after transient overload is removed. If the acceleration or deceleration rates are too rapid for the moment of inertia of the load, the drive is to automatically compensate to prevent drive trip.
 - .13 Speed Profile: Provide individual adjustable settings for start, stop, slope, and minimum and maximum speed points.
 - .14 Bumpless speed transfer: Provide a smooth speed transfer from remote control to local control and vice-versa, without setting the motor to zero speed.
-

-
- .15 Automatic Reset and Restart: Provide automatic restart of rotating equipment following power outage. Provide programmable automatic reset / restart after any individual trip condition resulting from over-current, over voltage, under voltage, or over-temperature.
 - .16 Re-start attempt limit: for safety, the drive shall shut down and require manual reset if the automatic reset function is not successful within a maximum of three attempts within a user-programmed time period.
 - .17 Pick up a spinning-load (Rotating Start): The VFD shall be user-programmable for rotating re-start, enabling the VFD to start into a rotating motor, regardless of direction, without tripping offline and without setting the motor to zero speed. The VFD shall start at the speed the motor is rotating and then accelerate the motor according to the speed reference signal. After the VFD trips due to under-voltage and whenever any momentary power loss occurs, the drive must activate an automatic restart mode (re-initiate and re-start) without waiting for the rotating equipment to stop, and without operator intervention.
 - .18 Torque Compensation: Provide user-programmable automatic boost in torque to handle impulse loads or demands for fast acceleration by momentarily increasing the output volt / hertz ratio. When selected, the function to be operative at all speeds even under overload conditions, and eliminates the motor speed droop that would otherwise occur.
 - .19 Provide adjustable skip frequencies with programmable bandwidth to avoid operation in a resonant speed area. Provide a minimum of 3 such frequency selections.

2.14 Drive Control (Hand Operation)

- .1 Provide an operator station on the drive door complete with the following features as a minimum. The following applies to a VFD with Bypass capability. Adjust requirements as applicable for VFDs without a Bypass starter.
 - .1 Control Switches
 - .2 Selector switch No. 1: "HAND-OFF-AUTO" operation.
 - .3 Selector switch No. 2: "VFD ENABLED -OFF -BYPASS ENABLED" operation.
 - .4 Potentiometer for local speed adjustment in VFD mode.
 - .2 Pilot lights on door
 - .1 Input Power: "ON" pilot light
 - .2 VFD Status: "STOP" and "RUN" indication
-

2.15 Drive Controls (auto Operation)

- .1 The VFD to accept an isolated output signal via the Building Management System to stop and start the drive.
- .2 The VFD to have the capability to interlock of up to 3 NIC external alarm interlocks to shut down the VFD and provide status of the trip.
- .3 The VFD to provide two (2) programmable Form C dry contact status outputs. Status of contacts to indicate:
 - .1 Run
 - .2 Fault
- .4 Controller "stop" interlock from a NC dry contact.
- .5 The VFD to accept an isolated analog input speed reference of 0 to 10 VDC or 4-20 mA from the field. The 4-20 mA analog input speed reference signal shall be optically isolated. Calibration adjustments shall be provided for settings within the speed ranges specified.

2.16 Isolated Bypass Operation (where specified on equipment schedule(s))

- .1 Provide for an automatically controlled three-contactor isolated bypass control, integral to the VFD enclosure.
 - .2 Coordinate over-current protection rating for the drive and bypass starter to protect both devices in either mode of operation.
 - .3 Provide a thermal overload relay sized to protect the motor for either mode of operation.
 - .4 Provide a three position "HAND-OFF-AUTO" and a "VFD-OFF-BYPASS" selector switch
 - .1 VFD MODE:
 - .1 Selector switch in "HAND" position: speed controlled by the potentiometer.
 - .2 Selector switch in "OFF" position: Motor cannot be started.
 - .3 Selector switch in "AUTO" position: VFD operates by remote start / stop command, the speed controlled by the isolated 0-10Vdc or 4 -20 mA signal.
 - .2 BYPASS MODE:
 - .1 Selector switch "HAND" position
-

- .2 Selector switch "OFF" position prevents motor from operating.
- .3 Selector switch "AUTO" position allows motor to start by remote start / stop command.
- .4 All Interlocks are in the circuit for all modes of operation.

2.17 Drive Parameter Settings

- .1 VFD configuring settings shall be field adjustable through the keypad and display unit or via the serial communication port.
- .2 The digital keypad must allow the operator to enter exact numerical settings. A plain English user menu (rather than codes) shall be provided in software to guide parameter setting. Drive parameters shall be factory set in EEPROM and be resettable by the user through the keypad. Keypad setting shall disable parameter changes by unauthorized personnel.

2.18 Diagnostics

- .1 On power-up, the VFD shall execute a self-diagnostic check. The integral programming display panel shall provide first fault indication of VFD protection functions. Fault indication to be retained if input power is lost.
- .2 Provide a software graphing feature for up to eight different programmable signals at the time of a fault trip or during operation
- .3 The fault log record shall be accessible via a portable computer, connected directly to VFD, as well as from readout on the keypad display on the panel door.
- .4 Fault codes shall provide direction as to board level and input-output level to aid in trouble-shooting.
- .5 The following faults to be displayed on the local programming panel:
 - .1 Over-current
 - .2 Short Circuit / Ground Fault
 - .3 Under voltage
 - .4 Over voltage
 - .5 Over temperature
 - .6 Power Supply Fault
 - .7 Motor stalled
- .6 Diagnostic and indicating features:

-
- .1 Power ON indication.
 - .2 All set points
 - .3 Percentage speed indicator.
 - .4 Overload indication.
 - .5 Short circuit indication.
 - .6 Ground fault indication.
 - .7 Over-voltage indication.
 - .8 Under-voltage indication.
 - .9 High temperature (controller).
 - .10 AC voltmeter (output).
 - .11 AC ammeter (output).
 - .12 Inverter ready.
 - .13 Inverter fault.
 - .14 External fault.
 - .15 Motor Frequency

2.19 Drives Connected to Emergency Power System

- .1 The VFD may be supplied from an emergency power distribution system, which is subjected to short power interruptions during test of the emergency generator system. The VFD shall continuously operate through this test mode. See “Rotating Start”, clause 2.13.17. Refer to the VFD Schedule on drawings.

2.20 Wiring and Identification

- .1 Control wiring shall be stranded TEW 105°C (220°F) rise.
 - .2 Terminal blocks for remote interface shall be Weidmueller SAK6N or approved equivalent.
 - .3 Provide wire markers at both ends of all control wires, Electrovert type Z or approved equivalent.
 - .4 Where applicable, provide lamicoid tag warning of more than one voltage and provide caution label regarding regenerative voltage that may be present on load side of output contactor.
-

3. Execution

3.1 Section Includes

- .1 Installation
- .2 Cabling and Grounding by Division 26
- .3 Start-Up
- .4 Commissioning
- .5 Start-up and Commissioning Service
- .6 Examination

3.2 Installation

- .1 Install VFDs in accordance with the manufacturer's recommendations.
 - .2 Set and secure VFD assembly in place on channel bases, or on housekeeping pad as permitted elsewhere, rigid, plumb and square to building floor and wall.
 - .3 Protect against dust and damage during entire construction period. If filters have been soiled replace filter media at the end of the construction period. To this end VFD supplier shall ship one (1) extra set of filter media for each drive equipped with filter systems from the factory. If unused these shall be turned over to the Owner for future replacements.
 - .4 After connections have been made, vacuum exterior and touch-up any damaged paint. Vacuum clean the interior.
 - .5 Mechanical Trade shall be responsible for the supply and complete commissioning of each variable speed drive to the satisfaction of Consultant and Owners Commissioning Forces. Division supplying the drive shall allow for factory representative to completely calibrate all drive circuits after installation on site. Final drive settings (the final "as left" state) shall be as-built and changes from earlier configurations shall be dated and signed. Copies of the data shall be provided both in the drives and the O&M Manuals for the Project.
 - .6 The VFD vendor shall include for the necessary engineering, programming and on-site commissioning related to the BACnet interface. Include for on-site coordination and check out with the BAS contractor, including point-to-point verification for those points utilized in the BAS programming and graphics. This shall include for points either hardwired as discrete points or points brought in through the BACnet interface.
 - .7 Prohibited locations for VFD installations are where greater than normal dust accumulations occur and where higher than normal ambient temperatures or poor ventilation exists. (Some examples are: near steam stations, steam converters, condensate
-

tanks, generators, or where passive or forced ventilation systems will bring dust into the space).

- .8 Conduit and Cable entries into VFDs shall be made through either the bottom or the side of the unit. Top entry into VFDs by conduits or cables is not permitted.

3.3 Cabling and Grounding by Division 26

- .1 Coordinate with the Electrical Trade to ensure the supply and installation of cables and electrical connections to the VFDs are correct.
- .2 Division 26 will provide separate conduits and or cables for VFD input and output power:
- .1 If the VFD is not preinstalled and pre-wired as a part of a packaged mechanical equipment assembly unit, supply, install, and connect Alcatel Drive Rx Cable (or equal) from VFD to designated motor load for motors separated by more than 10 meters of cable length from the VFD. For motors installed at 10m or less from the unit, the use of standard building wire inside of steel conduit and terminal sections of seal tight flex is deemed acceptable.
- .3 Supply, install, and connect the feeders with adequately sized grounding / bonding conductors in conduit (or cable) as indicated on the project drawings and / or in the specifications from motor control centre to VFD.
- .4 Supply and install a ground conductor in each control conduit with the signal and data control cables from Building Management System (BMS) to each VFD.
- .5 If a local disconnect is required (by either the engineered design or by Canadian Electrical Code) near the motor, the operating mechanism of the disconnecting means shall be so constructed that an auxiliary NO-NC contact will change state when the Switch is operated. Control wiring shall be installed between the disconnect switch and the VFD to enable the VFD to determine if the disconnect switch is open or closed. VFD safeties shall be enabled when the motor is disconnected on the load side of the VFD.
- .6 Local motor disconnects or isolating switches for motors driven by VFDs shall be identified with a separate lamicoid nameplate located as close as practicable to the operating handle of the field (local) disconnecting means. Tag color shall be Orange Face & White Core. The tag shall contain the following wording: "WARNING: Do not open while motor is rotating! Severe damage to VFD will occur! Shut down VFD and only then, open this Switch for Safety. Close switch prior to restarting VFD!". Warning nameplates shall be mechanically fastened to the disconnect switch.
- .7 Torque all conductors with calibrated torque wrench. Terminations to be checked, including but not limited to, power, line, load, ground, and control. Terminations shall be torqued to the manufacturer's recommendation.
-

3.4 Start-up

- .1 The mechanical trade will be responsible to coordinate the installation, testing, and start-up (prior to commissioning commencement) with other parties participating in the start-up activities.
- .2 Start-up to be accomplished as detailed in following example Vendor Start-up Requirements. These shall be considered the minimum general requirements and shall be in addition to the manufacturer's recommended start-up. Where the Vendor or assigned start-up agency believes any requirement to be harmful to the drive or would invalidate warranty, the item(s) of concern shall be identified in writing to the attention of the Engineer.

3.5 Commissioning by Vendor

- .1 The vendor shall provide start-up and commissioning of the variable frequency drive and its optional circuits by a factory-certified service technician who is experienced in start-up and repair services. Service technician shall be a certified journeyman electrician. Sales personnel and other agents who are not factory certified technicians for drive repair shall not be acceptable as commissioning agents.
- .2 The Contractor, in conjunction with the mechanical trade, is responsible to schedule start up and commissioning. Scheduling of Commissioning Activities will provide a minimum five (5) working days notice to the vendor and Owners commissioning team prior to each separate commissioning activity.
- .3 Complete vendors commissioning consistent with factory start up forms. These shall be considered the minimum requirements for Vendors Commissioning. Where the Vendor or Owners Commissioning Team believes any commissioning requirement to be harmful to the drive or would invalidate warranty the item(s) of concern shall be identified in writing to the attention of the Engineer.
- .4 Submit the following written documentation:
 - .1 Verification of proper wire terminations and conduit runs to and from the VFD.
 - .2 Completion of vendors Start-up and Commissioning Form.
 - .3 Verify BAS calibration.
 - .4 Confirm Set-up and tuning of control loop resident in the VFD.
 - .5 Confirm that commissioning procedures have been completed.

3.6 Owners Start-up and Commissioning Procedure

- .1 Each drive will be subject to an Owners start-up and commissioning procedure (hereafter referred to as the Owners Commissioning Team), that will include the Owner (or Owners
-

agent), mechanical trade, electrical trade, and the VFD Vendor. Refer to the sample Owners Commissioning Team check sheet, Article 3.9 that may be utilized by the Owner.

- .2 Provide the Owners Start-up & Commissioning Team with 7 days' notice of VFD start-up. They may elect to witness the vendors' start-up. Vendors' start-up services shall include checking and verifying proper installation and operation of the VFD, its installed options, and its interface to the building automation system as a minimum.
- .3 Owners Start-Up and Commissioning Team will verify the programming of the VFD and will provide a written copy of the settings to the Engineer.
- .4 Owners Start-Up and Commissioning Team will identify critical frequencies that may occur throughout the operating curve of the equipment. Vendor shall program the drive to run through the critical frequencies that have been identified.

3.7 Examination

- .1 The Contractor is to verify that the jobsite conditions for installation meet the factory recommendations and code required conditions for the VFD installation prior to start-up. These shall include as a minimum:
 - .1 Clearance spacing.
 - .2 Compliance with environmental ratings of the VFD system.
 - .3 Separate conduit installation of the input wiring, the motor wiring, and control wiring. At no time does any of this wiring run in parallel with each other.
 - .4 All power and control wiring is complete.
 - .5 Site has been suitably cleaned.
- .2 The VFD is to be covered and protected from installation dust and contamination until the environment is cleaned and ready for operation. The VFD system shall not be operated while the unit is covered.

3.8 VFD Schedule

- .1 Supply, install, start up, and commission VFD's serving motors on mechanical equipment as scheduled on drawings:
-

3.9 Owners Commissioning Team Check Sheets (sample):

VFD Information					
Make				Model Number	
Serial Number				Service Area	
Volts/Phase				Function	
Motor HP		Motor Amps		Drive Max Amps	
Comments:					

Associated Checklists					
Cooling Tower	<input type="checkbox"/>	Air Handling Unit	<input type="checkbox"/>	Other	<input type="checkbox"/>
Pump	<input type="checkbox"/>	Exhaust Fan	<input type="checkbox"/>	Other	<input type="checkbox"/>
Comments:					

Requested documentation submitted	Rec'd	Comments
Manufacturer's cut sheets	<input type="checkbox"/>	
Performance data (pump curves, fan curves, coil data, etc.)	<input type="checkbox"/>	
Installation and startup manual and plan	<input type="checkbox"/>	
O&M manuals	<input type="checkbox"/>	
Factory test results	<input type="checkbox"/>	
Sequences and control strategies	<input type="checkbox"/>	
Warranty Certificate	<input type="checkbox"/>	
Comments:		

Installation Checks			
Check if Acceptable; Provide comment if unacceptable	A	N A	Comment
General			
Installation per manufacturer's requirements	<input type="checkbox"/>	<input type="checkbox"/>	
Permanent label affixed and UL stamp approved	<input type="checkbox"/>	<input type="checkbox"/>	
Drive location not subject to excessive moisture or dirt	<input type="checkbox"/>	<input type="checkbox"/>	
Drive location not subject to excessive temperatures	<input type="checkbox"/>	<input type="checkbox"/>	
Appropriate Volts vs. Hz curve is being used	<input type="checkbox"/>	<input type="checkbox"/>	
Drive independently mounted	<input type="checkbox"/>	<input type="checkbox"/>	
Cooling air flow path clean and unobstructed	<input type="checkbox"/>	<input type="checkbox"/>	
VFD interlocked to control system	<input type="checkbox"/>	<input type="checkbox"/>	
Unit is programmed with full written programming record on site	<input type="checkbox"/>	<input type="checkbox"/>	
Accel time set to _____ and Decel time set to _____	<input type="checkbox"/>	<input type="checkbox"/>	
Coordinated with BAS for all interface ranges and signal isolation	<input type="checkbox"/>	<input type="checkbox"/>	
Restart on Power Failure parameter set to auto	<input type="checkbox"/>	<input type="checkbox"/>	
Drive min and max speed set to _____ Hz min and 60 Hz max	<input type="checkbox"/>	<input type="checkbox"/>	
Security settings set per owner direction and Password documented for owner	<input type="checkbox"/>	<input type="checkbox"/>	
Drive response to loss of signal set to _____	<input type="checkbox"/>	<input type="checkbox"/>	
Output pulse resolution set to _____ MHz. (This is coordinated with the application to minimize audible noise and coordinated with driven bearing allowances.)	<input type="checkbox"/>	<input type="checkbox"/>	
Input of motor FLA represents 100% to 105% of motor FLA rating	<input type="checkbox"/>	<input type="checkbox"/>	
Upper frequency limit set at 100%, unless explained otherwise	<input type="checkbox"/>	<input type="checkbox"/>	
Electrical and Controls			
Power disconnect is located within site of the unit it controls and labeled	<input type="checkbox"/>	<input type="checkbox"/>	

Installation Checks			
Check if Acceptable; Provide comment if unacceptable	A	N A	Comment
All electric connections tight	<input type="checkbox"/>	<input type="checkbox"/>	
Grounding installed for components and unit	<input type="checkbox"/>	<input type="checkbox"/>	
Safeties installed and operational	<input type="checkbox"/>	<input type="checkbox"/>	
Overload breakers installed and correct size	<input type="checkbox"/>	<input type="checkbox"/>	
All control devices and wiring complete	<input type="checkbox"/>	<input type="checkbox"/>	
Control system interlocks connected and functional	<input type="checkbox"/>	<input type="checkbox"/>	
Installation per manufacturer's instructions	<input type="checkbox"/>	<input type="checkbox"/>	
Rotates in the correct direction (for VFD, check Inverter and BYPASS modes)	<input type="checkbox"/>	<input type="checkbox"/>	
Checked the input voltage with drive disconnected	<input type="checkbox"/>	<input type="checkbox"/>	

Operational Checks			
Check if Acceptable; Provide comment if unacceptable		N A	Comment
Operation checked in HAND, OFF, and AUTO. As applicable operation also checked in BYPASS. Where applicable, ensure safeties are active in all modes	<input type="checkbox"/>	<input type="checkbox"/>	
Specified point-to-point checks have been completed and documentation record submitted for this system	<input type="checkbox"/>	<input type="checkbox"/>	
Start-up complete	<input type="checkbox"/>	<input type="checkbox"/>	

GOVERNMENT OF CANADA

Existing Building Renovation

Alberta, Canada

Project No.: 144202775.215

Section 23 05 04

VARIABLE FREQUENCY DRIVES

FOR HVAC EQUIPMENT

Page **23** of **27****3.10**Vendors sample start-up sheet

VFD Tag:			
Pkg. S/N:			
Date:			
Commissioning Agent		Phone	
Service Technician		Fax	
		Email	
Customer:		Phone:	
Address:		Fax:	
		Email:	
Project:		Building:	
Address:			
Site Contact:		Phone:	
Name:		Fax:	
		Email:	

NAMEPLATE INFORMATION							
Package Type:			VFD Tag:			Location:	
Package Model:			S/N:			Application:	
VFD	Model:		HP (CT)		HP (VT)		Voltage:
	S/N:		FLA (CT)		FLA (VT)		Logic #
	MFG		Date				

GOVERNMENT OF CANADA

Existing Building Renovation

Alberta, Canada

Project No.: 144202775.215

Section 23 05 04

VARIABLE FREQUENCY DRIVES

FOR HVAC EQUIPMENT

Page **24** of **27**

	#		Code				
Motor	Make:				Voltage:		HP:
	Model:				RPM:		FLA:
	Insulation Class:		Frame		SF:		Type:
	Ambient Temp:		Duty Cycle:		Efficiency:		Frequency:

PRE POWER-UP CHECKS							
Line Reactor	Make:		Model:		Connection:		
Load Reactor	Make:		Model:		Connection:		
Filters	Output:		RFI:		Arrestor:		
Environment		Temp. with -10 to 40C (14 to 104F)			If No:		
		Humidity OK?			If No:		
		Adequate Ventilation?			If No:		
		Drip Shield?			If No:		
		Clean?			If No:		
Wiring:	Input Power	Complete ?			Separate Conduit?		Proper Size?
	Output Power				Separate Conduit?		Proper Size?
	AC Control				Separate Conduit?		Proper Size?
	DC Control				Separate		Proper Size?

GOVERNMENT OF CANADA

Existing Building Renovation

Alberta, Canada

Project No.: 144202775.215

Section 23 05 04

VARIABLE FREQUENCY DRIVES

FOR HVAC EQUIPMENT

Page **25** of **27**

					Conduit?			
	Grounding						Proper Size?	
Fuses	Input Power:			Control XFMR Primary		Control XFMR Secondary:		
Motor Megger Test								

POWERED CHECKS							
Power Supply	Vab:	V	Vac:	V	Vbc:	V	
	+/- 10% ?		V a-b-c Balanced with 3% ?				
	DC Bus:		Within 5% of input? (AC x 1.414)				
Motor Rotation	VFD:		Bypass		Free Run Stop Time	sec	
Motor Current (in amps)	VFD	@ 60 Hz:	A	@ 45 Hz	A		
		@ 30 Hz:	A	@ 15 Hz:	A		
		Current within specification at all frequency ranges?					
	Bypass	A	Current within specification?				
Signal	Input	Type	OK?	Output	Type	OK?	
	Frequency Reference:			Frequency Feedback:			
	Run:			Current Feedback:			
	External Interlocks:			Run Status:			
	Run Permissive:			Fault Status:			

GOVERNMENT OF CANADA

Existing Building Renovation

Alberta, Canada

Project No.: 144202775.215

Section 23 05 04

VARIABLE FREQUENCY DRIVES

FOR HVAC EQUIPMENT

Page **26** of **27**

Operator	Bypass Module Type:		Key Pad Type:		Speed Pot	
Switches	VFD-Off-Bypass		Hand-Off-Auto		(Other)	
Lights	Power:		Hand:		Auto:	
	VFD:		Bypass:		At Speed:	
				Keypad Lit		Ext. Fault:

AUXILLIARY ITEMS / OPTIONS (e.g. PUMPS STARTERS; PAN HEATERS)			
Option Type #1:		Option Type #2:	
Voltage:		Voltage:	
HP / kW:		HP / kW:	
Fuses / Size:		Fuses / Size:	
Sel. Sw.		Sel. Sw.	
Pilot Light(s)		Pilot Light(s)	
Functions per Dwg?		Functions per Dwg?	
Measure Amps:		Measure Amps:	
Other Comments:		Other Comments:	
External PID Controller		Parameter Settings per Attached	
Network Communications			
Network Type (e.g. N2, FLN, BACnet)		Model / Type of Interface:	
		Address:	
General			
Parameters recorded and attached?		If no, why?	
Parameters saved to laptop?		File	

		Name:	
Parameters uploaded to keypad?			
Manual in the package?		If no, why?	
Wiring diagram in the package?		If no, why?	
“As Commissioned” marked up dwgs attached?		If no, why?	
Other instruction manuals in the package?		If no, why?	
Any changes to the package?		If yes, then notify us with the changes	
Commissioning Completed by (print):			
Sign:			
Commissioning Completion Date:			

END OF SECTION

1. General

1.1 Scope

- .1 This section covers general motor requirements for factory and field installed motors.
- .2 Refer to individual sections for application of motors and reference to specific motor requirements for motor driven equipment.
- .3 Motors shall be suitable for horizontal, vertical or belt driven mounting.

1.2 Submittals

- .1 Submit shop drawings for motor driven equipment, as required by equipment specification sections. Motor shop drawing information shall include, but not be limited to the following:
 - .1 Voltage/Phase./Hertz
 - .2 Motor power (kW or Watts)
 - .3 Full load amps
 - .4 Wiring diagrams (as required)

1.3 Delivery, Storage & Handling

- .1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.4 Waste Management and Disposal

- .1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC .

1.5 Related Work Specified in Other Sections

- .1 Refer to and comply with the following sections:
 - .1 General Service Packaged Air Compressors & Receivers Section 22 15 19
 - .2 Common Work Results for HVAC Section 23 05 00
 - .3 Variable Frequency Drives Section 23 05 04
 - .4 HVAC Fans Section 23 34 00
 - .5 Packaged Indirect Fired Make-Up Air Units Section 23 74 23.16
 - .6 Electrical Division 26
-

1.6 Standards

- .1 Provide motors designed, manufactured, and tested in accordance with the latest edition of the following codes and standards:
 - .1 National Electrical Manufacturers Association (NEMA)
 - .2 Electrical Equipment Manufacturers Association of Canada (EEMAC)
 - .3 Canadian Standards Association (CSA)
 - .4 Canadian Electrical Code (CEC) Part 1
 - .5 Institute of Electrical and Electronic Engineers (IEEE)
 - .6 American National Standards Institute (ANSI)

1.7 Quality Assurance

- .1 All motors shall be ULC listed and CSA certified.
- .2 All motors to be approved for use in the designated area classification by the Electrical Protection Branch, Alberta Department of Labor.
- .3 Full Voltage Start Applications:
 - .1 All motors shall be in accordance with NEMA standards, and CSA C390-93, or the latest version insofar as it is applicable. Motors also shall comply with the applicable portions of the Canadian Electrical Code.
- .4 Variable Frequency Drive and Soft Start Applications:
 - .1 Where equipment is noted to be controlled by a VFD on the equipment schedules, or in other Sections, the motors shall be in accordance with NEMA standards (MG-1) Part 31, and inverter duty class, or the latest version insofar as it is applicable. Motors also shall comply with the applicable portions of the Canadian Electrical Code.
 - .2 Motors connected to VFD(s) shall be wound using inverter spike resistant magnet wire capable of 1600V.

1.8 Testing

- .1 Production Tests: Each motor shall receive a routine commercial test per NEMA MG-1.12. Prototype test reports shall be for each rating.
 - .2 Sound Level: The noise level of each motor shall comply with NEMA MG-1.12.49.
 - .3 Vibration Level: The vibration level of each motor shall not exceed those values listed in NEMA MG-1.12.05.
-

1.9 Variable Speed Drives

- .1 Motors shall be designed for operation with Variable Frequency Drives as noted on the motor schedule.

2. **Products**

2.1 General Requirements

- .1 Provide motors for mechanical equipment as specified.
 - .2 Unless noted otherwise, provide open drip-proof, ball or roller bearing motors with grease fittings.
 - .3 Motors shall have standard voltage ratings consistent with the project distribution voltages.
 - .1 Motors 0.372 kW ($\frac{1}{2}$ HP) and less to be 120 volt, 60 cycle, single-phase power.
 - .2 Motors 0.559 kW ($\frac{3}{4}$ HP) and larger to be 3 phase power and for the scheduled voltage.
 - .3 Confirm electric voltage, phase and starter requirements with the electrical specifications.
 - .4 Refer to equipment schedules on drawings.
 - .4 Provide motors with grease or oil lubricated anti-friction type ball or roller bearings.
 - .5 Provide motors designed with Class B insulation; Class F insulation for totally enclosed motors.
 - .6 Provide all motors with terminal boxes, suitable for power connections.
 - .7 Provide screw adjustable bases on all belt-connected motors.
 - .8 Motors shall be of the capacitor start type when they may be manually cycled from a starting switch which is located in the finished space.
 - .9 Motors exposed to outdoor temperature to be lubricated with lubricants suitable for operation at 6°C below the lowest temperature recorded by ASHRAE or the Climatic Information (Supplement to the National Building Code), for the location in which they are installed.
 - .10 Refer to electrical specifications for voltage, frequency, and phase data. This shall take precedence over any reference in Division 23. Packaged equipment shall have connections as specified in Division 26.
 - .11 Where motor power is stated in watts or kilowatts, nominal motor horsepower multiplied by 746 or 0.746 respectively, has been used as the conversion factor.
-

2.2 Voltage and Frequency

- .1 Motors will be rated for operation on a 1-phase or 3-phase, 60 Hz power supply at 115 Volts, 208 Volts or 575 Volts. All motors shall be designed and manufactured to operate with $\pm 10\%$ voltage and $\pm 5\%$ frequency variations of the nameplate ratings. Combined voltage and frequency variation shall not exceed $\pm 10\%$. Confirm voltage for all motors with Division 26.

2.3 Torque

- .1 Motors shall meet or exceed the locked rotor (starting) and minimum breakdown torques specified in NEMA standard for Design B for the ratings specified.

2.4 Current

- .1 Locked rotor (starting) currents shall not exceed NEMA Design B maximum values for the specified rating. Motors shall be capable of a 20 second stall at six times full load current without injurious heating to the motor components.

2.5 Efficiency

- .1 Motors shall be Premium Efficient design and have a minimum and nominal full load efficiency which will meet or exceed the values listed in NEMA MG1-12.55 Table 12-6B when tested in accordance with NEMA test standard MG1-12.54.1, IEEE Test Procedure 112, Method B using accuracy improvement by segregated loss determination including stray load loss measurements. The minimum efficiency shall be guaranteed.

- .1 Premium efficiency open drip-proof motors shall have the following typical full load efficiencies (nominal):

kW (HP)	Premium Efficiency - Minimum Efficiency (%)		
	3600 RPM 2 Pole	1800 RPM 4 Pole	1200 RPM 6 Pole
0.746 (1)	74.0	82.5	80.0
1.12 (1.5)	81.5	84.0	84.0
1.49 (2)	82.5	84.0	85.5
2.24 (3)	82.5	87.5	86.5
3.73 (5)	84.0	87.5	87.5
5.59 (7.5)	86.5	89.5	88.5
7.46 (10)	87.5	90.2	90.2
11.2 (15)	88.5	91.7	90.2
14.9 (20)	89.5	91.7	91.0

kW (HP)	Premium Efficiency - Minimum Efficiency (%)		
	3600 RPM 2 Pole	1800 RPM 4 Pole	1200 RPM 6 Pole
18.6 (25)	90.2	92.4	91.7
22.4 (30)	90.2	93.0	92.4
29.8 (40)	91.0	93.0	93.0
37.3 (50)	91.7	93.6	93.0
44.7 (60)	92.4	94.1	93.6
55.9 (75)	92.4	94.1	93.6
74.6 (100)	92.4	94.5	94.1
93.2 (125)	93.0	94.5	94.1
111.9 (150)	93.0	95.0	94.5

- .2 Premium efficiency totally enclosed fan cooled motors shall have the following typical full load efficiencies (nominal).

kW (HP)	Premium Efficiency - Minimum Efficiency (%)		
	3600 RPM 2 Pole	1800 RPM 4 Pole	1200 RPM 6 Pole
0.746 (1)	74.0	82.5	80.0
1.12 (1.5)	81.5	94.0	85.5
1.49 (2)	82.5	94.0	86.5
2.24 (3)	84.0	87.5	87.5
3.73 (5)	86.5	87.5	87.5
5.59 (7.5)	87.5	90.2	89.5
7.46 (10)	88.5	90.2	89.5
11.2 (15)	89.5	91.0	90.2
14.9 (20)	89.5	91.7	90.2
18.6 (25)	90.2	92.4	91.7
22.4 (30)	90.2	92.4	91.7
29.8 (40)	91.0	93.0	93.0
37.3 (50)	91.7	93.6	93.0

kW (HP)	Premium Efficiency - Minimum Efficiency (%)		
	3600 RPM 2 Pole	1800 RPM 4 Pole	1200 RPM 6 Pole
44.7 (60)	92.4	94.1	93.6
55.9 (75)	92.4	94.5	93.6
74.6 (100)	93.0	94.5	94.1
93.2 (125)	94.1	94.5	94.1
111.9 (150)	94.1	95.0	95.0

2.6 Sound Level

- .1 The noise level of each motor shall comply with NEMA MG-1.12.49.

2.7 Vibration Level

- .1 The vibration level of each motor shall not exceed those values listed in NEMA MG-1.12.05.

2.8 Service Factor and Ambient

- .1 Standard motors shall be rated for a 1.15 service factor in a 40°C (104°F) ambient unless specified otherwise in the driven equipment specifications. Provide all motors with thermal overload protection. Motors 30 kW (40 HP) and larger shall have thermistor protection.

2.9 Insulation

- .1 Standard motors shall have a full Class F non-hygroscopic insulation system.
- .2 Standard motors shall be dipped and baked in a non-hygroscopic polyester high temperature varnish, spike resistant for motors connected to VFDs and soft-starts (NEMA MG-1 Part 31).
- .3 Moisture resistant (MR) copper magnet wire rated for 200°C (392°F) or better.

2.10 Nameplates

- .1 Nameplates shall be of stainless steel and stamped per NEMA Standard MG1-10.40. Nameplate information shall include the nominal efficiency value per standard MG1-12.54.2.

2.11 Belt Drives

- .1 Provide belt drives to the following requirements:

-
- .1 Provide steel, cast iron or aluminum sheaves for motors less than 0.559 kW (3/4 HP).
 - .2 Provide steel or cast iron sheaves keyed to shafts, for motors 0.559 kW (3/4 HP) and larger.
 - .3 For motors less than 7.46 kW (10 HP) provide standard adjustable pitch drive sheaves having +/-10% range. Use mid-position of range for specified RPM.
 - .4 For motors 7.46 kW (10 HP) and larger, provide fixed pitch drive sheaves with split tapered bushing and keyway. Provide final drive sheaves of size to suit final balancing.
 - .2 Match drive and driven sheaves.
 - .3 V-belts shall conform to the American Belt Manufacturers standards. Multiple belts shall be matched sets.
 - .4 Not less than a 2-belt configuration is required for each drive for motors 0.559 kW (3/4 HP) and larger.

3. Execution

3.1 General

- .1 Unless otherwise noted starters and protection devices will be included under the Electrical Division of the Specification.
- .2 Assist Division 26 to ensure proper connection, correct thermal overload protection and correct motor controls.
- .3 Where starters are included in this Division as an integral part of packaged equipment, they shall contain thermal overload protection in all ungrounded lines.
- .4 Equipment, which has more than one voltage rating, shall be fed from a single power source through a disconnect switch.
- .5 If delivery of specified motor will delay delivery or installation of any equipment, install an acceptable motor for temporary use. Final acceptance of equipment will not be given until specified motor is installed.

3.2 Setting and Alignment

- .1 Employ a journeyman millwright to align all V-belt drives and/or shaft coupling drives prior to initial start-up. The millwright shall also check that centrifugal fan wheels are properly centered on fan shafts.
 - .2 Align shaft couplings, using a dial indicator, to within +/-0.051 mm (0.002") after grouting is complete and the piping system is operational.
-

-
- .3 Align V-belt drives using a straight edge.
 - .4 Submit a certificate from the millwright employed, certifying that all shaft couplings and V-belt drives have been aligned and centrifugal fan wheels centered prior to initial start-up and checked again after final system balance adjustment.

END OF SECTION

1. General

1.1 Scope

- .1 This section includes the supply, installation, start-up, testing and commissioning for variable frequency drives (VFD) controllers, including but not limited to: associated enclosures, input and output filters, warranty, local and remote control.
- .2 The VFD and all specified components, including internal wiring between those components, must be installed and integrated into one common enclosure, supplied, factory tested, and commissioned by the VFD supplier. The integrated VFD assembly shall be ready for field installation and require only the connection of the incoming power cables, the motor load cables, and the control wiring for start-up, and the commissioning of the VFDs.
- .3 The VFD supplier must coordinate with the installation contractor with respect to delivery dates, technical support for the installation, equipment start-up, and the commissioning of the VFDs.
- .4 All drives and ancillary components specified in this section to be supplied by one manufacturer to assure a properly coordinated system.
- .5 Design all equipment using modularized solid state equipment to allow easy maintenance and replacement.

1.2 Submittals

- .1 Comply with the requirements of Section 23 05 00 – Common Work Results for HVAC.
 - .2 Provide the following shop drawing information:
 - .1 Catalog and technical data.
 - .2 Outline dimensions, shipping section dimensions, weight, and foundation requirements for all assemblies.
 - .3 Physical details of the cabinets, a wiring diagram, and a ladder diagram showing both internal connections and terminals for field wiring, showing function and identification of all terminals requiring field connections. Separate diagrams are required for each VFD size. Generic diagrams are not acceptable.
 - .4 Component fabrication drawings consisting of detailed circuit schematics, indicating all components in the VFD package, including line and load reactor impedance ratings and/or filter design type, VFD current, HP and voltage rating.
 - .5 Bolt and lug torque schedule for all power and control wiring termination points.
 - .6 Vendor's start-up sheets for the drive.
-

-
- .3 Upon delivery, provide as-built shop drawings for each unit. A copy of the as-built shop drawings shall be provided for each drive in addition to one set of drawings for each copy of the O&M Manuals. (See info in the project specifications and drawings for quantities in addition to that indicated herein, the quantities shall be the maximum indicated plus 1 copy for each drive).
- .4 Supply four (4) copies of Operation and Maintenance manual containing data for each VFD. Data shall include:
- .1 Troubleshooting charts for all device faults.
 - .2 An instruction manual for: programming and the hardware provided with the equipment at time of shipment.
 - .3 Manufacturer's start-up check sheet(s) with list(s) that outline all of the completed tasks. Check-sheets are to contain actual start-up data and shall list all settings and parameters present in the drive unit as commissioned.
 - .4 VFD field-test measurement results. All data provided shall be that from the last testing conducted on the drive. If original testing was redone, then the new data shall be provided in addition to the original data. Original tests must then be marked "Superseded. For Information Only". All test data shall be dated and signed".
 - .5 Settings sheets to record all VFD configuration options and selections for VFD set-up. Settings sheets are to contain actual start-up data and shall list all settings and parameters present in the drive unit as commissioned.
 - .6 Include a list of authorized recommended spare parts, service depots, spare parts list.
- .5 Provide copies of the VFD programming / troubleshooting software, as well as any connection cables required, to Owner. Provide one set of software and cabling, for each size of drive, for each O&M manual provided.

1.3 Delivery & Storage

- .1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.4 Waste Management and Disposal

- .1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.5 Related work specified in other sections

- .1 Common Work Results for HVAC Section 23 05 00
- .2 Common Motor Requirements for HVAC Equipment Section 23 05 13
-

.3 Testing, Adjusting and Balancing for HVAC Systems Section 23 05 93

.4 Electrical Division 26

1.6 Standards

.1 VFD units shall be ULC listed and CSA (or cUL) certified.

.2 VFD units shall comply with applicable requirements of the latest standards of CSA, ANSI, IEEE 519, NEMA MG1 and the Canadian Electrical Code.

1.7 Intended operation

.1 The VFD shall be designed to operate standard squirrel cage induction motors with a 1.0 service factor meeting NEMA MG1 Part 31. Refer to Section 23 05 13 – Common Motor Requirements for HVAC Equipment.

.2 The VFDs shall control one or more fan motor(s) or pump motor(s) as listed in the drawing schedules.

.3 The VFD shall communicate with, and be controlled by, the building automation system (BAS) which will provide Run Command and an Operating Speed reference to the VFD. VFD Run Status, Operating Speed, Load Amps, Power and Alarm or Fault data shall be communicated back to the BAS. The VFD shall also be capable of operating in PID Mode with the Run Command and PID Set Point communicated by the BAS. A process monitoring transmitter (supplied by the controls contractor) will be connected directly to the VFD. Refer to Controls, Sections 23 09 Series.

.4 Communication with the BMS shall be BACnet MSTP over EIA-485.

1.8 Factory Testing

.1 Prior to shipment, all VFD units are to be shop-tested at the factor or at the VFDs OEM/integrator's facilities. Testing shall include, but will not be limited to, a complete functional test to fully prove out the VFD and all the local and remote control functions and required parameter settings. Phase-loss protection for each of the 3 phases of the VFD shall be proven as part of the factory testing.

.2 Provide factory-certified copies of production test results to the Engineer prior to shipment of the equipment.

1.9 Harmonic Guidelines

.1 All VFD installations shall meet IEEE-519-1992 harmonic guidelines.

.2 Following award of contract, and prior to submitting shop drawings, the VFD vendor shall review the electrical system design and MCC locations and advise if filtering, in addition to the specified line reactors, is required.

1.10 Warranty

- .1 The VFD supplier shall provide warranty coverage for a minimum period of twelve (12) months commencing upon the date of substantial completion. Refer to Division 0 and Division 1.
- .2 The Vendor shall be responsible to bring a Factory Representative back to reset, repair, and re-commission the VFD if problems arise with the normal operation of that VFD during the warranty period.

1.11 Maintenance

- .1 VFD supplier is to include a preventative maintenance program (PMP) for a one year period. The PMP is to be broken down to daily, weekly, monthly and annual service periods. Each service period is to include all manufacturer recommended maintenance tasks which should be completed in each period. A maintenance checklist is to be cross referenced to the maintenance period and maintenance task.

1.12 Training

- .1 Provide an on-site, half day training seminar for maintenance and service personnel.
- .2 The VFD supplier shall detail an agenda for the training to be provided and to present it to the Engineer for review and adjustment. Refer to Section 23 05 00 – Common Work Results for HVAC.
- .3 The Vendor shall comply with the Engineers requests for modification of the content to suit its needs within the four (4) hour time allowance. The training agenda shall be provided four (4) weeks prior to the drive start-up, and the VFD Supplier shall schedule the timing & location of the seminar at a time and location suitable to the Engineer.
- .4 Refer to and comply with Section 23 05 00 – Common Work Results for HVAC.

2. **Products**

2.1 Section Includes:

- .1 Approved VFD Suppliers and Product
 - .2 Vendor Requirements – Service and Support
 - .3 General VFD Requirements
 - .4 Environmental Capabilities
 - .5 Input Power
 - .6 Output Power
 - .7 Equipment Protection
-

-
- .8 Approved Filter Manufacturers
 - .9 Integrated VFD Equipment Enclosure
 - .10 BACnet
 - .11 PID Control
 - .12 Control and Operational Features
 - .13 Drive Control (Hand operation)
 - .14 Drive Controls (Auto Operation)
 - .15 Isolated Bypass Operation
 - .16 Drive Parameter Settings
 - .17 Diagnostics
 - .18 Drives Connected to Emergency Power System
 - .19 Wiring and Identification

2.2 Acceptable Products

- .1 Variable Frequency Drive (VFD) as supplied by:
 - .1 ABB
 - .2 Cutler Hammer
 - .3 Danfoss
 - .4 General Electric
 - .5 Siemens
 - .6 TECO-Westinghouse
 - .7 Mitsubishi (MGI)

2.3 vendor requirements – Service and Support

- .1 The drive vendor must provide a factory-trained sales force locally available for applications assistance and to answer maintenance questions.
 - .2 The vendor must have a distributor organization, which locally stocks standard drives, modification kits, and spare parts.
-

-
- .3 The vendor must have factory-trained service representatives within the local Edmonton area. The factory representatives must be trained in the maintenance and troubleshooting of the equipment as specified herein.
 - .4 Vendor must provide regularly scheduled maintenance and training schools in Canada on the equipment supplied

2.4 General VFD Requirements

- .1 All units shall be ULc or CSA approved.
- .2 VFD unit shall comply with applicable requirements of the latest standards of CSA, ANSI, IEEE, NEMA, and the Canadian Electrical Code.
- .3 Unless otherwise noted, all horsepower/kW ratings are to be based on a Variable Torque load.
- .4 VFD shall be provided with a CSA (NEMA) Type 1 enclosure.
- .5 The VFD shall be rated for continuous duty while operating a NEMA design induction motor of the sizes and operating voltages as shown in the applicable schedules and indicated on the drawings.
- .6 The VFDs shall have a current rating at least 10% in excess of the motor full load amp rating. When subject to the range of ambient conditions, the VFD to be capable of delivering 110% of rated output current for up to one minute for variable torque loads
- .7 The VFD shall have a fixed bridge type converter (PWM) utilizing Insulated Gate Bipolar Transistor (IGBT) technology.
- .8 VFD operation to be fully digital with microprocessor control of frequency, voltage, and current.
- .9 Efficiency of VFD controller shall not be less than 97.5% at 60 Hz output at 100% rated load.

2.5 Environmental Capabilities

- .1 The drive shall operate without mechanical or electrical damage under any combination of conditions as follows:
 - .1 Ambient temperature: 0° to 40°C (32°F to 105°F)
 - .2 Humidity: 5 to 95% (non condensing)
 - .3 Vibration: up to 0.5 G
-

-
- .4 Altitude: 0 to 1200m (0 ft to 3940 ft); For altitudes above 1200m (3960 ft), the equipment must be properly de-rated such that the higher altitude rating is greater than the required output.
 - .5 The VFD unit may require fan-assisted cooling to ensure adequate heat dissipation. Such a system shall be installed in a manner that does not degrade the enclosure rating. Provide alarm status and shut-down for the VFD, on excessive temperature rise in the enclosure, for VFDs that utilize forced air fans for enclosure cooling.

2.6 Input Power

- .1 Input voltage shall be as indicated on motor schedules and drawings, line voltage variation ($\pm 10\%$), 3 phase, 60 Hz, grounded power supply without high or low line tripping. Confirm voltage before ordering.
 - .2 The VFD must be capable of operating under the following conditions without high or low line tripping: 3 phase, 60Hz, alternating current, grounded power supply, line voltage as shown (240,480, 600) $\pm 10\%$. Speed stability shall be $\pm 1\%$.
 - .3 Permit power line interruptions for high inertia loads such as fans and centrifuges for at least 2.0 seconds without the VFD shutting down on a fault providing an extended power loss ride-through. If the drive trips on undervoltage, the drive will activate the Automatic Restart. See "Rotating Start" clause 2.13.17.
 - .4 The VFD shall present a displacement power factor of 0.98 or better to the AC line over 10% to 100% speed range. Full load effective power factor shall be 96% or better.
 - .5 The VFD must operate satisfactorily when connected to a bus supplying other solid state power conversion equipment which may be causing up to 5% total harmonic voltage distortion and communication notches up to 36,500 volt microseconds.
 - .6 Normal power distribution is subject to voltage surges and sags as a normal condition of operation. Design and supply with each VFD the required inverter protection such that the VFD will not be stressed or damaged, in the following conditions:
 - .1 Line surges of up to 115% of rated voltage for up to 10 cycles. Based on 347/600 Volt systems.
 - .2 Line voltage sags down to 85% of rated voltage of up to 1 second duration.
 - .7 Provide a 5% impedance line reactor at in the drive input to protect electronic components from transient voltage conditions and to reduce harmonic current distortion.
 - .8 The VFD must not be sensitive to supplied power that has one phase grounded (Delta – with balanced voltages) or referenced to earth ground (Wye).
 - .9 The VFD must not be sensitive to incoming phase sequence.
-

-
- .10 VFDs shall be of the 6-pulse PWM- type complete with an external AC line reactor to reduce harmonic current distortion.

2.7 Output Power

- .1 The VFD shall produce a 3 phase output for motor loads.
- .2 Pulse-Width Modulating (PWM) circuitry must consist of a full wave diode bridge converter to convert incoming fixed voltage and frequency to a fixed DC voltage. The Pulse Width Modulation strategy shall incorporate a microprocessor to handle all Logic functions as well as the complex, sine-coded PWM generating algorithms that control output stage switching.
- .3 Generate the inverter output by IGBT power transistors only.
- .4 The VFD output waveform to be the PWM or Vector type waveform producing smooth torque at low frequencies and low motor current harmonics.
- .5 Harmonic loading shall not exceed the maximums acceptable for motor operation with a service factor of 1.0.
- .6 The VFD output voltage shall be user-adjustable to deliver voltage from 0 V to full voltage at 60 Hz.
- .7 The VFD shall be provided with user-adjustable settings to provide a frequency range of 0 to 120 Hz.
- .8 Unless otherwise specified, the VFD output voltage to be adjustable from 0 to full voltage reaching full voltage at 60 Hz.
- .9 Provide selectable constant V/Hz ratio PWM or variable V/Hz for Variable Torque loads.
- .10 The VFD must maintain capability for 100% of rated output current continuously, regardless of change in ambient conditions throughout its listed ambient conditions range.
- .11 PWM carrier frequency shall be user-selectable.
- .12 Manufacturer to indicate, at time of tender, the anticipated levels of electrical noise and heat generated. In any case, the Audible noise levels to be less than 85 dbA at 1 m out from any point on the VFD cabinet under normal operating condition, with the drive at full load.
- .13 Radio Frequency Interference (RFI) must be limited to levels specified in applicable standards. Equipment must be designed that use of radio communication equipment adjacent to VFD units is permissible. In addition, the VFD must not be susceptible to interference from radio equipment operated adjacent to it.
-

2.8 Equipment Protection

- .1 Protective devices to be incorporated are:
- .1 Three-pole fused disconnect switch to provide over-current protection with fuses rated at not more than 150% of drive input current rating, except if the VFD is specifically marked with a recommended rating for its over-current protection, then the VFD marking shall take precedence.
 - .2 The operation of the disconnect switch shall be interlocked with the VFD enclosure door. It shall not be possible to open the door without the disconnect being in the open position. A manual means to defeat this interlock for maintenance purposes shall be included, and the external operator handle for the switch must have lock-out capability.
 - .3 The symmetrical short-circuit interrupting rating shall be verified for every installation, and be coordinated with the VFDs electronic protection circuits. VFD supplier is responsible to obtain SSCIR information from the designer or design documents for the VFDs being constructed for the project.
 - .4 Integral electronic motor overload protection adjustable up to 150% of motor rating for 60 seconds.
 - .5 Ground fault protection.
 - .6 Over-voltage/over-current DC bus monitor/protection.
 - .7 Under-voltage protection, 85% of rated input voltage.
 - .8 Loss of phase and phase unbalance protection.
 - .9 Inverter over-temperature protection.
 - .10 Motor overload protection, adjustable 80 to 115% of FLA of motor.
 - .11 Where bypass contactors are utilized or where the VFD serves several motors, provide external dial adjustable motor overload protection relays with inherent single-phase protection. The current range of the overload block shall be selected to place the full-load current of the motor at approximately the centre of the dial scale for the supplied overload relay.
- .2 Include provision for adequate grounding within the equipment in addition to that provided to safeguard against electrostatic discharge damage.

2.9 Approved Filter Manufacturers

- .1 All applications with non-VFD or VFD rated motors shall require output dv/dt filters. The following manufacturers of filters are acceptable.
-

.1 TCI

.2 MTE

2.10 Integrated VFD Equipment Enclosure

- .1 The integrated VFD assembly, including all components shall be provided as a ventilated CSA (NEMA) Type 1 enclosure, with a hinged, gasketed door and a drip-shield constructed to project over the door and sized to protect all ventilation openings in the top of the enclosure (if any) from dripping water. It shall be suitable for wall or free-standing installation.
- .2 Supply full-length painted 100mm steel channels for floor-mounted VFD enclosures.
- .3 Where house-keeping pads are provided, the channel bases are not required. Where a drive is placed on top of a housekeeping pad, base construction shall be such that the door of the VFD will not drag on the house-keeping pad.
- .4 Forced air cooled enclosures shall have filters on all air inlet openings.
- .5 The backspan to be galvanized metal, non-painted, 16 gauge for EMC bonding requirements. Provide a minimum of 2 lugs for bonding conductors (sized per CEC). Lugs shall be bolted to the galvanized metal back-pan.
- .6 Door shall be grounded with multi-conductor or braided ground strap connecting the door to the grounding system in the enclosure interior.

2.11 BACnet

- .1 The VFD shall communicate with a building automation system (BAS) network by digital communication using the BACnet MSTP protocol (ANSI/ASHRAE Standard 135-2004) over EIA-485.

2.12 PID Control

- .1 Provide process controller circuitry incorporating a PID algorithm to control the frequency output of the VFD.
- .2 Input for the process controller shall be one of the analog input signals specified below (clause 2.13.1).
- .3 Set-point shall be reset, as selectable parameter, either by using the digital communication network or by using the second analog input signal.

2.13 Control and Operational Features

- .1 Provide two analog inputs that are both capable of receiving an input signal, user-selectable as either 4-20 mA or 0-10 Vdc. Provide individual optically isolated inputs for each analog signal.
-

-
- .2 Process Signal Inverter: Provide programmable control to allow speed of drive to vary inversely with input analog signal.
 - .3 Provide two analog outputs, individually isolated, either 0-10 Vdc or 4-20 mA, which can be programmed to be proportional to any two of the following:
 - .1 Output frequency
 - .2 Output power
 - .3 Output current
 - .4 Provide input for external switch to be used as a proof-of-open interlock for associated damper or valve.
 - .5 Provide a dry contact (output) for interlocking external devices such as signal to open a damper or valve of associated the equipment.
 - .6 Provide dry-contact output to signal VFD fault.
 - .7 The VFD shall be capable of operating with its output open-circuited (no motor connected), with no fault or damage, for start-up and testing purposes. The drive must be capable of running without a motor connected.
 - .8 All VFD set-up operations and adjustments to be digital and stored in a non-volatile memory (EEPROM).
 - .9 Local communications port: Provide a local interface to upload, download, and read drive parameter settings, through the use of a notebook computer. Include Windows based software for computer on CD-ROM(s) with all associated operating instructions. Software information shall be provided with the O&M manuals.
 - .10 Provide offset and gain programmable functions to set operating range.
 - .11 The VFD shall employ a programmable rate of acceleration and deceleration, either linear or S-curve. The VFD shall “coast” to a stop or new lower speed, if selected by the user.
 - .12 Speed Droop: Provide a speed droop feature that reduces the speed of the drive on transient overloads. The drive is to return to set speed after transient overload is removed. If the acceleration or deceleration rates are too rapid for the moment of inertia of the load, the drive is to automatically compensate to prevent drive trip.
 - .13 Speed Profile: Provide individual adjustable settings for start, stop, slope, and minimum and maximum speed points.
 - .14 Bumpless speed transfer: Provide a smooth speed transfer from remote control to local control and vice-versa, without setting the motor to zero speed.
-

-
- .15 Automatic Reset and Restart: Provide automatic restart of rotating equipment following power outage. Provide programmable automatic reset / restart after any individual trip condition resulting from over-current, over voltage, under voltage, or over-temperature.
 - .16 Re-start attempt limit: for safety, the drive shall shut down and require manual reset if the automatic reset function is not successful within a maximum of three attempts within a user-programmed time period.
 - .17 Pick up a spinning-load (Rotating Start): The VFD shall be user-programmable for rotating re-start, enabling the VFD to start into a rotating motor, regardless of direction, without tripping offline and without setting the motor to zero speed. The VFD shall start at the speed the motor is rotating and then accelerate the motor according to the speed reference signal. After the VFD trips due to under-voltage and whenever any momentary power loss occurs, the drive must activate an automatic restart mode (re-initiate and re-start) without waiting for the rotating equipment to stop, and without operator intervention.
 - .18 Torque Compensation: Provide user-programmable automatic boost in torque to handle impulse loads or demands for fast acceleration by momentarily increasing the output volt / hertz ratio. When selected, the function to be operative at all speeds even under overload conditions, and eliminates the motor speed droop that would otherwise occur.
 - .19 Provide adjustable skip frequencies with programmable bandwidth to avoid operation in a resonant speed area. Provide a minimum of 3 such frequency selections.

2.14 Drive Control (Hand Operation)

- .1 Provide an operator station on the drive door complete with the following features as a minimum. The following applies to a VFD with Bypass capability. Adjust requirements as applicable for VFDs without a Bypass starter.
 - .1 Control Switches
 - .2 Selector switch No. 1: "HAND-OFF-AUTO" operation.
 - .3 Selector switch No. 2: "VFD ENABLED -OFF -BYPASS ENABLED" operation.
 - .4 Potentiometer for local speed adjustment in VFD mode.
 - .2 Pilot lights on door
 - .1 Input Power: "ON" pilot light
 - .2 VFD Status: "STOP" and "RUN" indication
-

2.15 Drive Controls (auto Operation)

- .1 The VFD to accept an isolated output signal via the Building Management System to stop and start the drive.
- .2 The VFD to have the capability to interlock of up to 3 NIC external alarm interlocks to shut down the VFD and provide status of the trip.
- .3 The VFD to provide two (2) programmable Form C dry contact status outputs. Status of contacts to indicate:
 - .1 Run
 - .2 Fault
- .4 Controller "stop" interlock from a NC dry contact.
- .5 The VFD to accept an isolated analog input speed reference of 0 to 10 VDC or 4-20 mA from the field. The 4-20 mA analog input speed reference signal shall be optically isolated. Calibration adjustments shall be provided for settings within the speed ranges specified.

2.16 Isolated Bypass Operation (where specified on equipment schedule(s))

- .1 Provide for an automatically controlled three-contactor isolated bypass control, integral to the VFD enclosure.
 - .2 Coordinate over-current protection rating for the drive and bypass starter to protect both devices in either mode of operation.
 - .3 Provide a thermal overload relay sized to protect the motor for either mode of operation.
 - .4 Provide a three position "HAND-OFF-AUTO" and a "VFD-OFF-BYPASS" selector switch
 - .1 VFD MODE:
 - .1 Selector switch in "HAND" position: speed controlled by the potentiometer.
 - .2 Selector switch in "OFF" position: Motor cannot be started.
 - .3 Selector switch in "AUTO" position: VFD operates by remote start / stop command, the speed controlled by the isolated 0-10Vdc or 4 -20 mA signal.
 - .2 BYPASS MODE:
 - .1 Selector switch "HAND" position
-

-
- .2 Selector switch "OFF" position prevents motor from operating.
 - .3 Selector switch "AUTO" position allows motor to start by remote start / stop command.
 - .4 All Interlocks are in the circuit for all modes of operation.

2.17 Drive Parameter Settings

- .1 VFD configuring settings shall be field adjustable through the keypad and display unit or via the serial communication port.
- .2 The digital keypad must allow the operator to enter exact numerical settings. A plain English user menu (rather than codes) shall be provided in software to guide parameter setting. Drive parameters shall be factory set in EEPROM and be resettable by the user through the keypad. Keypad setting shall disable parameter changes by unauthorized personnel.

2.18 Diagnostics

- .1 On power-up, the VFD shall execute a self-diagnostic check. The integral programming display panel shall provide first fault indication of VFD protection functions. Fault indication to be retained if input power is lost.
 - .2 Provide a software graphing feature for up to eight different programmable signals at the time of a fault trip or during operation
 - .3 The fault log record shall be accessible via a portable computer, connected directly to VFD, as well as from readout on the keypad display on the panel door.
 - .4 Fault codes shall provide direction as to board level and input–output level to aid in trouble-shooting.
 - .5 The following faults to be displayed on the local programming panel:
 - .1 Over-current
 - .2 Short Circuit / Ground Fault
 - .3 Under voltage
 - .4 Over voltage
 - .5 Over temperature
 - .6 Power Supply Fault
 - .7 Motor stalled
 - .6 Diagnostic and indicating features:
-

-
- .1 Power ON indication.
 - .2 All set points
 - .3 Percentage speed indicator.
 - .4 Overload indication.
 - .5 Short circuit indication.
 - .6 Ground fault indication.
 - .7 Over-voltage indication.
 - .8 Under-voltage indication.
 - .9 High temperature (controller).
 - .10 AC voltmeter (output).
 - .11 AC ammeter (output).
 - .12 Inverter ready.
 - .13 Inverter fault.
 - .14 External fault.
 - .15 Motor Frequency

2.19 Drives Connected to Emergency Power System

- .1 The VFD may be supplied from an emergency power distribution system, which is subjected to short power interruptions during test of the emergency generator system. The VFD shall continuously operate through this test mode. See “Rotating Start”, clause 2.13.17. Refer to the VFD Schedule on drawings.

2.20 Wiring and Identification

- .1 Control wiring shall be stranded TEW 105°C (220°F) rise.
 - .2 Terminal blocks for remote interface shall be Weidmueller SAK6N or approved equivalent.
 - .3 Provide wire markers at both ends of all control wires, Electrovert type Z or approved equivalent.
 - .4 Where applicable, provide lamicoid tag warning of more than one voltage and provide caution label regarding regenerative voltage that may be present on load side of output contactor.
-

3. Execution

3.1 Section Includes

- .1 Installation
- .2 Cabling and Grounding by Division 26
- .3 Start-Up
- .4 Commissioning
- .5 Start-up and Commissioning Service
- .6 Examination

3.2 Installation

- .1 Install VFDs in accordance with the manufacturer's recommendations.
 - .2 Set and secure VFD assembly in place on channel bases, or on housekeeping pad as permitted elsewhere, rigid, plumb and square to building floor and wall.
 - .3 Protect against dust and damage during entire construction period. If filters have been soiled replace filter media at the end of the construction period. To this end VFD supplier shall ship one (1) extra set of filter media for each drive equipped with filter systems from the factory. If unused these shall be turned over to the Owner for future replacements.
 - .4 After connections have been made, vacuum exterior and touch-up any damaged paint. Vacuum clean the interior.
 - .5 Mechanical Trade shall be responsible for the supply and complete commissioning of each variable speed drive to the satisfaction of Consultant and Owners Commissioning Forces. Division supplying the drive shall allow for factory representative to completely calibrate all drive circuits after installation on site. Final drive settings (the final "as left" state) shall be as-built and changes from earlier configurations shall be dated and signed. Copies of the data shall be provided both in the drives and the O&M Manuals for the Project.
 - .6 The VFD vendor shall include for the necessary engineering, programming and on-site commissioning related to the BACnet interface. Include for on-site coordination and check out with the BAS contractor, including point-to-point verification for those points utilized in the BAS programming and graphics. This shall include for points either hardwired as discrete points or points brought in through the BACnet interface.
 - .7 Prohibited locations for VFD installations are where greater than normal dust accumulations occur and where higher than normal ambient temperatures or poor ventilation exists. (Some examples are: near steam stations, steam converters, condensate
-

tanks, generators, or where passive or forced ventilation systems will bring dust into the space).

- .8 Conduit and Cable entries into VFDs shall be made through either the bottom or the side of the unit. Top entry into VFDs by conduits or cables is not permitted.

3.3 Cabling and Grounding by Division 26

- .1 Coordinate with the Electrical Trade to ensure the supply and installation of cables and electrical connections to the VFDs are correct.
- .2 Division 26 will provide separate conduits and or cables for VFD input and output power:
- .1 If the VFD is not preinstalled and pre-wired as a part of a packaged mechanical equipment assembly unit, supply, install, and connect Alcatel Drive Rx Cable (or equal) from VFD to designated motor load for motors separated by more than 10 meters of cable length from the VFD. For motors installed at 10m or less from the unit, the use of standard building wire inside of steel conduit and terminal sections of seal tight flex is deemed acceptable.
- .3 Supply, install, and connect the feeders with adequately sized grounding / bonding conductors in conduit (or cable) as indicated on the project drawings and / or in the specifications from motor control centre to VFD.
- .4 Supply and install a ground conductor in each control conduit with the signal and data control cables from Building Management System (BMS) to each VFD.
- .5 If a local disconnect is required (by either the engineered design or by Canadian Electrical Code) near the motor, the operating mechanism of the disconnecting means shall be so constructed that an auxiliary NO-NC contact will change state when the Switch is operated. Control wiring shall be installed between the disconnect switch and the VFD to enable the VFD to determine if the disconnect switch is open or closed. VFD safeties shall be enabled when the motor is disconnected on the load side of the VFD.
- .6 Local motor disconnects or isolating switches for motors driven by VFDs shall be identified with a separate lamicoid nameplate located as close as practicable to the operating handle of the field (local) disconnecting means. Tag color shall be Orange Face & White Core. The tag shall contain the following wording: "WARNING: Do not open while motor is rotating! Severe damage to VFD will occur! Shut down VFD and only then, open this Switch for Safety. Close switch prior to restarting VFD!".Warning nameplates shall be mechanically fastened to the disconnect switch.
- .7 Torque all conductors with calibrated torque wrench. Terminations to be checked, including but not limited to, power, line, load, ground, and control. Terminations shall be torqued to the manufacturer's recommendation.
-

3.4 Start-up

- .1 The mechanical trade will be responsible to coordinate the installation, testing, and start-up (prior to commissioning commencement) with other parties participating in the start-up activities.
- .2 Start-up to be accomplished as detailed in following example Vendor Start-up Requirements. These shall be considered the minimum general requirements and shall be in addition to the manufacturer's recommended start-up. Where the Vendor or assigned start-up agency believes any requirement to be harmful to the drive or would invalidate warranty, the item(s) of concern shall be identified in writing to the attention of the Engineer.

3.5 Commissioning by Vendor

- .1 The vendor shall provide start-up and commissioning of the variable frequency drive and its optional circuits by a factory-certified service technician who is experienced in start-up and repair services. Service technician shall be a certified journeyman electrician. Sales personnel and other agents who are not factory certified technicians for drive repair shall not be acceptable as commissioning agents.
- .2 The Contractor, in conjunction with the mechanical trade, is responsible to schedule start up and commissioning. Scheduling of Commissioning Activities will provide a minimum five (5) working days notice to the vendor and Owners commissioning team prior to each separate commissioning activity.
- .3 Complete vendors commissioning consistent with factory start up forms. These shall be considered the minimum requirements for Vendors Commissioning. Where the Vendor or Owners Commissioning Team believes any commissioning requirement to be harmful to the drive or would invalidate warranty the item(s) of concern shall be identified in writing to the attention of the Engineer.
- .4 Submit the following written documentation:
 - .1 Verification of proper wire terminations and conduit runs to and from the VFD.
 - .2 Completion of vendors Start-up and Commissioning Form.
 - .3 Verify BAS calibration.
 - .4 Confirm Set-up and tuning of control loop resident in the VFD.
 - .5 Confirm that commissioning procedures have been completed.

3.6 Owners Start-up and Commissioning Procedure

- .1 Each drive will be subject to an Owners start-up and commissioning procedure (hereafter referred to as the Owners Commissioning Team), that will include the Owner (or Owners
-

agent), mechanical trade, electrical trade, and the VFD Vendor. Refer to the sample Owners Commissioning Team check sheet, Article 3.9 that may be utilized by the Owner.

- .2 Provide the Owners Start-up & Commissioning Team with 7 days' notice of VFD start-up. They may elect to witness the vendors' start-up. Vendors' start-up services shall include checking and verifying proper installation and operation of the VFD, its installed options, and its interface to the building automation system as a minimum.
- .3 Owners Start-Up and Commissioning Team will verify the programming of the VFD and will provide a written copy of the settings to the Engineer.
- .4 Owners Start-Up and Commissioning Team will identify critical frequencies that may occur throughout the operating curve of the equipment. Vendor shall program the drive to run through the critical frequencies that have been identified.

3.7 Examination

- .1 The Contractor is to verify that the jobsite conditions for installation meet the factory recommendations and code required conditions for the VFD installation prior to start-up. These shall include as a minimum:
 - .1 Clearance spacing.
 - .2 Compliance with environmental ratings of the VFD system.
 - .3 Separate conduit installation of the input wiring, the motor wiring, and control wiring. At no time does any of this wiring run in parallel with each other.
 - .4 All power and control wiring is complete.
 - .5 Site has been suitably cleaned.
- .2 The VFD is to be covered and protected from installation dust and contamination until the environment is cleaned and ready for operation. The VFD system shall not be operated while the unit is covered.

3.8 VFD Schedule

- .1 Supply, install, start up, and commission VFD's serving motors on mechanical equipment as scheduled on drawings:
-

3.9 Owners Commissioning Team Check Sheets (sample):

VFD Information					
Make				Model Number	
Serial Number				Service Area	
Volts/Phase				Function	
Motor HP		Motor Amps		Drive Max Amps	
Comments:					

Associated Checklists					
Cooling Tower	<input type="checkbox"/>	Air Handling Unit	<input type="checkbox"/>	Other	<input type="checkbox"/>
Pump	<input type="checkbox"/>	Exhaust Fan	<input type="checkbox"/>	Other	<input type="checkbox"/>
Comments:					

Requested documentation submitted	Rec'd	Comments
Manufacturer's cut sheets	<input type="checkbox"/>	
Performance data (pump curves, fan curves, coil data, etc.)	<input type="checkbox"/>	
Installation and startup manual and plan	<input type="checkbox"/>	
O&M manuals	<input type="checkbox"/>	
Factory test results	<input type="checkbox"/>	
Sequences and control strategies	<input type="checkbox"/>	
Warranty Certificate	<input type="checkbox"/>	
Comments:		

Installation Checks			
Check if Acceptable; Provide comment if unacceptable	A	N A	Comment
General			
Installation per manufacturer's requirements	<input type="checkbox"/>	<input type="checkbox"/>	
Permanent label affixed and UL stamp approved	<input type="checkbox"/>	<input type="checkbox"/>	
Drive location not subject to excessive moisture or dirt	<input type="checkbox"/>	<input type="checkbox"/>	
Drive location not subject to excessive temperatures	<input type="checkbox"/>	<input type="checkbox"/>	
Appropriate Volts vs. Hz curve is being used	<input type="checkbox"/>	<input type="checkbox"/>	
Drive independently mounted	<input type="checkbox"/>	<input type="checkbox"/>	
Cooling air flow path clean and unobstructed	<input type="checkbox"/>	<input type="checkbox"/>	
VFD interlocked to control system	<input type="checkbox"/>	<input type="checkbox"/>	
Unit is programmed with full written programming record on site	<input type="checkbox"/>	<input type="checkbox"/>	
Accel time set to _____ and Decel time set to _____	<input type="checkbox"/>	<input type="checkbox"/>	
Coordinated with BAS for all interface ranges and signal isolation	<input type="checkbox"/>	<input type="checkbox"/>	
Restart on Power Failure parameter set to auto	<input type="checkbox"/>	<input type="checkbox"/>	
Drive min and max speed set to _____ Hz min and 60 Hz max	<input type="checkbox"/>	<input type="checkbox"/>	
Security settings set per owner direction and Password documented for owner	<input type="checkbox"/>	<input type="checkbox"/>	
Drive response to loss of signal set to _____	<input type="checkbox"/>	<input type="checkbox"/>	
Output pulse resolution set to _____ MHz. (This is coordinated with the application to minimize audible noise and coordinated with driven bearing allowances.)	<input type="checkbox"/>	<input type="checkbox"/>	
Input of motor FLA represents 100% to 105% of motor FLA rating	<input type="checkbox"/>	<input type="checkbox"/>	
Upper frequency limit set at 100%, unless explained otherwise	<input type="checkbox"/>	<input type="checkbox"/>	
Electrical and Controls			
Power disconnect is located within site of the unit it controls and labeled	<input type="checkbox"/>	<input type="checkbox"/>	

Installation Checks			
Check if Acceptable; Provide comment if unacceptable	A	N A	Comment
All electric connections tight	<input type="checkbox"/>	<input type="checkbox"/>	
Grounding installed for components and unit	<input type="checkbox"/>	<input type="checkbox"/>	
Safeties installed and operational	<input type="checkbox"/>	<input type="checkbox"/>	
Overload breakers installed and correct size	<input type="checkbox"/>	<input type="checkbox"/>	
All control devices and wiring complete	<input type="checkbox"/>	<input type="checkbox"/>	
Control system interlocks connected and functional	<input type="checkbox"/>	<input type="checkbox"/>	
Installation per manufacturer's instructions	<input type="checkbox"/>	<input type="checkbox"/>	
Rotates in the correct direction (for VFD, check Inverter and BYPASS modes)	<input type="checkbox"/>	<input type="checkbox"/>	
Checked the input voltage with drive disconnected	<input type="checkbox"/>	<input type="checkbox"/>	

Operational Checks			
Check if Acceptable; Provide comment if unacceptable		N A	Comment
Operation checked in HAND, OFF, and AUTO. As applicable operation also checked in BYPASS. Where applicable, ensure safeties are active in all modes	<input type="checkbox"/>	<input type="checkbox"/>	
Specified point-to-point checks have been completed and documentation record submitted for this system	<input type="checkbox"/>	<input type="checkbox"/>	
Start-up complete	<input type="checkbox"/>	<input type="checkbox"/>	

GOVERNMENT OF CANADA

Existing Building Renovation

Alberta, Canada

Project No.: 144202775.215

Section 23 05 14

VARIABLE FREQUENCY DRIVES

FOR HVAC EQUIPMENT

Page **23** of **27****3.10**Vendors sample start-up sheet

VFD Tag:			
Pkg. S/N:			
Date:			
Commissioning Agent		Phone	
Service Technician		Fax	
		Email	
Customer:		Phone:	
Address:		Fax:	
		Email:	
Project:		Building:	
Address:			
Site Contact:		Phone:	
Name:		Fax:	
		Email:	

NAMEPLATE INFORMATION							
Package Type:			VFD Tag:			Location:	
Package Model:			S/N:			Application:	
VFD	Model:		HP (CT)		HP (VT)		Voltage:
	S/N:		FLA (CT)		FLA (VT)		Logic #
	MFG		Date				

GOVERNMENT OF CANADA

Existing Building Renovation

Alberta, Canada

Project No.: 144202775.215

Section 23 05 14

VARIABLE FREQUENCY DRIVES

FOR HVAC EQUIPMENT

Page **24** of **27**

	#		Code				
Motor	Make:				Voltage:		HP:
	Model:				RPM:		FLA:
	Insulation Class:		Frame		SF:		Type:
	Ambient Temp:		Duty Cycle:		Efficiency:		Frequency:

PRE POWER-UP CHECKS							
Line Reactor	Make:		Model:		Connection:		
Load Reactor	Make:		Model:		Connection:		
Filters	Output:		RFI:		Arrestor:		
Environment		Temp. with -10 to 40C (14 to 104F)			If No:		
		Humidity OK?			If No:		
		Adequate Ventilation?			If No:		
		Drip Shield?			If No:		
		Clean?			If No:		
Wiring:	Input Power	Complete ?			Separate Conduit?		Proper Size?
	Output Power				Separate Conduit?		Proper Size?
	AC Control				Separate Conduit?		Proper Size?
	DC Control				Separate		Proper Size?

GOVERNMENT OF CANADA

Existing Building Renovation

Alberta, Canada

Project No.: 144202775.215

Section 23 05 14

VARIABLE FREQUENCY DRIVES

FOR HVAC EQUIPMENT

Page **25** of **27**

					Conduit?				
	Grounding						Proper Size?		
Fuses	Input Power:			Control XFMR Primary		Control XFMR Secondary:			
Motor Megger Test									

POWERED CHECKS									
Power Supply	Vab:	V	Vac:	V	Vbc:	V			
	+/- 10% ?		V a-b-c Balanced with 3% ?						
	DC Bus:		Within 5% of input? (AC x 1.414)						
Motor Rotation	VFD:		Bypass		Free Run Stop Time	sec			
Motor Current (in amps)	VFD	@ 60 Hz:	A	@ 45 Hz	A				
		@ 30 Hz:	A	@ 15 Hz:	A				
		Current within specification at all frequency ranges?							
	Bypass	A	Current within specification?						
Signal	Input	Type	OK?	Output	Type	OK?			
	Frequency Reference:			Frequency Feedback:					
	Run:			Current Feedback:					
	External Interlocks:			Run Status:					
	Run Permissive:			Fault Status:					

GOVERNMENT OF CANADA

Existing Building Renovation

Alberta, Canada

Project No.: 144202775.215

Section 23 05 14

VARIABLE FREQUENCY DRIVES

FOR HVAC EQUIPMENT

Page **26** of **27**

Operator	Bypass Module Type:		Key Pad Type:		Speed Pot	
Switches	VFD-Off-Bypass		Hand-Off-Auto		(Other)	
Lights	Power:		Hand:		Auto:	
	VFD:		Bypass:		At Speed:	
				Keypad Lit		Ext. Fault:

AUXILLIARY ITEMS / OPTIONS (e.g. PUMPS STARTERS; PAN HEATERS)					
Option Type #1:			Option Type #2:		
Voltage:		Voltage:			
HP / kW:		HP / kW:			
Fuses / Size:		Fuses / Size:			
Sel. Sw.		Sel. Sw.			
Pilot Light(s)		Pilot Light(s)			
Functions per Dwg?		Functions per Dwg?			
Measure Amps:		Measure Amps:			
Other Comments:		Other Comments:			
External PID Controller		Parameter Settings per Attached			
Network Communications					
Network Type (e.g. N2, FLN, BACnet)		Model / Type of Interface:			
		Address:			
General					
Parameters recorded and attached?			If no, why?		
Parameters saved to laptop?			File		

		Name:	
Parameters uploaded to keypad?			
Manual in the package?		If no, why?	
Wiring diagram in the package?		If no, why?	
“As Commissioned” marked up dwgs attached?		If no, why?	
Other instruction manuals in the package?		If no, why?	
Any changes to the package?		If yes, then notify us with the changes	
Commissioning Completed by (print):			
Sign:			
Commissioning Completion Date:			

END OF SECTION

1. General

1.1 Scope

- .1 Provide meters, gauges and taps where shown on drawings and/or specified herein.

1.2 Reference Documents

- .1 American Society of Mechanical Engineers (ASME):
- .1 ASME Fluid Meter's Handbook: Their Theory and Application, Sixth Edition [1971].
 - .2 ASME B40.100 Pressure Gauges and Gauge Attachments.
 - .3 ASME B40.200 Thermometers, Direct Reading and Remote Reading.
- .2 Canadian General Standards Board (CGSB).
- .1 CAN/CGSB-14.4 Thermometers, Liquid-in-Glass, Self Indicating, Commercial/Industrial Type.
 - .2 CAN/CGSB-14.5 Thermometers, Bimetallic, Self-Indicating, Commercial/Industrial Type.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS):
- .4 Material Safety Data Sheets (MSDS).

1.3 Delivery & Storage

- .1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.4 Waste Management and Disposal

- .1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.5 Submittals

- .1 Submit shop drawings of proposed products to the engineer for review.
- .2 Submit list of all meters, including location, service, flow and corresponding reading for flow.
-

-
- .3 Submit shop drawings on thermometers, pressure gauges and meters. Shop drawings are to indicate, as minimum, the following:
- .1 Service conditions.
 - .2 Full details of primary element including standard of design and construction, materials.
 - .3 Accuracy statements for each component at specified flow rates and other conditions.
 - .4 Flow, temperature or pressure ranges.
 - .5 Signal processor calibration data.

2. Products

2.1 Acceptable Manufacturers

- 1. Thermometers: Ashcroft, Marsh Bellofram, Terice, Weiss, Weksler, Wika, Winters
- 2. Pressure Gauges: Ashcroft, Marsh Bellofram, Terice, Weiss, Weksler, Wika, Winters
- 3. Static Pressure Gauges: Dwyer, Magnehelic

2.2 Thermometers

- .1 Dial Thermometers: 75mm (3") diameter dial in drawn steel case, bimetallic helix actuated, brass separable socket or flange and bushing, glass cover, adjustable pointer.
- .2 Mercury Thermometer: Red reading mercury filled, 2° graduations, plastic or aluminum case, 230mm (9") scale, straight shank, separable socket, adjustable angle.
- .3 Provide separable brass wells to suit pipe diameter and extensions for insulation. For duct thermometers, provide extension stems, aluminum fastening flange and extension for insulation.
- .4 Thermometer range to suit service.
- .5 Graduate thermometers with Fahrenheit **and** Celsius scales.

2.3 Pressure Gauges

- .1 100mm (4") diameter, drawn steel case, phosphor bronze bourdon tube, brass movement, extruded brass socket, 1% midscale accuracy, front calibration adjustment, black figures on white background. Pressure gauges shall be liquid filled with ½% accuracy in locations subject to vibration (on pumps, air handling units, and chillers), and 1% accuracy in all other locations. Provide needle valve and syphon for steam service, pulsating damper and ball valve for water service.
-

.2 Provide each gauge with brass gauge cock or needle valve.

.3 Pressure range to suit service.

2.4 Pressure/Temperature Taps (Pete's Plugs)

.1 Fitting to allow a 3mm (12 gauge) O.D. plug-in gauge to measure temperature or pressure.

.1 Maximum pressure: 3450 kPa (500 psi)

.2 Maximum temperature: 135°C (275°F)

.2 Fitting constructed of:

.1 6mm (¼") NPT brass body with hex head screw cap and gasket.

.2 Protective screw cap to have retaining strap.

.3 Two self-closing valves constructed of norel.

.3 Test kit including the following:

.1 One 65mm (2½") diameter pressure gauge with 3mm (12 gauge) O.D. plug-in stem.

.2 Two 45mm (1¾") diameter temperature gauges with 3mm (12 gauge) O.D. x 125mm (5") plug-in stem, range 0°C to 110°C (32°F to 230°F).

.3 All above in protective carrying case with operating instructions.

.4 Installation:

.1 Install pressure/temperature taps into threaded pipe nipples welded to wall of pipe. Locate fittings in accessible spaces.

.2 Provide one pressure/temperature taps test kit.

2.5 Static Pressure Gauges

.1 Dial Gauge: 100mm (4") dial, diaphragm actuated, suitable for positive, negative, or differential pressure measurement. Accuracy within ±2% of full scale, complete with static pressure tips and mounting accessories.

.2 Inclined Vertical Manometer: molded plastic manometer, accuracy within ±3% of full scale, suitable for positive, negative or differential pressure measurement, complete with static pressure tips, and mounting accessories.

3. Execution

3.1 Thermometers – Installation

- .1 Provide thermometers at the inlet and outlet side of all equipment and components which create a temperature difference for both air and water circuits.
- .2 Thermometer locations are generally indicated, however, additional units may be required based on as-built conditions.
- .3 Check all thermometers for accuracy and recalibrate where necessary before work is handed over.

3.2 Pressure Gauges – Installation

- .1 Provide pressure gauges at the inlet and outlet side of all components which create a pressure difference.
- .2 Pressure gauge locations are generally indicated, however, additional units may be required based on as-built conditions.
- .3 Check all pressure gauges for accuracy and recalibrate where necessary before work is handed over.

3.3 Meters, Gauges and Flow Measuring Devices

- .1 All mechanical equipment shall be provided with instrumentation or test ports to verify critical parameters, such as capacity, pressures, temperatures and flow rates.
 - .2 For gauges on liquid service, provide tee in piping with bronze pulsation damper and ball isolation valve.
 - .3 Select gauges so that normal operating point is approximately mid-point of instrument range.
 - .4 Install gauges between equipment and first fitting valve.
 - .5 Install gauges in locations and angles that are easily readable from normal sight.
 - .6 Provide extensions where pressure gauges or thermometers are installed through insulation.
 - .7 Install pressure/temperature taps into threaded pipe nipples welded to wall of pipe. Locate fittings in accessible spaces.
 - .8 Install flow meters in uninterrupted straight pipe, minimum 5 pipe diameters downstream and 10 pipe diameters upstream, or according to manufacturer's recommendations. Minimum 3 pipe diameters lateral from any physical obstruction to insertion of meter probes.
-

-
- .9 Flow measuring devices shall be capable of communication with the central building automation system.
 - .10 Water flow devices shall conform to the requirements of ASHRAE Standard 90.1.
 - .11 On pipes 65mm (2½") and smaller, place well in tee used in lieu of an elbow to accommodate well.

3.4 Meters and Gauges Installation Schedule

- .1 Pressure Gauges:
 - .1 Where shown on drawings
- .2 Pressure/Temperature Taps - Pete's Plugs:
 - .1 Where shown on drawings
- .3 Thermometers:
 - .1 Where shown on drawings
- .4 Static Pressure Gauges:
 - .1 Across built-up filter banks
 - .2 Across unitary filter sections
 - .3 Across supply and return fans
 - .4 And where shown on drawings
- .5 Static Pressure Taps:
 - .1 Across all major dampers
 - .2 Across filter banks
 - .3 And where shown on drawings

END OF SECTION

1. General

1.1 Scope

- .1 Pipe hangers and supports
- .2 Duct hangers and supports
- .3 Sleeving for mechanical equipment
- .4 Equipment bases and supports
- .5 Pipe anchors
- .6 Access Doors

1.2 Reference Standards

- .1 American National Standards Institute/ American Society of Mechanical Engineers (ANSI/ASME)
 - .1 ANSI/ASME B31.1 Power Piping, (SI Edition).
 - .2 American Society for Testing and Materials (ASTM)
 - .1 ASTM A125 Specification for Steel Springs, Helical, Heat-Treated.
 - .2 ASTM A307 Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .3 ASTM A563 Specification for Carbon and Alloy Steel Nuts.
 - .3 Factory Mutual (FM)
 - .4 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
 - .1 MSS SP58 Pipe Hangers and Supports - Materials, Design and Manufacture.
 - .2 MSS SP69 Pipe Hangers and Supports - Selection and Application.
 - .3 MSS SP89 Pipe Hangers and Supports - Fabrication and Installation Practices.
 - .5 National Fire Protection Association (NFPA):
-

.1 NFPA 13-2010 Standard for the Installation of Sprinkler Systems

.6 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

.1 SMACNA HVAC Duct Construction Standards - Metal and Flexible

.7 Underwriter's Laboratories of Canada (ULC)

1.3 General Requirements

.1 Provide hangers and supports to secure equipment in place, prevent vibration, maintain grade,

.2 Provide for expansion and contraction of systems.

.3 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.

.4 Install supports of strength and rigidity to suit loading without unduly stressing the building. Locate adjacent to equipment to prevent undue stresses in piping and equipment. Where support is from concrete construction, avoid weakening concrete or penetrating waterproofing.

.5 Select hangers and supports for the service and in accordance with manufacturer's recommended maximum loading. Hangers shall have a safety factor of 5 to 1.

.6 Fasten supports and hangers to building structure. Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practical. When possible, set inserts in position in advance of concrete work. Drill concrete where inserts must be placed after concrete is poured.

.7 Ensure that supports, guides, anchors do not transmit excessive quantities of heat to building structure.

.8 Where structural bearings do not exist or where inserts are not in suitable locations for proper installation of pipes, conduits and ducts, provide approved support made of steel channels or angles from which to suspend hangers. Do not use existing piping, crane rails, trolley beams, mono rails, etc, for support.

.9 No percussion type fastening of any kind will be permitted without prior approval.

.10 Provide and set sleeves or block-outs required for equipment, including openings required for placing equipment.

.11 Provide sleeves for all piping through rated assemblies. In non-rated assemblies, provide sleeves for all heating, cooling, steam, condensate, domestic hot, domestic cold, and domestic recirculation piping. Sleeves to be sized to allow insulation to pass through to both sides of wall.

-
- .12 Provide sleeves for all piping through ceilings, floors and footings.
 - .13 Provide sleeves for duct penetrations through walls, ceilings, floors and footings. Provide locations and dimensions for block-outs imbedded material if provided by others.
 - .14 Do not weld piping, ductwork or equipment supports to building metal decking or building structural steel supports unless prior written approval has been obtained from the structural engineer.
 - .15 Obtain approval prior to drilling for inserts and supports for piping system. Discuss and obtain approval for hanging systems and methods with Structural Engineer.
 - .16 Obtain approval prior to using percussion type fastenings.
 - .17 Use of piping or equipment for hanger supports and use of perforated band iron, wire or chain as hangers is not permitted.

1.4 Submittals

- .1 Submit shop drawings and product data for the following items:
 - .1 Access doors
 - .2 Bases, hangers and supports
 - .3 Connections to equipment and structure

1.5 Delivery & Storage

- .1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.6 Waste Management and Disposal

- .1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

2. Products

2.1 Acceptable Manufacturers

- 1. Pipe Hangers: Anvil, Cooper B-Line, Crane
- 2. Access Doors: Acudor, Maxam, Mifab, Milcor, Williams Brothers

2.2 Inserts

- .1 Provide inserts to cast in concrete of malleable cast iron or galvanized steel and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms.
-

- .2 Furnish self-drilling expansion shell for poured-in-place concrete if the concrete is set. Under no circumstances will Ramset pins or other explosive type pins be allowed.
- .3 Size inserts to suit threaded hanger rods.

2.3 Pipe Hangers and Supports

- .1 Hangers for steel piping systems:

Service	Hanger Type	Material	Finish
1. Nominal pipe size 12mm to 50mm:			
All services	Adjustable ring	Carbon steel	Black, prime coated
2. Nominal pipe size 50mm to 100mm:			
All services	Adjustable clevis (heavy duty)	Carbon steel	Black, prime coated

- .2 Hangers for copper and special material piping systems:

Service	Hanger Type	Material	Finish
1. Nominal pipe size 15mm to 50mm:			
All services	Adjustable ring	Carbon steel	Copper plated
2. Nominal pipe size 50mm to 100mm:			
All services	Adjustable ring	Carbon steel	Copper plated

- .3 Fabricate hangers, supports and sway braces in accordance with ANSI B31.1 and MSS SP58.
- .4 Use components for intended design purpose only. Do not use for rigging or erection purposes.
- .5 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods. Cast iron roll and stand for hot pipe sizes 150mm (6") and over. Cup washers for hot piping below 150mm (6").
- .6 Wall Support, Pipe Sizes to 75mm (3"): Cast iron hook.
- .7 Wall Support, Pipe Sizes 100mm (4") and Over: Welded steel bracket and wrought steel clamp, adjustable steel yoke and cast iron roll for hot pipe sizes 150mm (6") and over.
- .8 Vertical Support: Steel riser clamp.
- .9 Floor Support, Pipe Sizes to 100mm (4") and All Cold Pipe Sizes: Cast iron adjustable pipe saddle, locknut nipple, floor flange and concrete pier or steel support.

-
- .10 Floor Support, Hot Pipe Sizes 125mm (5") and Over: Adjustable cast iron roll and stand, steel screws and concrete pier to steel support.
 - .11 Design hangers so they cannot become disengaged by movements of supported pipe.
 - .12 Provide copper plated hangers and supports for copper piping.
 - .13 Provide galvanized hangers and supports for galvanized piping.

2.4 Hanger Rods

- .1 Provide galvanized rods, threaded both ends, threaded one end, or continuous threaded.

2.5 Riser Clamps

- .1 Steel or cast iron pipe: galvanized carbon steel to MSS SP58, type 42.
- .2 Copper pipe: carbon steel copper plated to MSS SP58, type 42.
- .3 Bolts: to ASTM A307.
- .4 Nuts: to ASTM A563.

2.6 Insulation Protection Shields

- .1 Insulated cold piping:
 - .1 64 kg/m³ density insulation plus insulation protection shield to: MSS SP69, galvanized sheet carbon steel. Length designed for maximum 3 m span.
- .2 Insulated hot piping:
 - .1 Curved plate 300mm (12") long, with edges turned up, welded-in centre plate for pipe sizes 15mm (½") and over, carbon steel to comply with MSS SP69.

2.7 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 25mm (1") minimum.
-

-
- .6 Individually calibrated scales on each side of support calibrated prior to shipment, complete with calibration record.

2.8 Variable Support Spring Hangers

- .1 Vertical movement: 15mm (½”) minimum, 50mm (2”) maximum, use single spring pre-compressed variable spring hangers.
- .2 Vertical movement greater than 50mm (2’): use double spring pre-compressed variable spring hanger with 2 springs in series in single casing.
- .3 Variable spring hanger to be complete with factory calibrated travel stops.
- .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.

2.9 Equipment Supports

- .1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel meeting requirements of Division 05 – Metals. Submit calculations with shop drawings.

2.10 Equipment Anchor Bolts and Templates

- .1 Provide templates to ensure accurate location of anchor bolts.

2.11 Duct Hangers and Supports

- .1 Conform to SMACNA manuals.

2.12 Sleeves

- .1 Place pipe sleeves at all points where pipes pass through masonry or concrete walls or floors.
 - .2 Size sleeves in order to provide approximately 6.5mm (¼”) clearance, all around, between the sleeve and the duct or pipes, or where the pipe is insulated, provide approximately 6.5mm (¼”) clearance all around between the sleeve and insulation. Size sleeves through footings large enough to accommodate hub of cast iron soil pipe. Sleeve piping and drains where they pass below any footing to provide a minimum all around clearance of 50mm (2”) and backfill up the underside of the footing with concrete of the same strength as the footing.
 - .3 Terminate sleeves flush with walls and ceilings, 50mm above floors generally and 100mm above finished floor level in mechanical rooms.
-

-
- .4 Where sleeves are required for pipes passing through the roof, anchor the sleeve in roof construction, caulk between sleeve recess and stack, fasten roof flashing to the clamp device, make a water-tight durable joint.
 - .5 Fill all voids between sleeve material and pipe, conduit or duct passing through. Use the following procedure for sleeve caulking:
 - .1 Where sleeves pass through walls or floors, caulk the space between the pipe and sleeve with dry oakum and seal each side with a non-hardening mastic.
 - .2 Ensure no contact between copper tube or pipe and ferrous sleeve.
 - .6 Where piping or ducts pass through a construction which is required to have a specific fire resistance rating, seal any space between the pipe or duct and the construction, including the space between the pipe or duct and the sleeve, with non-combustible insulating material and close off on both sides with tight fitting metal caps constructed of 1.6mm metal. Use caulking approved by the consultant and by all authorities having jurisdiction.
 - .7 Pipes through Floors: Form with steel pipe or approved PVC sleeves.
 - .8 Pipes through Beams, Walls, Fire Proofing, Footings, Potentially Wet Floor: Form with steel pipe.
 - .9 Ducts: Form with galvanized steel.
 - .10 Size sleeve large enough to allow for movement due to expansion and to provide for continuous insulation.

2.13 Access Doors

- .1 Types:
 - .1 Drywall Surface – Flanged Door: Universal flush access door with concealed bar hinge and rounded safety corners; Acudor UF-5000.
 - .2 Drywall Surface – Hidden Flange: Access door with concealed bar hinge and rounded safety corners; flange of textured galvanized steel drywall taping bead with pre-punched holes; installed after drywall; Acudor DW-5040.
 - .3 Masonry: Universal flush access door with concealed bar hinge and rounded safety corners; Acudor UF-5000.
 - .4 Tile Surface: Stainless steel, universal flush access door with concealed bar hinge and rounded safety corners; Acudor UF-5000.
 - .5 Plaster Walls and Ceilings: Access door with expansion casing bead and 75mm (3") wide galvanized lath surround recessed 19mm (¾") to receive plaster; Acudor PS-5030.
-

-
- .6 Acoustic Plaster: 15mm ($\frac{5}{8}$ ") Secessed access door with self-furring lath and 75mm (3") galvanized lath surround recessed 19mm ($\frac{3}{4}$ ") to receive plaster; Acudor AP-5010.
 - .7 Acoustical Tile Ceilings: Door recessed 25mm (1") to receive acoustic tile; Acudor AT-5020.
 - .8 Fire Rated Walls: Self-closing, self-latching door; ULC – 2 hour "B" label; For use when temperature rise is not a factor; Acudor FB-5060.
 - .9 Fire Rated Walls: Self-closing, self-latching door with 50mm (2") fire rated insulation; ULC – 2 hour "B" label with a maximum temperature rise of 139°C (250°F) after 30 minutes; For use when temperature rise or heat transmission is a factor; Acudor FW-5050.
 - .10 Fire Rated Ceilings: Self-closing, self-latching, inward opening door with 50mm (2") fire rated insulation; ULC – 2 hour "B" label with a maximum temperature rise of 139°C (250°F) after 30 minutes; For use when temperature rise or heat transmission is a factor; Acudor FW-5050-UP.
- .2 Construction
- .1 Non-Rated Doors: One piece outer flange welded to mounting frame; Continuous, concealed hinge; Doors 400mm x 400mm (16"x16") and smaller – 16 gauge door, 18 gauge mounting frame; Doors over 400mm x 400m (16"x16") – 14 gauge door, 16 gauge mounting frame.
 - .2 Rated Doors: 25mm (1") wide flange; Continuous, concealed hinge; 20 gauge door, 16 gauge mounting frame.
 - .3 Stainless steel screwdriver operate cam latch (non-rated doors); Universal self-latching bolt operated by a knurled knob or flush key (rated doors).
 - .4 Steel access doors: 5 stage iron phosphate preparation with prime coat of grey baked enamel.
 - .5 Stainless steel doors: #4 satin polish.

3. Execution

3.1 General

- .1 Install as per manufacturer's instructions and recommendations.
 - .2 Provide rigid anchors for ducts and pipes immediately after vibration isolation connections to equipment unless spring hangers are specified.
-

3.2 Inserts

- .1 Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.
- .2 Set inserts in position in advance of concrete work. Provide reinforcement rod in concrete for inserts carrying pipe over 100mm (4").
- .3 For poured-in-place concrete, place inserts in a manner such that they are not disturbed during construction or interfere to the detriment of the strength of the structure.
- .4 Where concrete slabs form finished ceiling, finish inserts flush with slab surface.
- .5 Where inserts are omitted, drill through concrete slab from below and provide rod with recessed 100mm (4") minimum square steel plate and nut above slab.
- .6 Supply all templates, special frame inserts, etc., required to accommodate equipment supplied under this section and turn over to the contractor for installation. It is the responsibility of this section to ensure the correct placement and mounting of these items.
- .7 All cutting and patching required to accommodate the installation of inserts is the responsibility of this section, but the appropriate trades are to do the work in a manner satisfactory to the architect.

3.3 Pipe Hangers and Supports

- .1 Support horizontal steel and copper piping as follows:

Nominal Pipe Size mm (in)	Distance Between Supports mm (in)		Hanger Rod Diameter mm (in)
	Steel	Copper	
15 (½") to 20 (¾")	1800 (72")	1500 (60")	10 (3/8")
25 (1") to 40 (1½")	2100 (84")	1800 (72")	10 (3/8")
50 (2") to 65 (2½")	3000 (120")	2400 (96")	10 (3/8")
75 (3") to 100 (4")	3600 (144")	3000 (120")	15 (½")
150 (6") to 300 (12")	4200 (168")	4000 (160")	20 (¾")
350 (14") to 450 (18")	6000 (240")	6000 (240")	25 (1")

- .2 Install hangers to provide minimum 15mm (½") clear space between finished covering and adjacent work.
- .3 Use oversize hangers to accommodate pipe insulation thickness. For pipes up to 50mm (2") use high density rigid pipe insulation at hanger location, with an insulation protection shield. For pipes 65mm (2½") and over use insulation protection saddle.

-
- .4 Place a hanger within 300mm (12") of each horizontal elbow.
 - .5 Use hangers which are vertically adjustable 40mm (1½") minimum after piping is erected.
 - .6 On insulated copper piping, affix lead or other approved backing to ensure no contact between copper and ferrous hanger or other work.
 - .7 Support vertical piping not subject to expansion or contraction with bolted steel riser clamps at each floor level or a maximum of 3000mm (10'-0"), whichever is shorter. Secure vertical cast iron soil pipe with drive hooks at 1500mm (60") intervals set below hubs, and by riser clamps at each floor level.
 - .8 Vertical piping subject to expansion or contraction where grooved joint couplers are used shall be supported with riser clamps at each floor level. Ensure at least one grooved joint occurs between each floor.
 - .9 Vertical piping subject to expansion or contraction where welded or threaded shall be supported and anchored at maximum 20mm intervals with expansion joints. Provide guides at each floor.
 - .10 Provide supports for chromium plated piping or tubing or either chromium plated cast brass or chromium plated die-cast zinc alloy. Where exposed, use chromium plated bolts, screws, and nuts for assembly and attachment of such supports. Use supports for pipes running along walls of such length that the clearance between the pipe and the face of the wall will not be less than 20mm and not more than 25mm.
 - .11 Place piping hung or supported by rising or clevis hangers directly onto the hanger and insulation carried over the hanger, finish insulation neatly where the hanger protrudes over the insulation. Provide piping 50mm and over with pipe covering protection saddles and insulation butted against the saddle, also provide insulation between the pipe and saddle.
 - .12 Where piping is supported from floor, use cast iron adjustable pipe saddle supports with locknut nipple, floor flange and concrete pier or steel support. Where provision for expansion or contraction is required, use adjustable pipe roll stands with vertical adjustment and concrete pier or steel support.
 - .13 Support cast iron horizontal drainage pipe near each hub and on each side of gasket and clamp joints, with 1500mm (60") maximum spacing between hangers.
 - .14 For all horizontal drainage pipe (sanitary and storm) below structural slabs, provide clevis ring hangers supported from the structural slab.
 - .15 Provide insulation saddles for insulated pipe.
 - .16 For steel cold water insulated pipe, use prefabricated insulated shields with high density insulation and vapor barrier. Shield length to be four times insulation outside diameter.
-

-
- .17 For all insulated copper piping, use shields of 1.2mm galvanized sheet metal, length two times insulation outside diameter and ½ the insulation circumference.
 - .18 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 - .19 Where practical, support riser piping independently of connected horizontal piping.

3.4 Duct Hangers and Supports

- .1 Support duct work in accordance with SMACNA standards and, as a minimum, as follows.

3.5 Low Pressure Duct Hangers and Supports

- .1 Hanger Minimum Sizes:
 - .1 Up to 750mm (30") wide: 25mm (1") x 1.6mm (16 gauge) at 3.0m (10 ft) spacing;
 - .2 775mm (31") to 1200mm (48") wide: 40mm (1½") x 1.6mm (16 gauge) at 3.0m (10 ft) spacing;
 - .3 Over 1200mm (48") wide: 40mm (1½") x 1.6mm (16 gauge) at 3.4m (11ft) spacing.
 - .2 Horizontal Duct on Wall Supports Minimum Sizes:
 - .1 Up to 450mm (18") wide: 40mm (1½") x 1.6mm (16 gauge) or 25mm (1") x 3mm (12 gauge) at 3.4m (8ft) spacing;
 - .2 475mm (19") to 1000mm (40") wide: 40mm (1½") x 40mm (1½") x 3mm (12 gauge) at 1.2m (4ft) spacing.
 - .3 Vertical Duct on Wall Supports Minimum Sizes:
 - .1 At 3.6mm (10 gauge) spacing:
 - .1 Up to 600mm (24") wide: 40mm (1½") x 1.6mm (16 gauge);
 - .2 625mm (25") to 900mm (36") wide: 25mm (1") x 25mm (1") x 3mm (12 gauge);
 - .3 925mm (37") to 1200mm (48") wide: 30mm (1¼") x 30mm (1¼") 3mm (12 gauge).
 - .4 Vertical Duct Floor Supports Minimum Sizes:
 - .1 Riveted or screwed to duct;
-

- .1 Up to 1500mm (60") wide: 40mm (1½") x 40mm (1½") x 3mm (12 gauge);
- .2 Over 1500mm (60") wide: 50mm (2") x 50mm (2") x 3mm (12 gauge).

3.6 Medium and High Pressure Duct Hangers and Supports

- .1 Rectangular Duct Hangers Minimum Sizes:
 - .1 Up to 900mm (36") wide: 2 at 25mm (1") x 1.6mm (16 gauge) at 3.0m (10'-0") spacing;
 - .2 925mm (37") to 1500mm (60") wide: 2 at 25mm (1") x 1.6mm (16 gauge) at 2.4m (8'-0") spacing and 50mm (2") x 50mm (2") x 6mm (¼") trapeze;
 - .3 1525mm (61") to 3000mm (120") wide: 2 at 40mm (1½") x 2.7mm (12 gauge) at 2.4m (8'-0") spacing and 50mm (2") x 50mm (2") x 6mm (¼") trapeze;
 - .4 3200mm (128") to 6000mm (240") wide: 3 at 10mm (3/8") diameter at 1.2m (4'-0") spacing and 65mm (2½") x 65mm (2½") x 6mm (¼") trapeze.
- .2 Round Duct Hangers Minimum Sizes:
 - .1 At 3m (10'-0") spacings:
 - .1 Up to 450mm (18") diameter: 25mm (1") x 1.6mm (16 gauge);
 - .2 475mm (19") to 900mm (36") diameter: 25mm (1") x 2.7mm (12 gauge);
 - .3 925mm (37") to 1250mm (50") diameter: 40mm (1½") x 2.7mm (12 gauge);
 - .4 1300mm (51") to 2000mm (80") diameter: 2 at 40mm (1½") x 2.7mm (12 gauge) from girth reinforcing angle.
- .3 Vertical Duct Floor Supports Minimum Sizes:
 - .1 Up to 1200mm (48") wide: 40mm (1½") x 40mm (1½") x 3mm (12 gauge);
 - .2 Over 1200mm (48") wide: 50mm (2") x 50mm (2") x 5mm (3 gauge).
 - .3 Rivet to duct and tie angles together with rod, angles or "band iron".
 - .4 Angle reinforcing may be used for support omitting trapeze.

3.7 Sleeves

- .1 Set sleeves in position in advance of concrete work. Provide suitable reinforcing around sleeve.

-
- .2 Extend sleeves through potentially wet floors 25mm (1") above finished floor level. Caulk sleeves full depth and provide floor plate.
 - .3 Piping and duct work passing through floor, ceiling or wall, close off space between duct and sleeve with non-combustible insulation. Caulk both sides.
 - .4 Piping passing through perimeter walls below grade, mechanical room floor, roof or wall, close off space between pipe and sleeve with synthetic rubber compound mechanical type seals.
 - .5 Sleeves provided through walls or floors where liquids could potentially pass from one side to the other, provide sleeves with a 25mm (1") 'flange' welded to the external face of the sleeve at the mid-point of the thickness of the structure to provide a water stop.
 - .6 Install chrome plated escutcheons where piping passes through finished surfaces.

3.8 Access Doors

- .1 Provide access doors for maintenance or adjustment purposes for all mechanical system components including:
 - .1 Valves
 - .2 Volume and splitter dampers
 - .3 Fire Dampers
 - .4 Expansion joints
 - .5 Control components
 - .6 Cleanouts and traps
 - .2 Where access is required through removable acoustic tile ceilings, identify with coloured round stickers (6mm diameter) on all tees adjacent the tiles to be used for access.
 - .3 Where equipment is concealed by a continuous structural or architectural surface, supply access doors of design to suit and match the surface in which they will be installed.
 - .4 Provide stainless steel doors in walls of washrooms, kitchen, janitor rooms and laundry rooms.
 - .5 When located in a finished floor with tile, stonework, terrazzo, etc., a recessed bearing type access door is required. The door surface shall have a recess to take the particular surface and pattern if this is available at the time the units are ordered.
 - .6 Provide ULC listed fire rated access doors when installed in fire rated walls and ceilings.
 - .7 300mm x 300mm (12"x12") minimum, for inspection and hand access.
-

-
- .8 450mm x 450mm (18"x18") minimum, larger if indicated on drawings, where entry is required and access is difficult.
 - .9 Size access door to suit masonry modules when located in a masonry wall.
 - .10 Refer to architectural reflected ceiling plan for size and location of additional access doors.
 - .11 Ensure the number of access doors required is maintained at a minimum by locating mechanical components requiring access in accessible locations such as removable tile ceilings, etc.
 - .12 Provide a schedule of access doors showing location, type and size, together with samples, to the consultant for approval before installation. Avoid locating access doors in feature walls or ceilings without prior approval of the consultant.
 - .13 Access doors will be provided under Section 23 05 29, but installed by the trade governing the surface in which they are to be installed.

3.9 Metal Supports

- .1 Except where detailed on structural drawings, design, construct and install metal supports, stands, platforms and other metal structures including maintenance platforms required for and associated with the mechanical equipment. Ensure that structures are designed so that loads and impact loads are properly distributed into building structure.
- .2 Where equipment is indicated or specified to be floor mounted on stands or legs, fabricate these from structural steel section and/or steel pipe with adequate bracing and steel plate flanges for bolting to the concrete base or floor.
- .3 Where ceiling or wall mounting is indicated or specified, use a suspended platform, bracket or shelf, whichever is most suitable for the equipment and its location. Fabricate from standard structural steel sections and plate and/or steel pipe. Ensure that these structures are adequately fastened to the building structure.
- .4 Supports must be large enough to support the equipment along the entire length and width. Adequate provision must be made to install isolators if necessary either below the support or between support and the equipment.
- .5 If necessary to provide continuous and rigid support for equipment components, mount all components on channel or "I" beams before mounting on isolators.

END OF SECTION

1. General

1.1 Scope

- .1 Vibration isolation for piping, ductwork and equipment
- .2 Equipment isolation bases
- .3 Flexible piping connections
- .4 Resilient pipe anchors and guides

1.2 General

- .1 Supply all labor, materials, and equipment required and necessary to isolate and restrain the equipment as indicated on the drawings and specified herein and guarantee the function of the materials and equipment supplied.
- .2 Obtain all relevant equipment information and provide shop and placement drawings for all vibration isolation elements for review, before materials are ordered. The drawings shall bear the stamp and signature of the responsible supplier's technical representative.
- .3 Provide attachment to both the equipment and the structure meeting the specified forces involved.

1.3 Reference Standards

- .1 National Building Code of Canada (NBC) 2010
- .2 Alberta Building Code of Canada (ABC) 2014

1.4 Quality Assurance

- .1 Provide and install appropriate vibration isolation materials/products on mechanical equipment so that Average Noise Criteria curves, as outlined in ASHRAE Guide, are not exceeded.
- .2 All elastomeric components in type 1, type 2 isolation mounts shall be bridge bearing neoprene, meeting CSA Standard CAN3-S6 Section 11.10.
- .3 All vibration isolators and bases shall be supplied by an approved supplier with the exception of isolators which are factory installed and are standard equipment with the machinery.
- .4 The work shall be carried out in accordance with the specification and, where applicable, in accordance with the manufacturer's instructions and only by workmen experienced in this type of work.

- .5 Equipment supplier to ensure equipment is sufficiently rigid for isolator point loading. Project Mechanical Consultant must be advised of any equipment which requires an additional support base, at least 7 working days prior to tender closing.

1.5 Delivery & Storage

- .1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.6 Waste Management and Disposal

- .1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.7 Submittals

- .1 The manufacturer of vibration isolation shall provide submittals for products as follows:
 - .1 Descriptive Data:
 - .1 Schedule of flexibly mounted equipment, referencing drawings by number.
 - .2 Catalog cut or data sheets on vibration isolators.
 - .2 Drawings:
 - .1 Submit details of equipment bases including dimensions, structural member sizes and support point locations.
 - .2 Submit details of isolation hangers for ceiling hung equipment, piping and ductwork.
 - .3 Submit details of mountings for floor supported equipment, piping and ductwork.
 - .4 All hanger, mounting or pad drawings shall indicate deflections and model numbers as well as any other requirements in the specifications.
 - .5 Spring diameters, rated loads and deflections, heights at rated load and closed height shall be provided for all springs shown in the submittals in tabular form.
 - .6 Complete flexible connector details.
- .2 Provide an equipment isolation schedule that provides design data for each isolator including: spring O.D., free operating and solid heights, minimum static deflection, and ratio of horizontal to vertical stiffness.

- .3 Co-ordinate with Division 3 for the provision of housekeeping pads at least 100mm (4") high under all isolated equipment and where indicated on drawings. Provide at least 175mm (7") clearance between drilled inserts and edge of housekeeping pads and follow structural consultant's instructions for drilled inserts.
- .4 Bolt all equipment to the structure. Do not bridge isolation elements.

2. Products

2.1 Acceptable Manufacturers

- 1. Vibration Controls: : Kinetics, IAC Acoustics, Korfund, Mason, Vibro-Acoustic
- 2. Flexible Pipe Connectors : Flexonics, Mason

2.2 Description

- .1 Provide vibration isolation on all motor driven equipment with motors of 0.37 kW (0.5 HP) and greater power output (as indicated on the motor nameplate) and on piping and ductwork, as specified herein. For equipment less than 0.37 kW (0.5 HP), provide neoprene grommets at the support points.
- .2 Electrical cable connected to isolated equipment shall allow for a minimum $\pm 25\text{mm}$ ($\pm 1"$) of equipment movement in any direction.
- .3 Ensure isolation systems have a vertical natural frequency no higher than one third of the lowest forcing frequency, unless otherwise specified. Use dynamic stiffness in selection of elastomers and do not exceed 60 durometer.
- .4 Provide spring thrust restraints on all fans (except vertical discharge) in excess of 1 kPa (0.15 psi) static pressure, and on hanger supported, horizontally mounted axial fans with more than 333 N thrust due to static pressure.
- .5 Isolators and restraining devices which are factory supplied with equipment shall meet the requirements of this section.
- .6 Provide concrete inertia bases where specified or required by equipment manufacturer located between all vibrating equipment and the vibration isolation elements. Provide inertia bases on base mounted pumps over 7.5 kW (10 HP), except slab on grade installations. Refer to structural specifications for concrete work. Concrete work by General Contractor.

2.3 Isolators

- .1 All isolators shall be of the following types, supplied by approved manufacturers.

-
- .2 Vibration isolators shall have minimum operating static deflections as indicated in the Vibration Isolation Schedule or as indicated on the project documents but not exceeding published load capacities.
 - .3 Isolation hangers shall be selected by the manufacturer for each specific application to comply with deflection requirements as shown on the Vibration Isolation Schedule or as indicated on the project documents.
 - .4 Springs shall be selected to provide operating static deflections shown on the Vibration Isolation Schedule or as otherwise indicated on the project documents. Springs shall be color coded or otherwise identified to indicate load capacity.
 - .5 Isolator types shall be as follows:

- .1 Type 1 – Fiberglass Pad Isolator (Floor Mounted Equipment)

- .1 Isolator pads shall be pre-compressed molded fiberglass pads individually coated with a flexible, moisture impervious elastomeric membrane.
- .2 Pads shall be molded from fine (6.9 microns) bonded annealed glass fibers which have been stabilized during manufacture by compressing the material ten (10) times.
- .3 Pads shall have a constant natural frequency over the operating load range, and the stiffness shall increase proportionately with load applied.
- .4 Pads shall be no taller than the shortest horizontal dimension. Where the equipment base does not provide a uniform load surface, steel plates shall be bonded to the top of the pads.

Standard of Acceptance: Kinetics model KIP

- .2 Type 1 – Rubber Pad Isolators

- .1 Isolation pads shall be neoprene elastomer in-shear pads, used in conjunction with steel shims where required, having static deflections as tabulated.
- .2 Isolation pads shall be elastomer in-shear and shall be molded using 17,237 kPa (2500 psi) minimum tensile strength, oil resistant neoprene compounds with no color additives. Pads to be used in conjunction with steel shims where required, and will have static deflections as tabulated.
- .3 Pads shall be 50 durometer and designed to permit 413.7 kPa (60 psi) loading at a maximum rated deflection of 4mm (0.15").
- .4 When two isolation pads are laminated, they shall be separated by, and bonded to, a galvanized steel shim plate.

Standard of Acceptance: Mason – Super W Series

.3 Type 2 – Rubber Mounts (Floor Mounted Equipment)

- .1 Neoprene mountings shall be molded from oil-resistant compounds and have a minimum static deflection of 9mm (0.35”).
- .2 All metal surfaces shall be neoprene covered and have friction pads both top and bottom. Bolt holes shall be provided on the bottom and a tapped hole and screw on top.

Standard of Acceptance: Mason – Model ND

.4 Type 2 – Rubber Hanger (Suspended Equipment)

- .1 Vibration isolators with maximum static deflection requirements under the operating load conditions not exceeding 15mm (0.57”) shall be hangers consisting of an elastomer-in-shear insert encased in a welded steel bracket and provided with a stamped load transfer cap.
- .2 The elastomer insert shall be neoprene, molded from oil resistant compounds and shall be color coded to indicate load capacity and selected to operate within its published load range.
- .3 The hanger shall be designed to carry a 500% overload without failure and to allow a support rod misalignment through a 30-degree arc without metal-to-metal contact or short circuit.

Standard of Acceptance: Mason – HD Series

.5 Type 3 – Spring Isolators (Suspended Equipment, Piping & Ductwork)

- .1 Hangers shall consist of rigid steel frame containing a minimum 32mm (1-1/4”) thick natural rubber, or neoprene, rubber element at the top and a steel spring seated in a steel washer reinforced with a natural rubber, or neoprene, cup on the bottom.
- .2 The ratio of the spring diameter divided by the compressed spring height shall be no less than 0.8. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.
- .3 The natural rubber, or neoprene, element and the cup shall have molded bushings projecting through the steel box. In order to maintain stability the boxes shall not be articulated as clevis hangers nor the natural rubber, or neoprene, element stacked on top of the spring.
- .4 Spring and hanger lower hole diameters shall be large enough to permit the hanger rod to swing through a 30° arc from side to side before contacting the cup bushing and short circuiting the spring.

Standard of Acceptance: Mason – Model 30N

- .6 Type 3 – Pre-compressed Spring Isolators (Suspended Equipment, Piping & Ductwork)
- .1 Hangers shall consist of rigid steel frame containing a minimum 32mm (1-1/4") thick natural rubber, or neoprene, rubber element at the top and a steel spring seated in a steel washer reinforced with a natural rubber, or neoprene, cup on the bottom.
 - .2 The ratio of the spring diameter divided by the compressed spring height shall be no less than 0.8. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.
 - .3 The natural rubber, or neoprene, element and the cup shall have molded bushings projecting through the steel box. In order to maintain stability the boxes shall not be articulated as clevis hangers nor the natural rubber, or neoprene, element stacked on top of the spring.
 - .4 Spring and hanger lower hole diameters shall be large enough to permit the hanger rod to swing through a 30° arc from side to side before contacting the cup bushing and short circuiting the spring.
 - .5 Hangers shall be pre-compressed and locked at the rated deflection by means of a steel pre-compression washer to keep the piping, or equipment, at a fixed elevation during installation.
 - .6 The hangers shall be designed with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load. Deflection shall be clearly indicated by means of a scale.

Standard of Acceptance: Mason – Model PC30N

- .7 Type 3 – Spring Isolators (Suspended Ductwork)
- .1 Hangers shall consist of rigid steel frame containing a steel spring seated in a steel washer reinforced with a natural rubber, or neoprene, cup on the bottom.
 - .2 The ratio of the spring diameter divided by the compressed spring height shall be no less than 0.8. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.
 - .3 The natural rubber, or neoprene, element and the cup shall have molded bushings projecting through the steel box. In order to maintain stability the boxes shall not be articulated as clevis hangers nor the natural rubber, or neoprene, element stacked on top of the spring.

- .4 Spring and hanger lower hole diameters shall be large enough to permit the hanger rod to swing through a 30° arc from side to side before contacting the cup bushing and short circuiting the spring.

Standard of Acceptance: Mason – Model (W) 30

2.4 Bases

- .1 All bases shall be of the following types, supplied by approved manufacturers.

- .1 Type A – Direct Isolation

- .1 No base required. Isolators may be attached directly to the supported equipment.

- .2 Type B – Structural Bases

- .1 Bases shall be fabricated from structural beam sections with welded isolator brackets and pre-located anchor bolt holes, and shall be designed and supplied by the isolation materials manufacturer.

- .2 Rectangular bases are preferred for all equipment. Centrifugal refrigeration machines and pump bases may be T or L shaped. Pump bases for split case pumps shall be large enough to support suction and discharge elbows.

- .3 Section depth of each member shall be greater than 10% of the longest span between supporting isolators, or as shown on the drawings or indicated in the project documents. Lateral cross members shall be added, as necessary, to form a structurally integral, welded frame to provide a rigid, distortion-free frame to support and anchor separate equipment components or driving and driven members.

- .4 Isolator support brackets shall be welded to the structural beams as required to obtain the lowest mounting height for the supported equipment and provide a base clearance of 25mm (1”).

Standard of Acceptance: Mason – Model WF

- .3 Type B – Structural Rails

- .1 Bases shall be structural beam sections, with welded on isolator support brackets and pre-located and drilled anchor bolt holes or skids, and shall be designed and supplied by the isolation materials manufacturer.

- .2 Beam sections shall not be structurally connected to each other. Structural members shall have sufficient rigidity to prevent distortion of the equipment, as determined by the vibration isolation manufacturer.

- .3 Isolator support brackets shall be welded to the structural beams as required to obtain the lowest mounting height for the supported equipment and provide a base clearance of 25mm (1").

Standard of Acceptance: Mason – Model ICS

2.5 Acoustical Seals

- .1 Acoustical seals shall be used where indicated on drawings.
- .2 Split seals shall consist of pipe halves with minimum 20mm (3/4") thick neoprene sponge cemented to the inner faces. The seal shall be tightened around the pipe to eliminate clearance between the inner sponge face and the piping.
- .3 Seals shall project a minimum of 25mm (1") past either face of the wall. Where temperatures exceed 107°C (225°F), 10 lb. density fiberglass, with caulked ends, will be used in lieu of the sponge.
- .4 Concrete may be packed around the seal to make it integral with the floor, wall or ceiling if the seal is not in place prior to the construction of the building member.

Standard of Acceptance: Mason – Model SWS

2.6 Flexible Pipe Connectors

- .1 Braided spools for steel piping up to 50mm (2" diameter): Stainless steel inner core and braid welded; schedule 40 carbon steel NPT nipples; suitable for service at 1724 kPa (250 psi) at 120°C (250°F).

Standard of Acceptance: Flexonics BSN connector

- .2 Braided spools for copper piping: Bronze hose and braid; copper female sweat ends; suitable for 1035 kPa (150 psi) at 21°C (70°F).

Standard of Acceptance: Flexonics BRC connector

Male Nipples (Min. Lengths)

15x300mm (1/2"x12")	30x300mm (1 1/4"x12")	50x300mm (2"x12")
20x300mm (3/4"x12")	40x300mm (1 1/2"x12")	65x450mm (2 1/2"x18")
25x300mm (1"x12")		

- .3 Braided spools for steel piping 65mm (2 1/2") and over: Stainless steel inner core and braid; 150lb raised face forged steel slip on flanges; suitable for service at 951 kPa (138 psi) at 120°C (250°F).

Standard of Acceptance: Flexonics BSFS connector

Flanged (Min. Lengths)		
75x300mm (3"x12")	150x450mm (6"x18")	300x600mm (12"x24")
100X300mm (4"x12")	200x450mm (8"x18")	350x750mm (14"x30")
125x450mm (5"x18")	250x450mm (10"x18")	400x800mm (16"x32")

2.7 Flexible Rubber Connectors

- .1 Rubber expansion joints shall be peroxide cured EPDM throughout with Kevlar tire cord reinforcement. Substitutions must have certifiable equal or superior characteristics. The raised face rubber flanges must encase solid steel rings to prevent pull out. Flexible cable wire is not acceptable. Sizes 40mm to 600mm (1½" to 24") shall have a ductile iron external ring between the two spheres. Sizes 400mm to 600mm (16" to 24") may be single sphere. Sizes 20mm to 50mm (¾" to 2") may have one sphere, bolted threaded flange assemblies and cable retention.
- .2 Minimum ratings:
 - .1 Through 400mm (16"): 1724 kPa at 77°C (250 psi at 170°F) and 1482 kPa at 121°C (215psi at 250°F)
 - .2 450mm to 600mm (18"to 24"): 1241 kPa at 77°C (180psi at 170°F) and 1034 kPa at 121°C (and 150psi at 250°F)
 - .3 Higher published rated connectors may be used where required.
- .3 Safety factors shall be a minimum of 3/1. All expansion joints must be factory tested to 150% of maximum pressure for 4 minutes before shipment.
- .4 The piping gap shall be equal to the length of the expansion joint under pressure. Control rods passing through 13mm (½") thick neoprene washer bushings large enough to take the thrust at 0.7 kg/mm² (1000psi) of surface area may be used on unanchored piping as a noise break only.
- .5 All expansion joints shall be installed on the equipment side of the shut off valves.

Standard of Acceptance: Mason – Models SFU, SFDCR, SFDEJ, CR (control rods)

3. Execution

3.1 Application

- .1 Execute the work in accordance with the specifications and, where applicable, in accordance with the manufacturer's instructions and only by workmen experienced in this type of work.
- .2 Coordinate work with other trades to avoid rigid contact with the building.
- .3 Any contacts with other trades which will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions should be brought to the engineer's attention prior to installation. Corrective work necessitated by discrepancies after installation shall be at the responsible contractor's expense.
- .4 The contractor shall not install any equipment, piping, duct or conduit which makes rigid connections with the building unless isolation is not specified. "Building" includes, but is not limited to, slabs, beams, columns, studs and walls. Any rigid connections between equipment and the building shall not degrade the noise and vibration control system herein specified.
- .5 Where piping connected to noise generating equipment is routed from the mechanical room through plumbing chases, position piping to avoid contact with the concrete structure, future framing, drywall and other finishes which may radiate noise. Provide an acoustical barrier such as fibrous material and resilient acoustical caulking or acoustical split wall seals. Refer to drawings for acoustic barrier locations and requirements. Submit proposed details to meet this requirement.
- .6 Installation of vibration isolators must not cause any change of position of equipment, piping or duct work resulting in stresses or misalignment.
- .7 Isolator hangers shall be installed with the housing a minimum of 6mm (1/4") below but as close to the structure as possible. Where isolator hangers would be concealed by non-accessible acoustical sub-ceiling, install the hangers immediately below the sub-ceiling for access.
- .8 For all equipment mounted on vibration isolators, provide a minimum clearance of 50mm (2") to other structures, piping, equipment, etc. All isolators shall be adjusted to make equipment level.
- .9 Use the lowest RPM scheduled for two speed equipment in determining isolator deflection.
- .10 Provide spring thrust restraints on all fans (except vertical discharge) in excess of 1 kPa (0.15 psi) static pressure, and on hanger supported, horizontally mounted axial fans with more than 333 N thrust due to static pressure.

-
- .11 Horizontal limit springs shall be provided on fans operating in excess of 1.5 kPa (6" WG) static pressure, except vertical discharge fans, and on hanger supported, horizontally mounted axial fans where thrust due to static pressure exceeds 300 N.
 - .12 Provide spring-loaded thrust restraints for fans and air handling units where movement under any operating condition will exceed 10mm (0.375").
 - .13 Before bolting isolators to the structure, start equipment and balance the systems so that the isolators can be adjusted to the correct operating position before installing anchors.
 - .14 When recommended by the manufacturer, isolator base plates shall be bolted to the structure or foundation. Bolting shall incorporate neoprene bushings and washers.
 - .15 Where hold down bolts for isolators penetrate roofing membranes, provide "gum cups" and sealing compound to maintain waterproof integrity of roof. Ensure sealing compound is compatible with isolator components such as neoprene.
 - .16 Flexible pipe connectors per 2.5.1 shall be provided and installed per Table 3.0T1. Where not required, Contractor shall make provision for possible future installation by installing appropriate spool pieces.
 - .17 Where a pump intake pipe or similar pipe configuration requires a pedestal support, construct inertia or steel base large enough to accommodate pedestal.
 - .18 Provide vibration isolation for mechanical motor driven equipment throughout, unless specifically noted otherwise.
 - .19 Set steel bases for 25mm (1") clearance between housekeeping pad and base. Set concrete inertia bases for 50mm (2") clearance. Adjust equipment level.
 - .20 Deflections 12mm (½") and over shall use steel spring isolators.
 - .21 Deflections 5mm (¼") and under shall use neoprene isolators.
 - .22 Prior to making piping connections to equipment with operating weights substantially different from installed weights, the equipment shall be blocked up with temporary shims to the final heights. When full load is applied, the isolators shall be adjusted to take up the load just enough to allow shim removal.
 - .23 Adjustable, horizontal stabilizers on close spring isolators shall be adjusted so that the side stabilizers are clear under normal operating conditions.
 - .24 Piping Isolation
 - .1 Isolate piping, either suspended or floor mounted, connected to vibration isolated equipment. At a minimum, the first three (3) hangers shall provide the same deflection as the equipment isolators to a maximum deflection of 50mm (2"). The remaining isolators shall have a minimum 25mm (1") static deflection.

- .2 Pipe vibration isolation is to be provided on the pipe for the distance noted in the table below. At a minimum, the first three (3) pipe hangers before and after vibration isolated equipment will have vibration isolation. Pipe hanger spacing is to be as noted in Section 23 05 29 – Hangers and Supports for HVAC Equipment and Piping.

Pipe Size	Distance from Vibrating Equipment
20mm (¾")	4.5m (15'-0")
25 to 100mm (1 - 4")	15.0m (50'-0")
150 to 200mm (6" - 8")	18.0m (60'-0")
250mm & Larger (10" & Larger)	21.0m (70'-0")

- .3 Type 2 or Type 3 isolators shall be used for pipe hanger vibration isolation. In noise-sensitive areas only Type 3 hangers are to be used.
- .4 Spring hanger isolators shall be cut in to the hanger rods and installed after the system is filled. Alternatively, provisions must be made to ensure piping does not change height during installation and start-up.
- .5 Floor supports for piping connected to vibration isolated equipment shall use Type 3 and Type 4 isolators. The first two (2) supports shall be a restrained spring type with a blocking feature. Where pipe stands are used to support elbows, a Type 1 isolator shall be used under the base of the pipe support.
- .6 Piping attached to isolated equipment with flexible connections or to air handling units with internal vibration isolators meeting the requirements of these specifications is exempt from these requirements.

.25 Ductwork Isolation:

- .1 Isolate all ductwork that is rigidly connected to isolated equipment for a minimum distance of 15m (50 ft) from the equipment. Ductwork attached to isolated equipment with flexible connections or to air handling units with internal vibration isolators is exempt from these requirements, unless noted otherwise on the drawings.

- .1 Suspended ductwork shall be supported by Type 3 isolators with a minimum 25mm (1") static deflection.
- .2 Floor supported ductwork shall be isolated from the structure with Type 3 (Floor mounted equipment)

- .26 Specified supplemental equipment base types can be deleted for unitary packaged air handling equipment having a rigid frame and casing providing a distortion free platform for attachment of vibration isolators.

-
- .27 Noise and vibration isolator types and minimum operating static deflections for suspended, or floor mounted, sheet metal ductwork air plenums, pressure reducing valves, sound traps and similar air distribution elements shall be as follows:
- .1 Type 3 hangers, or Type 3 floor mounts, with minimum operating static deflections equal to 50% of connected equipment isolator deflection, or 25mm (1"), whichever is greater, shall be used to support all sheet metal air distribution elements located within mechanical equipment rooms, traveling between equipment rooms, and for a minimum of 15m (50') from connections to vibration isolation mechanical equipment.
- .2 Type 3 hangers, or floor mounts, with minimum operating static deflection of 25mm (1"), shall be used to support all sheet metal ductwork having air velocities of 5.08 m/s (1000 fpm) and higher, which is supported by structures above or below spaces having noise criteria levels of NC 35 or lower.
- .28 On completion of installation of all insulation materials and before startup of isolated equipment all debris shall be cleared from areas surrounding and from beneath all isolated equipment leaving equipment free to move on the isolation supports.
- .29 Spring hangers shall be installed without binding.
- .30 Adjust isolators as required and ensure springs are not compressed.
- .31 Provide neoprene side snubbers or retaining springs where side torque or thrust may develop.
- .32 Where movement limiting restraints are provided, they shall be set in a position with minimum 6mm (1/4") air gap. Restraints, isolator equipment and attachment points shall be designed to withstand the impact of the isolated equipment subjected to an acceleration not exceeding 3g (0.006615 lb) without permanent distortion or damage.
- .33 Wiring connections to isolated equipment shall be flexible.
- .34 Correct, at no additional cost, all installations which are deemed defective in workmanship and materials at the contractor's expense.

3.2 Inspection

- .1 The contractor shall notify the local representative of the vibration isolation materials manufacturer prior to installing any vibration isolation devices. The contractor shall seek the representative's guidance in any installation procedures with which he is unfamiliar.
- .2 A qualified representative of the isolator manufacturer shall inspect the isolated equipment after installation and submit a concise report stating any deficiencies in the installation.
- .3 On completion of installation of all noise and vibration isolation devices herein specified, the local representative of the isolation materials manufacturer shall inspect the

completed system and report in writing any installation errors, improperly selected isolation devices, or other fault in the system that could affect the performance of the system.

- .4 The installing contractor shall submit a report to the Engineer, including the manufacturer representatives' final report, indicating all isolation material is properly installed or steps to be taken by the contractor to properly complete the isolation work as per specification.

3.3 Performance

- .1 Install isolators of type and deflection according to the following table.

Vibration Isolation Schedule (from 2007 ASHRAE Handbook)														
Equipment Location														
Slab on Grade						Floor Span								
						Up to 6.1m (20 ft)			6.1 to 9.1m (20 to 30 ft)			9.1 to 12.2m (30 to 40ft)		
Equipment Type	kW (HP) & Others	RPM	Base Type	Isolator Type	Min. Defl. mm (in)	Base Type	Isolator Type	Min. Defl. mm (in)	Base Type	Isolator Type	Min. Defl. mm (in)	Base Type	Isolator Type	Min. Defl. mm (in)
Centrifugal Fans														
≤ 550Ø (≤ 22"Ø)	All	All	B	2	6 (0.25)	B	3	19 (0.75)	B	3	19 (0.75)	C	3	38 (1.50)
≥ 600Ø (≥ 24"Ø)	≤29.8 (≤40)	Up to 300	B	3	64 (2.50)	B	3	89 (3.50)	B	3	89 (3.50)	B	3	89 (3.50)
		300 to 500	B	3	38 (1.50)	B	3	38 (1.50)	B	3	64 (2.50)	B	3	64 (2.50)
		501 & Up	B	3	19 (0.75)	B	3	19 (0.75)	B	3	19 (0.75)	B	3	38 (1.50)
	≥37.3 (≥50)	Up to 300	C	3	64 (2.50)	C	3	89 (3.50)	C	3	89 (3.50)	C	3	89 (3.50)
		300 to 500	C	3	38 (1.50)	C	3	38 (1.50)	C	3	64 (2.50)	C	3	64 (2.50)
		501 & Up	C	3	25 (1.00)	C	3	38 (1.50)	C	3	38 (1.50)	C	3	64 (2.50)

END OF SECTION

1. General

1.1 Scope

- .1 Painting and identification of equipment, piping and related components for the following:
 - .1 Fire Protection Systems
 - .2 Plumbing Systems
 - .3 Ventilation Systems

1.2 Quality Control

- .1 Coordinate color coding of piping and equipment with work of Section 09 91 23 – Interior Painting.
- .2 All painting identified in this section is to be performed by Section 09 91 23 – Interior Painting Contractor, under the direction of the Division 23 contractor.
- .3 Color code mechanical equipment, piping and ductwork. Refer to Part 3 of this section.

1.3 Definitions

- .1 For the purposes of this Section, the following definitions apply:
- .2 Concealed: Piping, ductwork and equipment in trenches, shafts, furrings and suspended ceilings.
- .3 Exposed: Piping, ductwork and equipment in mechanical rooms or otherwise not “concealed”.

1.4 Related Work Specified in Other Sections

- | | | |
|----|------------------------------|------------------|
| .1 | Submittals | Division 01 |
| .2 | Interior Painting | Section 09 91 23 |
| .3 | Common Work Results for HVAC | Section 23 05 00 |

1.5 Reference Standards

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME A13.1-2007 Scheme for the Identification of Piping Systems
 - .2 Canadian Gas Association (CGA)
 - .1 CAN/CGA B149.1 Natural Gas and Propane Installation Code
-

-
- .3 Canadian General Standards Board (CGSB)
 - .1 CGSB-1-GP-12c Color Identification and Selection
 - .2 CAN/CGSB-1.60 Interior Alkyd Gloss Enamel.
 - .3 CAN/CGSB-24.3 Identification of Piping Systems
 - .4 National Fire Protection Association (NFPA)
 - .1 NFPA 13 Standard for the Installation of Sprinkler Systems
 - .5 WHMIS Pictograms – Workplace Hazardous Materials Information System – GHS Globally Harmonized System of Classification and Labeling Chemicals) – Pictograms

1.6 Delivery & Storage

- .1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.7 Waste Management and Disposal

- .1 Separate waste materials for reuse and recycling in accordance with 23 05 00 – Common Work Results for HVAC.

1.8 Submittals

- .1 Submit a schedule of pipe and equipment identification methods, materials and colors to the Engineer for review.

2. Products

Not Applicable

3. Execution

3.1 General

- .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.

3.2 Identification Labels

- .1 Identification Labels for all mechanical piping and ductwork systems, to include:
 - .1 WHMIS Pictogram (as applicable), same color as legend letters.
-

- .2 A lettered legend on a coloured background, defining the contents in the pipe, its pressure and temperature and the information necessary to define the hazard.
- .3 Arrows to define the direction of flow, same colour as legend letters.
- .4 50mm (2") wide black tape at each end of the label, wrapped around the entire circumference of pipe/insulation to secure the Identification Labels.
- .2 Identification Labels may be accomplished by paint, stenciling and/or factory fabricated labels. Labels shall cover full circumference of pipe or insulation.

3.3 Location of Labels

- .1 Orient labels on piping systems in visual sight lines while standing at floor levels.
- .2 Locate labels as follows:
 - .1 Upstream of valves.
 - .2 Adjacent to changes in direction.
 - .3 Branches.
 - .4 Where pipes pass through walls or floors.
 - .5 On straight pipe runs at 6 m intervals.
 - .6 Where system is installed in pipe chases, ceiling spaces, shafts, or similar 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.
- .3 Adhere labels to piping/insulation. Labels to cover entire pipe circumference. Secure both ends of labels with 50mm (2") wide black tape around the entire pipe circumference.

3.4 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 the Engineer.

3.5 Ductwork Identification

- .1 Use 65mm high black stenciled letters with arrows indicating flow. Identify both systems number and type of air where possible.
 - .1 Duct identification to be:

Duct Service	Legend
Supply Air, Air Handling Unit # []	S/A – AH-[]
Exhaust Air, Exhaust Fan # []	E/A – EF-[]

- .2 Maximum distance between markings to be no more than 15 meters maximum. Identify duct on each side of dividing walls or partitions and behind each access door.
- .3 Division 23 contractor to apply stencil lettering only after the final finish has been applied.

3.6 Piping Identification

- .1 Identification Methods
 - .1 Piping identification system entails primary color, or pipe marker, secondary color strip, pipe service legend and direction of flow arrow
 - .2 Primary color, where required, shall be applied to pipe in its entirety.
 - .3 Secondary color strips minimum of 600mm (24") long shall be applied at 6 meter (20 ft) intervals, at change of direction, at both sides of walls and floors where penetrated, at each piping rise or drop, at major branch connections and major valves, at service connections to equipment, and at least ones in each room through which piping passes.
 - .4 Legend shall be stenciled, capital block lettering, color as noted in Color Schedule. The size of lettering shall be as follows:

Outside Pipe Diameter (including covering) mm (in)	Minimum Height of Letters mm (in)
≤ 50 (≤ 2")	25 (1")
65 to 150 (2½" to 6")	30 (1¼")
200 to 250 (8" to 10")	65 (2½")
≥ 300 (≥ 12")	90 (3½")

- .5 Directional arrows shall be black stenciled 150mm (6") long by 50mm (2") wide for piping 75mm (3") and larger, and 100mm (4") long and 25mm (1") wide for piping 65mm (2½") and smaller. Double-headed arrows shall be used where the direction of flow is reversible
- .6 Legend and directional arrows shall be applied on top of secondary color strip.

- .7 Painting contractor to band all exposed or concealed piping except drainage piping and vent piping outside mechanical rooms, under the direction of Division 23 contractor, in the primary color listed in the Color Schedule. Paint bands to completely encircle the pipe for a length of 300mm (12") in primary color.
- .8 Piper markers shall conform to the following:

Outside Pipe Diameter (including covering) mm (in)	Minimum Length of Label Field Color mm (in)	Minimum Height of Letters mm (in)
20 to 30 ($\frac{3}{4}$ " to $1\frac{1}{4}$ ")	200 (8")	15 ($\frac{1}{2}$ ")
40 to 50 ($1\frac{1}{2}$ " to 2")	200 (8")	20 ($\frac{3}{4}$ ")
65 to 150 ($2\frac{1}{2}$ " to 6")	300 (12")	30 ($1\frac{1}{4}$ ")
200 to 250 (8" to 10")	600 (24")	65 ($2\frac{1}{2}$ ")
$\geq 300 (\geq 12"$)	800 (32")	90 ($3\frac{1}{2}$ ")

- .9 Field color and lettering color are to be as per the Color Schedule.
- .10 All bands shall be neatly arranged and in a straight line across groups of pipes.
- .11 Identify piping runs at least once in each room. Do not exceed 15m (50 ft) between identifications in open areas.
- .12 All bands, symbols, etc., are to be put in readily visible locations to be seen from floor level. Where piping is partially obscured by other piping and/or equipment, identify on both sides of obscuring equipment.
- .13 Where piping passes through walls, partitions and floors, identify on both sides of where it enters and leaves.
- .14 Division 23 contractor to apply stencil lettering only after the final finish has been applied.
- .15 Where piping is concealed in pipe chase or other confined space, identify at points of entry and leaving and at each access opening.
- .16 Identify piping at starting and end points of runs and at each piece of equipment.
- .17 Identify piping at major manual and automatic valves immediately upstream of valves.
- .18 Use white arrow on red background for fire protection.

.2 Identification Methods

- .1 Exposed Piping in Mechanical Room

-
- .1 Apply primary color to all piping in mechanical room in accordance with above requirements.
 - .2 Apply secondary banding, legend and direction of flow arrows in accordance with above requirements.
 - .2 Exposed Piping in Finished Areas
 - .1 All exposed piping shall be painted in their entirety to match space color scheme. Primary color requirements are waived in these areas.
 - .2 Apply secondary banding, legend and direction of flow arrows in accordance with above requirements.
 - .3 Concealed Piping
 - .1 No primary color coding required.
 - .2 Apply secondary banding, legend and direction of flow arrows in accordance with above requirements.
 - .4 Lettering and Direction of Flow
 - .1 Lettering: Block capitals to sizes and colors listed in CAN/CGSB 24.3..
 - .2 For hazardous piping system: black letters and arrows.
 - .3 Fire protection, other piping systems and ductwork: white letters and arrows, unless otherwise specified.
 - .5 Pictograms
 - .1 Where required, to Workplace Hazardous Materials Information System (WHMIS) regulations.
 - .6 Miscellaneous
 - .1 Aluminum jacketed piping shall be identified the same as concealed piping.
 - .2 Exposed piping in service areas, other than mechanical rooms, shall be identified the same as concealed piping.
 - .3 Additional requirements for particular piping systems:
 - .1 Natural gas and propane gas:
 - .1 Paint complete piping system yellow to CAN/CGAB149.1.
-

-
- .2 Apply legend and flow arrows after painting.

3.7 Manufacturer's Nameplates

- .1 Provide a factory applied nameplate on each piece of manufactured equipment indicating size, equipment name, manufacturer's name, serial number, electrical characteristics and performance characteristics.
- .2 Provide registration plates (such as pressure vessel, ULC and CSA approved plates as required by respective agency and as required by the specifications).
- .3 Nameplates of non-Canadian made equipment shall include the name and address of the Canadian agent providing the product.
- .4 Mechanically fasten nameplates securely in a conspicuous and easily read location.
- .5 Do not apply insulation or paint over nameplates.

3.8 Equipment Identification

- .1 The Division 23 contractor shall provide each piece of equipment with a lamacoid plate stating equipment name, system identification and equipment identification number. Lamacoid plates shall be a minimum 3mm thick with black letters on white background. Lettering to be:
 - .1 Terminal cabinets and control panels: 8mm high lettering
 - .2 Equipment in mechanical rooms and outdoors: 20 mm high lettering
 - .3 Equipment located elsewhere: 12mm high lettering
 - .2 Identify each piece of equipment with the symbol and number to be identified with record drawing equipment name and number.
 - .3 Equipment which is electrically driven and is identified shall have identical nameplates at the starter.
 - .4 All nameplates are to be mechanically fastened, easily visible without need to use a ladder or extraordinary body position. Affix additional nameplates if necessary.
 - .5 Provide the Engineer with an example of the contents of each type of nameplate. Obtain approval prior to engraving.
 - .6 Submit a complete schedule of all equipment to have identification and the symbol and description to be engraved on the lamacoid plates or stamped brass tags.
 - .7 Identify as a minimum the following with engraved plastic nameplates:
 - .1 All mechanical equipment
-

-
- .2 VFDs
 - .3 Electronic thermostats, temperature sensors, humidistats, humidity sensors and CO2 sensors.
 - .4 Electric starting switches, electric disconnects, remote push buttons and control panels.

3.9 Valve Identification

- .1 Division 23 contractor to provide 40mm (1½") diameter brass tags with 20mm (¾") engraved lettering and brass jack chain. Secure to items with brass hooks and non-ferrous chains or tie-wraps. Affix a tag to all valves or on piping directly adjacent to the valve.
- .2 Valve tags are not required where valves are directly adjacent to the equipment they serve.
- .3 Provide neat, typewritten valve location identification charts giving valve tag numbers, valve service and valve location, make/model/size with or without handwheel, type of control and normal position. Frame one copy in metal with acrylic face and mount in equipment room. Provide additional copies for inclusion in each operating and maintenance manual.
- .4 Number valves in each system consecutively.
- .5 Valve tags shall be provides as follows:
 - .1 Tag pneumatic/electric controls, instruments and relays. Key to control schematic on which instruments are numbered in sequence.
 - .2 Tag all valves in mechanical rooms.
 - .3 Tag all control valves external to mechanical rooms. This includes control valves on radiant panels, perimeter radiation and air terminal boxes.
 - .4 Tag all circuit balancing valves and isolating valves external to mechanical rooms except valves at terminal heating and cooling equipment.
 - .5 Identify and tag thermostats and temperature sensors relating to terminal unit and valve numbers.

3.10 Building Automation System Identification

- .1 Utilize tags and nameplates as described for mechanical equipment and valves for automation system components.
-

-
- .2 Use BAS mnemonics specified in BAS specification sections on tags and nameplates to identify BAS physical points and equipment.
 - .3 Identify each control element (freeze stats, humidistats, discharge temperature controllers, etc) with a laminated laser printed tag or an embossed metal band secured to each control element.
 - .4 Identify the following BAS components with laminated plastic nameplates:
 - .1 Remote control unit (RCU) panels.
 - .2 Subpanels.
 - .3 Associated equipment panels.
 - .4 Panel mounted valves; identify function of each valve.

3.11 Access Door Identification

- .1 Painting contractor to provide under the direction of the Division 23 contractor.
- .2 Each access door for concealed equipment such as isolation valves, terminal boxes and coils shall be provided with stenciled number, minimum height shall be 20mm (3/4").
- .3 Provide neat, typewritten directory giving access door number, service and location. Frame one copy under glass and mount in equipment room. Provide additional copies for inclusion in each operating and maintenance manual.

3.12 Above Ceiling Equipment Markers

- .1 Provide markers in T-bar and drywall type ceilings to identify locations of all dampers, valves and equipment located above the ceilings.
 - .2 Locate markers on T-bar closed to equipment.
 - .3 Apply self-adhesive plastic dots, 15mm (1/2") diameter, color coded, applied to T-bar ceiling or access door.
 - .4 Color code as follows:
 - .1 Yellow – HVAC equipment and duct cleaning access
 - .2 Red – Fire, smoke and sprinkler equipment
 - .3 Green – Plumbing equipment and valves
 - .4 Blue – HVAC valves and dampers
 - .5 Black – Control dampers and sensors
-

3.13 Site Painting

- .1 Treat exposed uninsulated ductwork with a coat of zinc chromate primer. Apply one (1) coat of anti-corrosive metal primer and two (2) coats of machinery enamel.
- .2 Insulated exposed ductwork shall have one (1) coat of latex primer sealer and one (1) coat of flat latex.
- .3 Air conditioning and ventilation units, tanks, other units with galvanized finish or stainless steel finish shall not be painted. Apply two (2) coats of machinery enamel to units with prime coat finish.
- .4 Paint exposed piping. Finish exposed uninsulated pipes and drainage lines with one (1) coat of metal primer and two (2) coats of machinery enamel which shall be brushed out to a thin even coat, white in color or as selected by architect. Neutralize galvanized pipes with copper sulfate solution prior to painting. Insulated pipes shall have one (1) coat of latex primer sealer and one (1) coat of flat latex, milk white color. Do not paint aluminum jacketed piping except for identification.
- .5 After all non-aluminum jacket piping is painted, the mechanical contractor shall direct the painting of color bands on all piping by the painting contractor. The Division 23 contractor shall stencil letters designating the pipe service and direction of flow. The symbol shall be finished in the color code of the mechanical specification.
- .6 Steel grilles, diffusers and louvers that are primed only by the mechanical contractor shall have final painting carried out by the painter. Colors will be selected later by the architect from manufacturer's standard range.

3.14 Equipment Protection and Clean-Up

- .1 Ensure that new and existing equipment and surfaces are carefully covered with tarping, or heavy duty plastic. Ensure that spills and splatter on finishes and equipment are cleaned up totally and promptly.

3.15 Visible (Exposed) Ductwork

- .1 Paint visible ductwork as directed by Architect. Refer to section 09 91 00.
- .2 Paint ductwork/flexible connectors that are visible behind grilles/diffusers, matt black. Refer to Section 09 91 00.

3.16 Pre-Painted Equipment

- .1 Division 23 Contractor to repair all pre-painted equipment that has been damaged or has faded.
-

3.17 Equipment Bases

- .1 Equipment bases/housekeeping pads are to be painted grey with 100mm (1”) yellow and black angled bands around the edges.

3.18 Color Code Schedule

- .1 Color numbers for Identification Labels on piping systems, valves and equipment are defined in Federal Standard 595C Colors for color code identification

Mechanical Primary Colors for Pipe Lines/Equipment

Black	:	17038
Yellow	:	13591
Green	:	14193
Orange	:	12473
Brown	:	10115
Red	:	11350
White	:	17860
Aluminum	:	16515
Blue	:	15180
Grey	:	16293
Light Blue		15450
Purple		17155

- .2 Identification Symbols and Colors for Piping

Fluid	Pipe Color	Lettering Color	WHMIS Symbol	Identification
Domestic Cold Water	Green	White	N/A	DCW
Domestic Hot Water	Green	White	N/A	DHW
Domestic Hot Water Return	Green	White	N/A	DHWR
Fire Protection Water	Red		N/A	
Fire Sprinkler Water	Red		N/A	

END OF SECTION

1. General

1.1 Scope

- .1 Mechanical contractor coordination with balancing agency.
- .2 Balance, adjust, and test air and liquid systems and equipment and submit reports using identical units to those shown on contract documents.
- .3 Test operation of the fire dampers and combination fire/smoke dampers.
- .4 Bring to the attention of the consultant, any items that are, in the opinion of the balancing agency, installed incorrectly, prior to commencement of balancing procedures.

1.2 Quality Assurance

- .1 Work specified in this section shall be performed by an Independent Agency specializing in this type of work. Provide proof that the agency has successfully completed five projects of similar size and scope and is a certified member of Associated Air Balance Council, or similar association. List personnel, and their qualifications, who will be employed during the testing and balancing period.
- .2 Balancing (of both air and liquid systems) and sound level readings shall be performed by the same agency.
- .3 Balancing procedures shall be in accordance with AABC's "National Standards for Field Management and Instrumentation – Total System Balance", SMACNA, ASHRAE Standards, or other similar procedures.
- .4 During the one year warranty period, the owner may request re-check or re-setting of outlets or fans as listed in test report. Provide technicians and equipment required during visits for seasonal adjustments.

1.3 Related Requirements

- .1 Commissioning Section 01 91 00
- .2 Commissioning (Cx) Plan Section 01 91 33

1.4 Related Work Specified in Other Sections

- .1 Common Work Results for HVAC Section 23 05 00

1.5 Approved Agencies

- .1 Contractor to submit proposed agency for Consultant and Owner approval.
 - .2 Provide documentation confirming qualifications and previous experience with projects of similar size and complexity.
-

1.6 Mechanical Contractor Responsibilities

- .1 Bring the work to an operating state and ready for balancing, including:
 - .1 Clean equipment and ductwork.
 - .2 Install air terminal devices.
 - .3 Provide temporary filters in air handling equipment and carry out a rough air balance to ensure all equipment performs required function.
 - .4 Replace filters with specified filters prior to final balancing.
 - .5 Verify lubrication of equipment.
 - .6 Install permanent instrumentation.
 - .7 Complete the "start-up" of equipment.
 - .8 Check rotation and alignment of rotating equipment and tension of belted drives.
 - .9 Set control points of automatic apparatus, check-out sequence of operation.
 - .10 Make available control diagrams and sequence of operation.
 - .11 Clean work, remove temporary tags, stickers, and coverings.
 - .12 Make available one (1) copy of Maintenance Manuals especially for use in balancing.
 - .13 Provide Balancing Agency a complete set of mechanical drawings and specifications.
 - .2 Cooperate with the Balancing Agency as follows:
 - .1 Make corrections as required by Balancing Agency.
 - .2 Allow Balancing Agency free access to site during construction phase. Inform Balancing Agency of any major changes made to systems during construction and provide a complete set of record drawings for their use.
 - .3 Provide and install any additional balancing valves, dampers, and other materials requested by the balancing agency and/or necessary to properly adjust or correct the systems to design flows.
 - .4 Provide and install revised pulleys and sheaves for rotating equipment and shave pump impellers, as required to properly balance the systems to design flows. Obtain requirements from balancing agency (Refer to Section 25 05 93 – Testing, Adjusting and Balancing for HVAC Systems).
-

-
- .5 Operate automatic control system and verify set points during Balancing.

1.7 Site Visits

- .1 Total of six (6) site visits shall be made to correspond with the general monthly site meetings held by the Contractor. After each site visit, a written report shall be submitted to the Contractor and Engineer. Site visits shall commence after the start of air and liquid distribution work and be spread over the construction period to the start of the balancing work.
- .2 A review of the installation and access to all valves, dampers, and equipment shall be made at the specified site visits and any additional dampers or valves required for proper balancing shall be forwarded in writing to be reviewed by the Engineer.
- .3 Allow for two (2) visits of one (1) day to site to adjust systems for seasonal changes during warranty. Coordinate time of visits with the Owner. Submit reports to Engineer.
- .4 Begin balancing after equipment start-up and testing and after systems have been completed and are in full working order. Place systems and equipment into full operation and continue operation during each working day of balancing.

1.8 Balancing Agenda

- .1 General: Submit balancing agenda to the Engineer and commissioning contractor for review at least sixty (60) days prior to the start of balancing work. Start balancing work only after agenda has been approved. Include descriptive data, procedure data, and sample forms in agenda.
- .2 Descriptive Data: General description of each system including associated equipment and different operation cycles, listing of flow and terminal measurements to be performed.
- .3 Procedure Data: Procedures for converting test measurements to establish compliance with requirements specify type of instrument to be used, method of instrument application (by sketch) and correction factors.
- .4 Use forms approved by AABC. AABC test sheets required are as follows:
- .1 Air Moving Equipment Test Sheet.
- .2 Exhaust Fan Test Sheet.
- .3 Diffuser and Grille Test Sheet.
- .4 Duct Traverse Zone Totals Sheet.
- .5 Duct Traverse Readings Sheet.
-

-
- .5 The total air and water systems shall have the AABC Field Test and Diagnosis Section I through Section VI Form completed.
 - .6 At the completion of balancing the first major air system, the balancing agent shall notify the Engineer to re-visit the site to evaluate work completed to this time. Provide the Engineer with ten (10) business days written notice, prior to request for site visit.

1.9 Balance Report

- .1 Submit (2) copies of rough balancing reports to the Engineer for review, prior to on-site verification and acceptance of Project.
 - .2 Provide four (4) copies of final reports to contractor for inserting in Owner's Operating and Maintenance Manuals as described in Section 23 05 00 – Common Work Results for HVAC.
 - .3 General description of each system including associated equipment and different operation cycles, listing of flow and terminal measurements to be performed (selection points for proposed sound measurements).
 - .4 Procedure Data: Procedures for converting test measurements to establish compliance with requirements. Specify type of instrument to be used, method of instrument application (by sketch) and correction factors.
 - .5 Sample Forms: Forms showing application of procedures to typical systems.
 - .6 Balance Reports:
 - .1 Submit copies of reports described prior to final acceptance of project. Provide copies for the consultant and for inclusion in Operating and Maintenance Manuals.
 - .2 Provide reports in soft-cover, three-ring binder manuals, complete with index page and indexing tabs and cover identification at front and side.
 - .3 Stamp reports by a registered professional engineer certifying adherence to agenda, calculation procedure and final summaries.
 - .4 Include types, serial number and dates of calibration of instruments.
 - .7 System Data Reports:
 - .1 Reports shall include balance and equipment data listed. Report all values in units identical to those specified and shall be shown for design values and actual measured values.
 - .2 Include schematic diagrams of systems showing final damper and component location and positioning.
-

-
- .3 Report design and final observed air capacities, velocities, etc., including outside air and return air volumes at various damper positions.
 - .4 Report air temperatures at various mixing damper positions, at inlet and outlet of all heat transfer equipment and at supply terminals.
 - .5 Report static pressure readings at various system operating conditions showing total static, duct static, etc.
 - .6 Report equipment characteristics at various system operating conditions including, but not limited to, motor name-plate data and actual RPM, adjustable sheave position, fan inlet velocity, filter pressure drop, fan pitch angle, calculation factors for air terminals, etc.

1.10 System Data

.1 Air Handling Equipment

.1 Design Data:

Total air flow rate;

Fan total static pressure;

System static pressure;

Motor kW (HP), r/min, amps, Volts, Phase;

Outside air flow rate L/s (cfm);

Fan r/min;

Fan/kW (HP);

Inlet and outlet, dry and wet bulb temperatures.

.2 Installation Data:

Manufacturer and model;

Size;

Arrangement discharge and class;

Motor type, kW (HP), r/min, voltage, phase, cycles, and load amperage;

Location and local identification data.

.3 Recorded Data:

Supply Air Fan

Fan @ 100% Outside Air

Air flow rate;

Fan total static pressure;

System static pressure;

Fan r/min;

For Axial Fans, note blade pitch angle

Motor operating amperage;

Inlet and outlet, dry and wet bulb temperatures.

- .2 Duct Air Quantities - All mains supplying more than 10% of Volume, outside air and exhaust (maximum and minimum) major return air openings back to duct shafts.

Duct sizes;

Number of pressure readings;

Sum of velocity measurements;

Average velocity;

Duct recorded air flow rate;

Duct design air flow rate.

- .3 Air Inlet and Outlets:

Outlet identification location and designation;

Manufacturers catalogue identification and type;

*Application factors;

Design and recorded velocities;

Design and recorded air flow rates;

Deflector vane or diffuser cone settings.

* (Refer to 3.1.3 for supporting information)

2. Products

2.1 Instruments

- .1 Use accurate instruments for measurements. Use only certified calibration agencies for calibration.
- .2 Provide calibration histories for each instrument. Recalibration or use of other instruments may be requested when accuracy of readings is questionable.

3. Execution

3.1 General Procedure

- .1 Permanently mark, by stick-on labels and/or fluorescent paint, settings on valves, splitters, dampers, and other adjustment devices.
 - .2 Subsequent to correctional work, take measurements to verify balance has not been disrupted or that any such disruption has been rectified.
 - .3 Where vane anemometer is used to measure supply, return or exhaust air grilles, AK factors shall be determined as follows:
 - .1 Determine and tabulate similar sized grilles being balanced for AK schedule.
 - .2 Traverse all ducts serving grilles (outlined in AK schedule) to verify AK factors.
 - .3 AK factor from schedule must be approved by Engineer during initial review with balancer on site. (Balancer shall include written procedure for determination of AK factors).
 - .4 No flow hoods are to be used for measurement of exhaust or return air grilles.
 - .4 Balancing shall be performed to the following accuracies:
 - .1 Air - terminal outlets $\pm 10\%$ (outlets less than 200 L/s (425 CFM))
 - .2 Air - terminal outlets $\pm 5\%$ (outlets greater than 200 L/s (425 CFM))
 - .3 Air - central equipment $\pm 5\%$
 - .5 Balancing contractor shall advise mechanical contractor of required revised pulleys, sheaves and impeller shavings to allow proper balancing of systems.
 - .6 Where axial fans require blade pitch changes, this shall be the responsibility of the balancing contractor.
 - .7 Check and adjust entire system approximately six months after final acceptance. Adjust system if deviations have occurred since balance report acceptance. Submit report.
-

-
- .8 The work shall also include the following:
- .1 Setting of all pressure regulating and reducing valves to operating and code conditions.
 - .2 Check and setting of all relief and safety valves to code requirements.
 - .3 Balancing of all air flows from fans in ducts, through air outlets to design conditions.
 - .4 Balancing building systems to maintain designed pressure relationships between various areas.
- .9 Test the operation of each fire damper and fire/smoke damper.

3.2 General Air System Balancing

- .1 All new air systems to be balanced to show air volumes and velocities at main and branch ducts and at all terminals. Fan volumes to be recorded at various mixed air conditions.
 - .2 Record system air temperatures at various mixed air conditions.
 - .3 Adjust air flow and terminals to eliminate objectionable air noise at terminal.
 - .4 Use Pitot tube transverse across entire duct area to measure air flow.
 - .5 Vary total air system quantities by adjustment of fan speeds.
 - .6 Where modulating dampers are installed, take measurements at both high and low extremes.
 - .7 Balance variable volume system to maximum air flow rate with full cooling flow and to minimum air flow rate with full heating flow.
 - .8 Perform balancing, adjusting, and testing with building doors and windows in their normal operation position.
 - .9 The following procedure shall be adopted for central systems:
 - .1 Ensure dampers or volume control devices are in fully open position.
 - .2 Balance central apparatus to $\pm 5\%$ air flow.
 - .3 Balance branches and mains in accordance with 3.1.4.
 - .4 Recheck central apparatus.
 - .5 Balance all terminal air outlets in accordance with 3.1.4.
 - .6 Re-balance central apparatus to $\pm 5\%$.
-

-
- .7 Recheck all air outlets.
 - .10 When balancing air outlets:
 - .1 Rough balance furthest outlets and then balance sequentially back to source.
 - .2 Fine balance furthest outlet back to source.
 - .11 Take static pressure readings and air supply temperature readings at 10 points on the system.
 - .12 Make air quantity measurements in ducts by "Pitot Tube" traverse of entire cross sectional area. Take a minimum of 16 for rectangular ducts, and 10 on each vertical and horizontal axis for round ducts, traverse readings. If readings are inconsistent across duct, try to obtain straight run of six (6) diameters widths upstream and re-do traverse.

3.3 Variable Volume Air System Procedure

- .1 Perform air system balancing for each variable volume air system as per AABC specification as described in the following:
 - .1 Check and note the following items on the supply and return fans:
 - .1 Proper fan rotation.
 - .2 Filter condition (clean and dirty, as specified).
 - .3 Cooling coil condition (dry and wet).
 - .2 Set up the system to operate with maximum return air and minimum outside air.
 - .3 Set all thermostats to their normal set-points allowing the terminals to operate in a modulated position.
 - .4 Obtain the following preliminary data at the supply and return fans:
 - .1 Fan RPM.
 - .2 Motor current and voltage.
 - .3 Fan, coil(s) and filter statics.
 - .4 Name-plate data on the fans and motors.
 - .5 Check and set the fan belt tension.
 - .5 Measure the static pressure at the end of each major branch.
 - .6 Adjust the supply fan controller and/or RPM to achieve the minimum static pressure required at the end of each branch, the return fan controller and/or RPM may also have to
-

be adjusted. Monitor the branch static pressure and verify that they are above the minimum required in steps 7 through 11.

- .7 Starting at the variable volume terminal closest to the fan, set the thermostat to full cooling.
 - .8 Make a preliminary measurement of the terminal l/s delivery and proportionally balance the outlets. In co-operation with the terminal manufacturer adjust the total l/s to obtain design delivery.
 - .9 Set the thermostats to full heat and measure the terminal l/s delivery. In co-operation with the terminal manufacturer adjust the total l/s to obtain design delivery.
 - .10 Set the thermostat to its normal set-point.
 - .11 Repeat steps 7 through 10 for all variable volume controllers, working and from the fan.
 - .12 Set enough thermostats to full cooling to allow the supply and return fans to operate at their maximum capacity (ie: if the supply fan is sized for total of the maximum capacity of each terminal, all thermostats should be set to full cool. If the supply fan is sized for diversity, enough terminals to approximate the fan capacity should be set to full cool).
 - .13 Measure the static pressure at the end of each major branch.
 - .14 Adjust the supply fan controller and/or RPM to achieve the minimum static pressure required at the end of each branch. The return fan controller and/or RPM may have to be adjusted also. Energy consumption is minimized by adjusting the fan RPM to obtain the required static pressure without throttling vortex or discharge dampers.
 - .15 Traverse the main supply duct and return duct.
 - .16 Balance the return system.
 - .17 Balance the exhaust system.
 - .18 Obtain the following final data at the supply, return and exhaust fans:
 - .1 Fan RPM.
 - .2 Motor current and voltage.
 - .3 Fan, coil(s) and filter statics.
 - .4 Approximate motor sheave setting.
 - .5 Check and set the fan belt tension.
 - .19 Set all thermostats to their normal set-points and allow them to become satisfied.
-

-
- .20 Measure the static pressure at the end of each major branch and verify that it is at or above the minimum required.
 - .21 Test the supply and return systems to ensure that both systems have changed capacity in proper proportion. The mixed air plenum should maintain a negative pressure at all times to provide adequate outside air intake.
 - .22 Check the following controls:
 - .1 Economizer system – function, calibration and damper synchronization.
 - .2 Face and by-pass dampers – function and calibration.
 - .3 High temperature limit shut-off – function and calibration.
 - .4 Low temperature limit shut-off – function and calibration.
 - .23 Set all controls to their normal set-points.
 - .24 Test and adjust each diffuser, grille and register to within 5% of design requirements.
 - .25 Identify each diffuser, grille and register as to location and area.
 - .26 Identify and list size, type and manufacturer of diffusers, grilles, registers and all testing equipment. Use manufacturer's rating on all equipment to make required calculations.
 - .27 In readings and test of diffusers, grilles and registers, include required m/s velocity and test m/s velocity, and required l/s and test l/s after adjustments.
 - .28 In co-operation with the control manufacturer's representative, set adjustments of automatically operated dampers to operate as specified, indicated and/or noted.
 - .29 Adjust all diffusers, grilles and registers to minimize drafts in all areas.
 - .30 Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Effect volume control only by duct internal devices such as dampers and splitters.
 - .31 Vary total system air quantities by adjustment of fan speeds. Vary branch air quantities by damper regulation.
 - .32 Where modulating dampers are provided, take measurements and balance at extreme conditions. (Balance variable volume systems at maximum air flow rate - full cooling, and at minimum air flow rate - full heating).
 - .33 Verify all terminal unit factory settings for maximum air flow (and minimum if applicable). Adjust terminal unit controller if required. Record adjusted units.
 - .34 The final balanced condition of each area shall include testing and adjusting of pressure conditions. Test and record building pressurization levels in variable volume systems
-

throughout full range of fan delivery rates, under both heating and cooling conditions. For multi-storey building test pressure conditions at ground, intermediate and upper levels. Front doors, exits, elevator shafts, should be checked for air flow so that exterior conditions do not cause excessive or abnormal pressure conditions. Document abnormal building leakage conditions noted.

- .35 Complete balancing to achieve positive building pressure unless otherwise instructed. A positive pressure relative to outside of 10 Pa (0.04" WG) minimum and 20 Pa (0.08" WG) maximum shall be achieved, measured with negligible outside wind velocity.

3.4 Fire Damper/Fire Stop Flap Verification

- .1 Visually inspect all fire dampers and fire stop flaps:
- .1 Installation is straight.
 - .2 Wall angles properly installed.
 - .3 Duct has break away connection.
 - .4 Fire stopping material where used is properly installed.
 - .5 Adequate access.
 - .6 Clearance between sleeve and wall.
- .2 Inspect all fire damper blades and tracks prior to test firing. Sheet metal trade to clean all dirty dampers and tracks to satisfaction of balancer.
- .3 Manually remove each fusible link to ensure damper blade drops properly, then reset damper. Mark dropped fire damper with black felt marker.
- .4 Testing of 10% of the fusible links shall be performed with a suitable heat source capable of generating sufficient heat to detonate fusible link without burning or generating carbon deposits on the blades, frame or adjacent ductwork. Selection of links to be test dropped to be as directed by Engineer. Retesting and resetting shall be witnessed by Engineer.
- .5 If fire damper does not close properly, sheet metal trade to repair installation and balancing agency to retest.
- .6 All fire damper tests shall be witnessed by two parties, certified by Contractor and endorsed by the testing personnel.
- .7 Contact Alberta Building Code enforcement authorities in writing prior to testing each damper and have authorities witness tests as required.

3.5 Balancing Report

- .1 Submit draft copies of rough balancing reports prior to final acceptance of project.
-

-
- .2 Include types, serial number and dates of calibration of instruments.
 - .3 Record test data on a sepiamade from the latest available revised set of mechanical drawings and submit three (3) copies upon completion of the balancing contract for inclusion in equipment and maintenance manuals.
 - .4 Submit with report, fan and pump curves with operating conditions plotted. Submit grille and diffuser shop drawings and diffusion factors.
 - .5 Report shall be indexed as follows:
 - .1 Air
 - Summary
 - Procedure
 - Instrumentation
 - Drawings
 - Equipment Summary
 - Fan Sheets
 - Fan Curves
 - Fan Profile Data
 - Static Data
 - Air Monitoring Station Data
 - Traverse Data and Schedule
 - Terminal Unit Summary
 - Outlet Data Summary and Schematics (per system)
 - Building Schematic
 - Building Pressurization Data
 - Weather Conditions at Time of Test
 - Diagnostic
 - Millwright Reports
-

GOVERNMENT OF CANADA

Existing Building Renovation

Alberta, Canada

Project No.: 144202775.215

Section 23 05 93

TESTING, ADJUSTING AND

BALANCING FOR HVAC

Page **14** of **14**

END OF SECTION

1. General**1.1 Scope**

- .1 Domestic water systems (hot, cold, recirculation), ambient to 82°C (180°F)
- .2 Duct thermal insulation
- .3 Duct acoustic insulation
- .4 Exterior ductwork
- .5 Adhesives, tie wires, tapes
- .6 Recovery materials

1.2 Reference Standards

- .1 American Society for Testing and Materials (ASTM)
 - 1. ASTM B209M Specification for Aluminum and Aluminum Alloy Sheet and Plate
 - 2. ASTM C335 Steady State Heat Transfer Properties of Pipe Insulation
 - 3. ASTM C411 Hot-Surface Performance of High Temperature Thermal Insulation
 - 4. ASTM C423 Standard Method for Sound Absorption and Sound Absorption Coefficients by Reverberation Room Method
 - 5. ASTM C449 Mineral Fiber Hydraulic Setting Thermal Insulating and Finishing Cement
 - 6. ASTM C533 Calcium Silicate Block and Pipe Thermal Insulation
 - 7. ASTM C534 Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
 - 8. ASTM C547 Mineral Fiber Pipe Insulation
 - 9. ASTM C553 Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
 - 10. ASTM C612 Mineral Fiber Block and Board Thermal Insulation
 - 11. ASTM C921 Practice for Determining the Properties of Jacketing Materials for Thermal Insulation
 - 12. ASTM C1071 Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound
-

.1 Product Data

	.1	Submit manufacturer's product data in accordance with Section 23 05 00 – Common Work Results for HVAC.	
	.1	Submit product data and test reports when requested to substantiate that insulation and recovery assemblies meet flame/smoke development ratings and performance requirements for the assembly and thickness used.	
	.2	Submit information showing installed insulation and membrane products meet the requirements of ASHRAE 90.1.	
.2		Shop Drawings	
	.1	Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures, and Section 23 05 00 – Common Work Results for HVAC.	
	.1	For each application submit an insulation schedule to include the following information:	
	.1	Materials	
	.2	"k" value	
	.3	Thickness	
	.4	Density	
	.5	Finish	
	.6	Jacketing	
.3		Submit information showing installed insulation and membrane products meet the requirements of the National Energy Code of Canada for Buildings (NECB), 2011 and ASHRAE 90.1-2010.	
1.4		<u>Delivery & Storage</u>	
	.1	Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.	
1.5		<u>Waste Management and Disposal</u>	
	.1	Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.	
1.6		<u>Related Work Specified in Other Sections</u>	
	.1	Common Work Results for HVAC	Section 23 05 00
	.2	Plumbing	Division 22
	.3	Heating, Ventilation and Air Conditioning	Division 23

1.7 Quality Assurance

- .1 Insulation shall be installed by skilled workmen regularly engaged in this type of work.
- .2 Materials shall meet fire and smoke hazard ratings as stated in this section and defined in applicable building codes.

1.8 Product Options and Substitutions

- .1 Refer to Division 01 for requirements pertaining to product options and substitutions.
- .2 Alternative insulations are subject to approval. Alternatives shall provide the same thermal resistance within 5%, at normal conditions as material specified.

1.9 Definitions

- .1 For the purposes of this Section, the following definitions apply:
 - .1 Concealed: Piping, ductwork or equipment in trenches, shafts, furring, and suspended ceilings.
 - .2 Exposed: Piping, ductwork or equipment in mechanical rooms or otherwise not "concealed".
 - .3 "k" Value: Thermal conductivity of insulating material per unit of thickness (W/m.°C).

1.10 Flame/Smoke Development Ratings

- .1 Insulation materials, recovery materials, vapor barrier facings, tapes and adhesives shall have maximum flame spread rating of 25 and maximum smoke developed rating of 50, when tested in accordance with CAN/ULC-S102. Materials required which do not meet this rating must be treated on site with finish which will provide necessary ratings.
- .2 Insulating materials and accessories shall withstand service temperatures without smoldering, glowing, smoking or flaming when tested in accordance with ASTM C411.
- .3 ULC or ULI label or listing or satisfactory certified report from an approved testing laboratory will be required to indicate that the fire hazard ratings for materials proposed for used do not exceed those specified.

1.11 Job Conditions

- .1 Perform work at ambient and equipment temperatures as recommended by the adhesive manufacturer. Make good separation of joints or cracking of insulation due to thermal movement, poor workmanship, or material defects.
-

2. Products

2.1 Acceptable Manufacturers

- 1. Insulation : Owen's Corning/Fiberglas Canada Inc., Manson, Knauf Fiberglass, Ottawa Fibre
- 2. Adhesives and Coatings : Bakor, 3M Company, Durodyne, Benjamin Foster
- 3. Sealants : Dow Corning, Tremco

2.2 General

- .1 Flame proofing treatments subject to deterioration due to the effects of moisture or high humidity are not acceptable.
- .2 All adhesives, sealers, vapor coatings, etc., shall be compatible with the materials to which they are applied and shall not deteriorate insulation material.
- .3 All insulation materials shall meet Building Code Standards, and packages or containers of such materials shall be appropriately labelled.

2.3 Hot Pipe Insulation

- .1 Hot Pipe Insulation – Mineral Fiber
 - .1 Material: Formed rigid mineral fibre insulation sleeving to ASTM C547.
 - .2 "k" Value: Maximum 0.035 W/m.°C at 24°C (0.24 btu in/hr/ft² at 75°F)
 - .3 Service Temperature: Up to 150°C (300°F)
 - .4 Jacket: Factory applied general purpose jacket.

2.4 Cold Pipe Insulation

- .1 Cold Pipe Insulation: Mineral Fiber:
 - .1 Material: Formed mineral fibre rigid insulation sleeving to ASTM C547.
 - .2 "k" Value: Maximum 0.035 W/m.°C at 24°C (0.24 btu in/hr/ft² at 75°F)
 - .3 Service Temperature: -14°C to 100°C (7°F to 212°F)
 - .4 Jacket: Factory applied vapor barrier jacket to CGSB 51-GP-52Ma, Type 1, with longitudinal lap seal.

2.5 Hot Duct Insulation

- .1 Hot Duct Insulation - Round and Oval:
-

-
- .1 Material: Flexible mineral fiber blanket insulation to ASTM C553 faced with factory applied vapor retarder jacket to CGSB 51-GP-52Ma.
 - .2 "k" Value: Maximum 0.035 W/m/°C at 24°C (0.24 btu in/hr/ft² at 75°F)
 - .3 Service Temperature: 20°C to 65°C (68°F to 149°F)

.2 Hot Duct Insulation - Rectangular

- .1 Material: Rigid mineral fiber insulation to ASTM C612 with factory applied vapor retarder jacket to CGSB 51-GP-51Ma.
- .2 "k" Value: Maximum 0.035 W/m/°C at 24°C (0.24 btu in/hr/ft² at 75°F)
- .3 Service Temperature: 20°C to 65°C (68°F to 149°F)

2.6 Cold Duct Insulation

.1 Cold Duct Insulation - Round and Oval:

- .1 Material: Flexible mineral fiber blanket insulation to CAN/CGSB-51.11.
- .2 "k" Value: Maximum 0.035 W/m/°C at 24°C (0.24 btu in/hr/ft² at 75°F)
- .3 Service Temperature: -40°C to 65°C (-40°F to 150°F)
- .4 Jacket: factory applied reinforced aluminum foil vapour barrier to CGSB 51-GP-52Ma.

.2 Cold Duct Insulation - Round (Exposed to Outdoors):

- .1 Material: Semi-rigid mineral fiber in roll form.
- .2 "k" Value: Maximum 0.035 W/m/°C at 24°C (0.24 btu in/hr/ft² at 75°F)
- .3 Service Temperature: -40°C to 65°C (-40°F to 150°F)
- .4 Jacket: Factory applied reinforced aluminum foil vapor barrier to CGSB 51-GP-52Ma.

.3 Cold Duct Insulation - Rectangular:

- .1 Material: Rigid mineral fiber insulation to CAN/CGSB-51.10.
 - .2 "k" Value: Maximum 0.035 W/m/°C at 24°C (0.24 btu in/hr/ft² at 75°F)
 - .3 Service Temperature: -40°C to 65°C (-40°F to 150°F)
 - .4 Jacket: Factory applied reinforced aluminum foil vapor barrier to CGSB 51-GP-52Ma.
-

2.7 Acoustic Ductwork Insulation

- .1 Material: Rigid mineral fiber acoustical insulation to ASTM C1071, Type 2
- .2 Density: 48 kg/m³ (minimum)
- .3 Acoustic Properties: Minimum NRC of 0.70 for 25mm thickness based on Type A mounting to ASTM C423
- .4 "k" Value: maximum 0.035 W/m°C at 24°C (0.24 btu in/hr/ft² at 75°F) when tested in accordance with ASTM C177
- .5 Service Temperature: -40°C to 65°C (-40°F to 150°F)
- .6 Surface Finish: Absolute roughness of exposed surface not to exceed 0.58mm (26 gauge), coated to prevent fibre erosion at air velocities up to 25.4 m/s (5000 ft/m)

2.8 Accessories

- .1 For mineral fiber insulation materials:
 - .1 FSK Tape: vapor barrier tape consisting of laminated aluminum foil, glass fiber scrim and paper, with pressure sensitive self adhesive.
 - .2 ASJ Tape: vapor resistant tape consisting of all service jacket material with pressure sensitive self adhesive.
 - .3 Adhesive: quick setting adhesive for joints and lap sealing.
- .2 Lap Seal Adhesive: Quick setting adhesive for joints and lap sealing of vapour barriers.
- .3 Canvas Adhesive: Dilute, washable, fire retardant lagging adhesive for cementing canvas jacket to duct insulation.
- .4 Pins: Welding pins 4mm (0.15") diameter shaft with 35mm (1½") diameter head for installation through the insulation. Length to suit thickness of insulation with 35mm (1½") square nylon retaining clips.
- .5 Thermal Insulating and Finishing Cement: To ASTM C449 mineral fiber hydraulic setting thermal insulating and finishing cement for use up to 650°C (1200°F).

2.9 Recovery Materials

- .1 Canvas: ULC listed, 220g/m² plain weave cotton fabric treated with fire retardant lagging adhesive to ASTM C921.
 - .2 Aluminum: ASTM B209, 0.5mm (0.02") thick smooth with longitudinal slip joints and 50mm (2") end laps, 0.4mm (0.015") thick die shaped fitting covers with factory attached protective liner on interior surface.
-

-
- .3 PVC: To CAN/CGSB-51.53-95, 0.38mm (0.015") thick for interior use and 0.57mm (0.022") thick for exterior use, off-white in color with one-piece premoulded fitting covers.

- .4 Black Rubber Finish: Insulation manufacturers recommended vinyl lacquer type coating.

3. Execution

3.1 Installation - General

- .1 Do not install insulation until after the required piping, ductwork and equipment tests have been completed, witnessed and certified.
- .2 Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application. Finish with systems at operating conditions, where possible.
- .3 Install in accordance with TIAC National Standards and manufacturer's recommendations.
- .4 Ensure insulation is continuous through floor and wall sleeves etc. Pack around piping and ducts with fireproof self-supporting insulation materials, properly sealed.
- .5 Finish insulation neatly at hangers, supports and other protrusions.
- .6 Install insulation at ambient temperatures within acceptable temperature ratings for tapes, sealants and adhesives.
- .7 Apply insulation to provide smooth and even finish, uniform diameter, no sagging, wrinkling, etc.
- .8 A complete moisture and vapor seal shall be provided wherever insulation terminates against metal hangers, anchors and other projections through insulation and cold surfaces for which vapor seal is specified.

3.2 Installation – Pipe Insulation

- .1 On vertical piping with diameters 25mm (1") and larger, use insulation supports welded or bolted to pipe directly above lowest pipe fitting. Repeat supports on 4.5m (14 ft) centers and at each valve and flange.
- .2 Tightly fit insulation sections to pipe to make smooth and even surfaces. Cut insulation for proper fit where weld beads protrude. Bevel away from studs and nuts to allow their removal without damage to insulation. Trim closely and neatly around extending parts of pipe saddles, supports, hangers, clamp guides and seal with insulating/finishing cement.

3.3 Installation – Duct Insulation

- .1 Insulated in their entirety are all emergency generator ventilation, ductwork, all combustion air and relief air ductwork, all exhaust air ductwork for a distance of 5m (16 ft) from the exterior walls or openings, ductwork carrying hot or cold conditioned air and outside air ductwork.
-

-
- .2 Unless otherwise indicated, do not insulate ducts carrying air at room ambient temperature, exhaust air ductwork except as noted above, return air ductwork, relief air ductwork and ductwork fitted with an approved acoustic thermal lining.
 - .3 Do not insulate ductwork with external thermal insulation where acoustic duct insulation is specified or indicated.
 - .4 Add extra thickness of insulation at standing seams, flanged joints and any other duct protrusions. Adhere jacket lap joints with an adhesive which will be guaranteed to maintain the adhesion under all conditions.
 - .5 Ductwork carrying outside air must be insulated completely so there is no break in either the insulation thickness or vapor barrier.
 - .6 Provide recovering jackets on exposed insulation throughout, including equipment rooms. Insulation located in crawl spaces, shafts and suspended ceiling spaces is not considered exposed. Make smooth any uneven insulated surface before recovering.
 - .7 Cover insulation exposed to outdoors with aluminum jacket secured with aluminum bands on 200mm (8") centers. Longitudinal slip joints, lap circumferential joints 75mm (3") minimum and seal all joints with compatible waterproof lap cement.
 - .8 Where duct velocities exceed 10m/s (2000ft/m), cover insulation with 0.8mm perforated galvanized steel with 24% free area.
 - .9 Locate insulation or cover seams in least visible locations. Locate seams on ductwork in ceiling spaces on the underside of the duct.
 - .10 Stagger butt joints where multi-layered insulation is used.
 - .11 Butt duct insulation at top of duct. Stagger all joints where more than one layer of insulation is used. Tape all insulation joints neatly.
 - .12 Straps or twin ties used to secure insulation shall not unduly compress the insulation. Sagging of duct insulation is also not allowed.

3.4 Hot Pipe Insulation Application

- .1 Apply mineral fiber insulation when pipe surface temperatures are 50°C to 60°C (122°F to 140°F).
 - .2 Apply mineral fiber insulation and recovery over full length of pipe without penetration of hangers, interruption at sleeves and fittings. Seal butt joints with 100mm (4") wide ASJ tape.
 - .3 Terminate mineral fiber insulation at each end of unions and flanges. Trowel finishing cement into bevel.
 - .4 Cover fittings and valves with equivalent thickness of finishing cement. Apply finishing cement over exposed fittings and valves before applying canvas recovering. Insulate with tightly placed flexible insulation and apply PVC fitting covers.
-

-
- .5 Cut mineral fibre insulation layers straight on 10m (32 ft) centers with 25mm (1") gap to allow for expansion between terminations. Pack void tightly with insulation and protect joints with aluminum sleeves.
 - .6 Seal black rubber insulation butt joints and seams with black rubber insulation adhesive.
 - .7 Recover exposed mineral fiber insulated piping with PVC.
 - .8 Recover mineral fibre insulated piping exposed to outdoors with waterproof aluminum jacket.
 - .9 Do not insulate the following piping system components:
 - .1 Unions, flanges, strainers, expansion joints, flexible piping connectors.
 - .2 Valve bonnets on domestic water systems.
 - .3 Drains, plugs and caps.

3.5 Cold Pipe Insulation Application

- .1 Apply vapor retardant mineral fiber insulation and recovery over full length of pipe without penetration of hangers, interruption at sleeves and fittings. Apply adhesive to ends of butt joints and seal joint seams with 100mm (4") wide strips of joint tape.
- .2 Insulate complete system including valves, unions, flanges, strainers, drains, caps and fittings. Cover fittings and valves with equivalent thickness of finishing cement. Cover finishing cement with open mesh glass cloth and vapor retardant adhesive. Seal lap joints with 100% coverage of joint tape and seal the assembly with vapor retardant adhesive. Alternatively, insulate with tightly placed flexible insulation and apply reinforcing membrane embedded in vapor retardant coating and apply PVC fitting covers.
- .3 Recover exposed mineral fiber insulated piping with PVC.
- .4 Recover mineral fiber insulated piping exposed to outdoors with aluminum.
- .5 Coat exposed black rubber insulation with two coats of black rubber finish material.

3.6 Hot Duct Insulation Application

- .1 Adhere insulation to round and oval ductwork with contact adhesive applied in 150mm (6") wide strips on 400mm (16") centers. Band on outside with wire until adhesive has set.
 - .2 Butt insulation and seal joints with lap seal adhesive; cover joint ASJ tape.
 - .3 Secure rigid insulation on rectangular ducts with 50% area coverage using contact adhesive, impale on pins located 400mm (16") on centre, secure in place with retaining clips.
-

-
- .4 Butt rigid insulation on rectangular ducts and seal joints with lap seal adhesive; cover joints with 100mm (4") strips of open mesh cloth imbedded between two coats of lap seal adhesive.

3.7 Cold Duct Insulation Application

- .1 Adhere mineral fiber insulation to round and oval ductwork with adhesive applied in 150mm (6") wide strips on 400mm (16") centers. Band on outside until mastic sets then remove bands.
- .2 Butt mineral fiber insulation and seal joints with lap seal adhesive; cover joint with FSK tape.
- .3 Secure rigid insulation on rectangular ducts with 50% area coverage of adhesive and impale on pins located 400mm (16") on centre and secure in place with the retaining clips.
- .4 Butt rigid insulation on rectangular ducts and seal joints with lap seal adhesive; cover joints with 100mm (4") strips of open mesh cloth imbedded between two coats of lap seal adhesive.

3.8 Acoustic Duct Insulation Application

- .1 Do work in accordance with recommendations of SMACNA duct liner standards as indicated in SMACNA HVAC Duct Construction Standards, Metal and Flexible, except as specified otherwise.
- .2 Install in accordance with manufacturer's recommendations, and as follows:
 - .1 Fasten to interior sheet metal surface with 100% coverage of adhesive.
 - .2 In addition to adhesive, install weld pins not less than 2 rows per surface and not more than 425mm (17") on centers.
- .3 Seal butt joints, exposed edges, weld pin and clip penetrations and damaged areas of liner with joint tape and sealer. Install joint tape in accordance with manufacturer's written recommendations, and as follows:
 - .1 Bed tape in sealer.
 - .2 Apply two coats of sealer over tape.
- .4 Replace damaged areas of liner at discretion of the Engineer.
- .5 Protect leading and trailing edges of duct sections with sheet metal nosing having 15mm (½") overlap and fastened to duct.

3.9 Exposed Ducts

- .1 Make smooth any uneven insulated surface before recovering.
-

-
- .2 Finish exposed ducts with canvas jacket suitable for paint finish.
 - .3 Finish ducts exposed to outdoors with aluminum jacket. Caulk all joints on jacket for weather tight finish. Locate longitudinal joints in least weather exposed position.

3.10 Duct Insulation

- .1 Insulated in their entirety are all combustion air and relief air ductwork, all exhaust air ductwork for a distance of 5m (16 ft) from the exterior walls or openings, ductwork carrying hot or cold conditioned air and outside air ductwork.
- .2 Unless otherwise indicated, do not insulate ducts carrying air at room ambient temperature, exhaust air ductwork except as noted above, return air ductwork, relief air ductwork and ductwork fitted with an approved acoustic thermal lining.
- .3 Add extra thickness of insulation at standing seams, flanged joints and any other duct protrusions. Adhere jacket lap joints with an adhesive which will be guaranteed to maintain the adhesion under all conditions.
- .4 Ductwork carrying outside air must be insulated completely so there is no break in either the insulation thickness or vapor barrier.
- .5 Provide recovering jackets on exposed insulation throughout, including equipment rooms. Insulation located in crawl spaces, shafts and suspended ceiling spaces is not considered exposed. Make smooth any uneven insulated surface before recovering.
- .6 Cover insulation exposed to outdoors with aluminum jacket secured with aluminum bands on 200mm (8") centers. Longitudinal slip joints, lap circumferential joints 75mm (3") minimum and seal all joints with compatible waterproof lap cement.
- .7 Where duct velocities exceed 10m/s (2000ft/m), cover insulation with 0.8mm perforated galvanized steel with 24% free area.

3.11 Insulation Installation Thickness Schedule – Piping

	Piping	Pipe Sizes mm (in)	Insulation Thickness mm (in)	Recovery Jacket
1.	Domestic Cold Water Piping	40 (1½") & under 50 (2") & over	15 (½") 25 (1")	Canvas
2.	Domestic Hot Water Supply & Recirculation Piping	50 (2") & under 65 (2½") & over	25 (1") 40 (1½")	Canvas

3.12 Insulation Installation Thickness Schedule – Ducting

	Ducts & Equipment	Insulation Thickness mm (in)	Recovery Jacket
1.	Combustion Air and Relief Duct	50 (2")	Canvas
2.	Exhaust Ducts within 3m (10'-0") of Exterior Walls or Openings.	25 (1")	Canvas
3.	Outside Air Intake Ducts	50 (2")	Canvas
4.	Ductwork exposed to outdoors	50 (2")	Aluminum
5.	Ductwork exposed to outdoors with acoustic lining	50 (2") (Acoustic)	-
6.	Plenums (Outside Air & Exhaust Air)	100 (4")	-
7.	Plenums (Systems with Cooling Coils)	100 (4")	-
8.	Supply Ducts	25 (1")	Canvas
9.	Acoustic Lining (where indicated)	25 (1") (unless indicated otherwise)	-

END OF SECTION

1. General

1.1 Scope

- .1 Provide all materials and services as documented within these specifications and as required to furnish a complete and fully operational DDC Building Automation System (BAS) to monitor and control the building systems referred to in this specification.
- .2 The work includes the supply and installation of DDC controllers, instrumentation, control devices, conduit, wiring, tubing and other devices as necessary to provide a complete system of BAS controls, compliant with these specifications.
- .3 Supply, install and configure all software, programming and databases; set up equipment operating schedules; and perform system activation functions as identified within these specifications, to provide a complete and fully operational BAS.
- .4 Provide:
 - .1 Submittals,
 - .2 System Documentation,
 - .3 Acceptance Testing, and
 - .4 Instructions to Owners

1.2 Related Work

- | | | |
|----|--|--------------------|
| .1 | Instrumentation and Control Devices for HVAC | Section 23 09 13 |
| .2 | Sequence of Operations for HVAC Controls | Section 23 09 93.1 |
| .3 | Point Schedules for HVAC Controls | Section 23 09 93.2 |

1.3 Work by Others

- .1 Distribution and installation of wells, flow insertion fittings, motorized valves and motorized dampers into the piping systems.

1.4 Quality Assurance

- .1 Provide a complete system of BAS controls for mechanical systems by specialty BAS firms having proof of completing three (3) projects of similar size.
 - .2 The BAS equipment shall be of one manufacturer throughout and shall have service for the system from manufacturer's factory authorized service, resident in the City of Edmonton, Red Deer or Calgary.
-

-
- .3 Software engineering and support shall be resident in the City of Edmonton, Red Deer or Calgary.

1.5 Shop Drawings

- .1 Submit shop drawings in accordance with Section 23 05 00 – Common Work Results for HVAC and with the requirements outlined below.
 - .2 Submit the shop drawings and technical data describing the proposed system within 90 days after award of the BAS contract. Provide sufficient detail to enable the consultant to evaluate the proposed system and determine whether the requirements of the specification will be met.
 - .1 Schematic of system architecture indicating the type and location of all digital controllers, the major system equipment monitored and controlled by each panel and how the controllers are to be networked.
 - .2 The proposed digital I/O points list including at a minimum the point mnemonic, point description, controller number and controller I/O point number.
 - .3 Equipment schedule for all hardware, valves, dampers, field instrumentation, input/output devices, transducers and actuators.
 - .4 Technical description and specifications for the primary and sub-networks.
 - .5 Schematic diagram for each mechanical system showing all input/output points, wiring diagrams for all I/O points and a written detailed operational description of control sequences. For terminal equipment controllers, submission of field point wiring diagrams for each type is adequate.
 - .6 Engineering/technical data and maintenance information for each system component, including sizing and arrangements as requested. Include calculations for control valve selections.
 - .3 Shop drawings are to be submitted in an organized fashion complete with table of contents, tab sheets and sequentially numbered pages to enable easy location of information. This also applies to component data sheets.
 - .4 Component data sheets shall be organized by device type with tab sheets for each section i.e. Controllers, Digital Input devices, Digital output devices, Analog input devices, Analog output devices.
 - .5 The table of contents for component data sheets must indicate product description, specification I/O device type or specification section, and page number.
 - .6 Component specification sheets that include more than one product shall be clearly marked to identify the applicable product(s), options and specifications.
-

-
- .7 Submit copies of the complete shop drawings to the consultant for review and approval. Partial submissions may be accepted depending on the detail and acceptance by the Consultant. Provide additional copies of the complete approved shop drawings with the O&M Manuals.
 - .8 Within 120 days after award of the contract submit printed copies of all dynamic graphic displays, proposed calibration check sheets.
 - .9 Within 180 days after award of the contract submit two (2) draft Operating and Maintenance manuals as specified in this section under System Documentation.
 - .10 BAS shop drawings shall be based on approved mechanical equipment shop drawings. The Mechanical Contractor is to provide approved mechanical equipment shop drawings to the BAS Contractor.

1.6 Owner Orientation

- .1 Formal training sessions shall commence only after "as-built" drawings have been completed, reviewed and approved by the Engineer.
 - .2 Individuals who have had specific training as an instructor shall conduct training sessions.
 - .3 All training sessions shall include training materials and shall follow a documented course outline.
 - .4 A copy of the training materials, which shall include a detailed course outline, shall be submitted to the Engineer for approval three weeks prior to commencing any training sessions.
 - .5 Any training conducted without prior approval of the Engineer shall be repeated at the discretion of the Engineer and/or will not count toward the contractors training obligations.
 - .6 The BAS contractor shall provide three weeks written notice to the Engineer and building Owner prior to commencing formal training sessions.
 - .7 The BAS contractor shall provide three (3) complete sets of training manuals to the Owner prior to commencing of the training session, plus one manual to the Engineer.
 - .8 Provide for operator training according to the following schedule.
 - .1 A one (1) day system and component familiarization seminar/workshop during the first week of trial usage.
 - .2 A one (1) day seminar/workshop the week before the 7-day acceptance test covering all aspects of system use as follows:
 - .1 Operation of hardware components
-

- .2 System software configuration
- .3 User/system interaction
- .4 Calibration of sensors and system
- .5 Trouble shooting of system and components
- .6 Preventative maintenance

- .3 A one (1) day review workshop at one month after system acceptance.

1.7 Warranty

- .1 Include warranty provisions identified in the specifications.
- .2 In addition to the warranty in item .1, provide a two (2) year warranty on all items provided under this contract including but not limited to all equipment, wiring and software. The warranty period shall commence on the date of final written acceptance of the BAS system.
- .3 Provide on site service including all labor, materials and software to maintain the complete control system in optimal functioning condition during the warranty period.
- .4 Perform preventive maintenance (PM) during the warranty period.
- .5 In addition to warranty call backs provide two (2) service and calibration inspections of a minimum four (4) of hours duration each. These calls will be initiated by the Owner.
- .6 The overtime premiums for weekend and overtime service calls shall be clearly identified within your proposal.
- .7 The BAS contractor shall supply and install at no cost all system software updates and upgrades occurring up to 2 months prior to the expiration of the warranty period.
- .8 Maintain a service log on site of all control system maintenance activities during the warranty period.

1.8 System Activation

- .1 Submit control calibration and point verification check sheets to the Engineer for approval prior to any calibration of devices or end to end point verification commences. Check sheets to include:
 - .1 Controller identification number
 - .2 Controller input/output point number
 - .3 Control point mnemonic

-
- .4 A complete concise English description of each point
 - .5 Device controlled
 - .6 Interlock devices
 - .7 Measured and displayed analog input values
 - .8 Analog Output zero and full scale verification
 - .9 End to End verification for all points
 - .10 Wire labels verification
 - .11 Device tag verification
 - .12 Date of verification
 - .13 Initials of person performing verification
-
- .2 Submit sample control loop trend log plot, of the type to be used for demonstrating control loop tuning, to the Engineer for approval.
 - .3 Verify that each hardware component has been properly installed as recommended by the manufacturer and is functioning correctly.
 - .4 Calibrate all devices including sensors, transmitters, transducers, current relays, valve actuators, damper motors, etc., verifying that end to end calibration accuracy as specified has been achieved.
 - .5 Ensure tight shut off and fail safe operation of valves and dampers. Hysteresis shall not be greater than 5% of the operating range.
 - .6 Set damper linkages, static pressure/volume controls as required.
 - .7 Set up run time capture for each digital input point.
 - .8 Set up alarm point for each digital input/output pair, with delay before alarm is annunciated.
 - .9 Set up deviation alarm for each control loop measured variable input with appropriate alarm interlocks, dead-bands and time delays.
 - .10 Set up high and low alarm limit points for analog input points as shown on the point list.
 - .11 Set up zero scale and full scale alarms for each analog input to alarm point failures.
-

1.9 Acceptance Testing

- .1 A final operational acceptance test of seven consecutive days shall be conducted on the complete and total installed and operational control system to demonstrate that it is functioning properly in accordance with the specifications.
 - .2 The correct operation of all monitored and controlled points shall be demonstrated as well as the operation and capabilities of all sequences, reports, specialized control programs and algorithms, diagnostics and all other software. Specific testing shall include but not be limited to:
 - .1 Power Failure Restart.
 - .2 Outside Air Temperature Reset Schedules
 - .3 Night Setback
 - .4 Free Cooling
 - .5 Mechanical Cooling
 - .6 Mechanical Heating
 - .3 In the event of the failure of function, during the test, of any of the hardware components or software application or routines, the test will recommence and run until seven failure-free test days have occurred.
 - .4 Prior to conducting the final operational acceptance testing, submit to the Engineer:
 - .1 Completed calibration and verification check sheets including airflow station calibration sheets.
 - .2 Hard copy and electronic copy on CD of final data base listings.
 - .3 If electronic copy of final database listing is not in Microsoft Word, Excel or Access format, provide a final points list to the Engineer in either Microsoft Word, Excel, or Access format.
 - .4 Hardcopy of all system Graphics.
 - .5 A signed declaration stating that all work has been completed or identifying any outstanding deficiencies and the anticipated completion date(s).
 - .5 After successful completion of the acceptance test, the Engineer will issue written acceptance of the control system.
 - .6 For all systems prior to substantial completion the BAS contractor shall successfully demonstrate the response to
 - .1 All fire alarm interlocks, shut-down sequences and fire control strategies
-

.2 All power failure interruptions

.7 The initiation of the Fire Alarm system into alarm mode and simulation or tripping of the main power feeders shall be performed by others.

1.10 System Documentation

.1 Operating and Maintenance Manuals

.1 The BAS Operation and Maintenance Manuals shall contain operational, product data, cleaning and maintenance information on all products and equipment supplied as part of this projects BAS. The final Manuals shall accompany the Project Record Drawings and shall be in place prior to substantial performance.

.2 Submit a draft Manual for format review three (3) months after award of Contract and three (3) Manuals of Documentation for interim submission at 75% construction. Draft Manuals are to be complete in all aspects less control programming. Interim submission is to include all control shop drawings, programming and system descriptions. Draft and Interim Manuals are to be submitted in 3 ring binders. Final Manuals to be in catalogue type binder.

.3 Each manual shall be 215 mm x 280 mm capacity extension type Catalogue Binder bound in heavyweight fabricord, colour to be reviewed with the Owner prior to order and hot stamped in white lettering front and spine.

.4 The spine and front face of the binder shall be lettered with the following:

.1 Full identification title of the project

.2 Building Automation System

.3 Operation and Maintenance Manual

.4 Set X of Y

.5 Volume X of Y

.5 The manual shall be arranged according to the following format. Utilize colour coded laminated mylar plastic divider tabs with headings according to section.

.1 Table of Contents

.2 Introduction

.3 Control System Design

.4 Building System Descriptions

.5 DDC Panel Layout

-
- .6 Shop Drawings
 - .7 Equipment Schedules
 - .8 Certification and Testing
 - .9 Product Manuals
 - .10 Maintenance
 - .11 Software & Certificates
 - .6 On the first page of each binder, before the table of contents identify the following:
 - .1 Prime Consultant: name, address, telephone number.
 - .2 Contractor: name, address, telephone number.
 - .3 Subcontractors: name address, telephone number.
 - .7 Table of Contents
 - .1 Include in each binder a table of contents that provides an index in order of appearance of all sections and subsections within the manual.
 - .8 Introduction
 - .1 Provide a written explanation of the layout of the manual.
 - .2 List all other control system manuals submitted for this project including all software manuals and hardware manuals. Identify the quantities of each manual provided.
 - .9 Control System Design
 - .1 Design Intent
 - .1 Explain, in this section, the design intent and give a system overview which outlines the relationships between the hardware, operating system, control software and other control components.
 - .2 Provide a detailed description of all parts, components and software in the system.
 - .3 Describe the system architecture. Provide a system configuration schematic with the location, type and model of all control panels, work stations, remote access modems, etc. and
-

identify the major equipment monitored and controlled by each panel.

.4 The schematic must identify network communication protocols and communication speeds between all control panels and indicate BACnet compatibility where applicable.

.5 Identify the number of controllers that can be added to each network and sub-network and any maximum distance between controllers or maximum length of network without the need to add additional communication devices.

.6 Identify all software products provided including third party software. This shall include but not be limited to all operator workstation, graphics, controller and laptop software. For each product, indicate the number of software licenses provided, the name of the respective vendor and any software protection devices required. Indicate the number of software protection devices provided.

.2 Operations

.1 Provide an overview of the building automation system operations. Include basic instruction on:

.1 System access

.2 Alarms management (including, how and where alarms are annunciated, after-hours reporting of critical alarms, etc.)

.3 Commonly used reports

.4 Laptop, local and remote system access and

.5 Basic trouble shooting directions.

.2 These instructions are to provide a basic understanding of the system operations and are to reference specific areas of the software manuals for further detailed instructions.

.3 Provide detailed back-up and data recovery procedures including recommended frequencies and data to be backed up. Here again refer to specific areas of product manuals where appropriate. Provide sample back-up log sheets.

.10 Building System Descriptions

-
- .1 System Design intent - Explain, in this section, the design intent and give a system overview which outlines the system components and the intended system function.
 - .2 Provide a schematic, control sequences, wiring diagram, device list and points list for each building system controlled by the BAS.
 - .3 Control sequences shall identify start-up and shut-down sequences, control loop set-points, reset schedules, system interlocks, etc.
 - .4 As built record drawings in 11" X 17" format, folded to fit into the O&M binders may be used to provide part or all of the information required for this section.
- .11 DDC Panel Layout
- .1 Provide as-built panel layout sheets and include locations of all panels.
 - .2 Include a panel points list that identifies each point name with concise English description and termination point. Identify panel spare points.
 - .3 Identify power source for each panel including emergency/normal, UPS, panel number and circuit number.
- .12 Shop Drawings
- .1 Insert in this section all approved shop drawings organized in the format specified in section 23 05 00 – Common Work Results for HVAC.
- .13 Equipment Schedules
- .1 Provide an equipment schedule for all hardware provided including valves, dampers, actuators, controllers, transducers, input/output devices and other instrumentation.
- .14 Certification and Testing
- .1 Provide final copies of all completed calibration and verification check sheets including all airflow station calibration check sheets.
- .15 Product Manuals
- .1 Include in this manual or within product, user manuals and technical manuals, complete and detailed instruction on the use, setup and support of all control system software and hardware provided under this project.
 - .2 Provide detailed instructions on set-up and user operations including but not limited to system access, navigation, alarms, trending, historical trending, reporting and trouble shooting.
-

.3 Provide complete detailed instruction on database structure, set-up, initialization, expansion and editing.

.4 Provide complete detailed instruction to enable creation, modification and implementation of control sequences.

.16 Maintenance

.1 Provide a description in this section of maintenance procedures for all equipment and systems, as defined in this specification, including a schedule for recommended planned and preventative maintenance work items and intervals.

.2 Include a preventative maintenance program complete with suggested check list sheets.

.3 Provide a list of resources to call upon for maintenance and servicing of equipment which includes name, address and phone numbers for supplier and service contact for each piece of equipment.

.4 Include in this section a complete set of as-built drawings if not included elsewhere in this manual.

.5 Certification, guarantee, warranty.

.17 Software & Certificates

.1 Provide original copies of all software distribution media on CDs inserted into vinyl page holders that are designed for 3 ring binders. The originals are to be provided in "Set 1" of these O&M manuals and back-up copies are to be provided in "Set 2".

.2 Provide software registration certificates, or other documents that verify authenticity of software.

.3 Provide back-up copies of entire system at the time of system turn over on CDs in vinyl CD page holders designed for 3 ring binders. Backup to include complete control sequence source code.

1.11 Record Drawings

.1 Before the certification of substantial performance will be issued the contractor must provide the Engineer with record drawings as follows:

.1 One electronic copy of record drawings in AutoCAD version 2000 or Visio format.

.2 Four (4) copies of as-built white prints in 280mmx432mm (8½" x 17") capacity blue binders bound in heavy fabricated, hot stamped in white lettering front and

spine. Each is to be identified As-Built Drawings and permanently numbered 1 to 4.

.3 The spine shall be lettered with the full identification title of the project and the front face shall be lettered with the following on the respective binders:

.1 Full identification title of the project

.2 Prime Consultant and Sub-Consultant - full identification

.3 Prime Contractor - full identification

.4 Mechanical Contractor - full identification

.4 Maintain an accurate record of all deviations and changes on a record drawing set of prints. Such record is to be maintained on a day-to-day basis.

.5 Maintain as-built data on the data gathering and automatic control equipment schedule and panel schedules.

2. Products

2.1 Approved Contractors

.1 Tenders on the following will be accepted:

.1 Siemens Building Systems – APOGEE product

.2 Johnson Controls – Metasys product

.3 ESC Automation – Delta Controls product

.4 Serv-All – Reliable Controls

.2 Alternates to these approved control system products can be submitted as a separate price from the base system specified.

2.2 General

.1 Provide control system components consisting of thermostats, control valves, dampers, actuators, indicating devices, and interface equipment required to operate mechanical equipment and perform functions specified.

.2 Provide all materials and labor required to connect control components.

2.3 BAS Architecture

.1 The BAS system shall be native BACnet, utilizing BACnet BTL approved modules and incorporating BACnet on all primary and secondary communication networks.

-
- .2 The BAS shall be comprised of a network of interoperable, stand-alone digital controllers, operator work stations, server, graphical user interface software, network devices and other devices as specified herein.
 - .3 The BAS shall incorporate the ability to access all user interface functions as specified within these documents using standard internet browsers. Operator access to the BAS shall not require any proprietary operator interface or configuration software to be loaded on the respective PC and access shall only be limited by password.
 - .4 Provide for access to the BAS system by five (5) concurrent users, whether in the building or by Internet utilizing a standard web browser.
 - .5 The BAS system shall incorporate BACnet native devices and they shall be ANSI/ASHRAE 135-2012 BACnet BTL compliant. For components utilized on this project, they shall include the following capabilities:
 - .1 Enterprise Level Server – BACnet I/P with Web Server software
 - .2 Operator Workstation – BACnet I/P with Operator Workstation Software (B-OWS)
 - .3 Building Controllers – BACnet I/P with Building Controllers software (B-BC)
 - .4 Routers – BACnet I/P with Building Controllers software (B-BC)
 - .5 Advanced Application Controllers – BACnet I/P and/or MS/TP with Advanced Application software (B-AAC)
 - .6 Application Specific Controllers – BACnet MS/TP with Application Software (B-ASC)
 - .7 Third Party Devices – BACnet I/P and/or MS/TP with BACnet software
 - .6 The installed system shall provide secure multilevel password access to all features, functions and data contained in the overall BAS.
 - .7 Provide licenses for all software residing in the BAS system and transfer these licenses to the Owner, at no cost, prior to project completion. Provide software on CDs and/or DVDs and licenses for:
 - .1 Database creation and editing
 - .2 Engineering of the system
 - .3 Service, Troubleshooting and/or Tool software
 - .4 Graphics generation
 - .5 Trending
-

-
- .6 Historical trending to cover all hardware and software points
 - .7 Long term historical storage
 - .8 Mapping of database into the existing NAIT BAS network
 - .8 With the CDs and/or DVDs as noted above it shall not require the Owner to obtain any information, data, programs, etc. from the manufacturer and shall not require access over the internet to the manufacturer's site to perform the functionality. Provide 3 copies of the above CDs and/or DVDs.
 - .9 Downloading and Uploading
 - .1 Provide the capability to generate BAS software-based sequences, database items and associated operational definition information and user-required revisions to same, at any Operator PC, and the means to download same to the associated controller.
 - .2 Application software tool used for the generation of custom logic sequences shall be provided to the owner as part of this project.
 - .3 Provide the capability to upload BAS operating software information, database items, sequences and alarms to the designated server.

3. Execution

3.1 Electrical Work

- .1 The BAS contractor shall supply and install all line and low voltage power and control wiring for the BAS system, including all 120/1/60 emergency power wiring to power the various BAS components. Refer to Section 23 09 13 for system requirements.
 - .2 For each 120/1/60 exhaust fan motor that is controlled from the BAS, the BAS contractor shall supply an electrical horsepower rated relay module, fully enclosed and turn over to the Electrical contractor for installation. The power wiring to the module and from the module to the motor shall be provided by the Electrical contractor, with the BAS contractor supplying and installing the control wiring to the BAS system.
 - .3 The BAS contractor shall supply and install all necessary 120/24 transformers and power supplies for the BAS equipment and shall supply and install all conduit, wire, fittings, boxes, etc. to extend the 24 volt AC/DC power to all the BAS equipment.
 - .4 Separate 120/24 volt transformers and/or power supplies shall be provided to **each** digital controller and transformers shall not be shared between digital controllers nor shall the transformers serving the digital controllers power the sensors, transducers, etc.
-

3.2 Air Handling Units / Two systems

- .1 The units providing ventilation air to the building shall be complete with integral controls to control the full functionality of the unit. The units shall normally operate continuously.
- .2 Each unit shall provide external dedicated hardware connection points to the BAS for overall monitoring and enabling of the unit.
- .3 The BAS transducers for filter monitoring shall be mounted in the control panel of the AHU unit.

3.3 MUA Units / Two systems

- .1 The units providing make up air to the building shall be complete with integral controls to control the full functionality of the unit. The units shall normally operate continuously.
- .2 Each unit shall provide external dedicated hardware connection points to the BAS for overall monitoring and enabling of the unit.
- .3 The BAS transducers for filter monitoring shall be mounted in the control panel of the AHU unit.

3.4 Exhaust Fans

- .1 Refer to the points list for exhaust fans that are controlled. Provide separate control and monitoring of fans for each typical application.
- .2 For the garage exhaust fan the CO and NO2 sensors shall be utilized to control operation of the exhaust fan along with the intake motorized damper.

3.5 Split A/C Units

- .1 The BAS contractor shall provide all control wiring between the roof mounted condenser and the indoor units. Note the usage of one roof mounted unit serving two indoor units; include for the necessary control wiring interconnections.
- .2 The BAS room sensor shall provide for alarming within the room.

END OF SECTION

1. General

1.1 Scope

- .1 Control Devices and Hardware
 - .1 Control Panels
 - .2 Wire
 - .3 Conduit and Cables
 - .4 Related Accessories
 - .5 Room Sensors
 - .6 Outdoor Air Sensors
 - .7 Duct Mount Sensors
 - .8 CO & NO2 Sensors

2. Products

2.1 Control Panels

- .1 Mount digital controllers in control panels with field interface equipment (i.e. relays, transducers, etc.) segregated in the panel and minimizing the electrical interference and heat to the digital controllers.
- .2 The power supplies, transformers, contactors, etc. shall be mounted in separate ventilated metal enclosures.
- .3 Control panels are to be of unitized cabinet type construction, fabricated from rolled sheet metal sheet with baked enamel finish, flush fitting, gasketed doors hung on piano type hinges and locking handles. All panels shall be CSA approved and equal to Hoffman enclosures and shall be common keyed.
- .4 Mount gauges, pilot lights, push buttons and switches flush on cabinet panel face.
- .5 Mount panels on vibration free walls or free standing angle iron supports. Provide engraved plastic nameplates for instruments and controls inside cabinet and on cabinet face.
- .6 Provide pans and rails for mounting terminal blocks, relays, wiring and other necessary devices.
- .7 Provide an individual switch for disconnection and a fuse for isolation of all panel mounted instruments requiring a 120 volt supply.

-
- .8 Make all wiring connections in the shop from the equipment mounted on the panel to numbered terminal blocks conveniently located in the panel, including the power supply for all instruments.
 - .9 Identify all wiring by means of stamped markings on heat shrinkable tubing that is permanently fastened to wiring. Install all wiring neatly and laced or bunched into cable form using plastic wire clips, where practical, contained in plastic wiring channels with covers. Maximum 25 conductors to each wire bundle.
 - .10 Install bonding conductor between main control and auxiliary panels complete with grounding lugs, in addition to CSA grounding requirements.
 - .11 Provide terminal blocks, tabular clamp, 300 V, complete with track. Each terminal shall be clearly indelibly marked with the wire number connection to it. Each field connecting conductor shall be served by one terminal. Provide 20% spare unit terminals, with a minimum of two spare terminals. Provide all necessary terminal block accessories such as manufacturer jumpers and marking tape.
 - .12 Power for control panels shall be 120/1/60 15 amp circuits from power panel provided by Division 26.

2.2 Wire

- .1 Control wiring for digital functions shall be 20 AWG minimum with 300 Volt insulation.
- .2 Control wiring for analog functions shall be 20 AWG minimum with 300 Volts insulation, twisted and shielded, 2 or 3 wire to match analog function hardware.
- .3 Sensor wiring shall be 22 AWG minimum twisted and shielded, 2 or 3 wire to match analog function hardware or 16 AWG as required by code.

2.3 Conduits and Cables

- .1 All wiring, whether line voltage, low voltage or control wiring shall be in conduit or fully enclosed metal trays. Flexible conduit may be used for final connection of control devices. Maximum length of flexible conduit to be 1m (3 ft). Conform to Division 26 requirements for conduit, tray, fittings, junction boxes, cabinets, wire, cable and trays specifications.
- .2 Exposed plenum rated cable shall not be utilized; all wiring shall be in conduit.
- .3 Seal conduit where such conduit leaves heated areas and enters unheated area.
- .4 In the field, run low level (<30 volts) signal lines in separate conduit from high level (>30 volts) signal and power transmission lines.
- .5 In the field panel, run low level signal lines in separate conduit from high level signal and power transmission lines.

-
- .6 Identify each cable and wire at every termination point by means of stamped markings on heat shrinkable tubing that is permanently fastened to wiring.
 - .7 Provide instrumentation complete with standard electrical conduit box for termination unless otherwise noted.
 - .8 Color code all conductors and conduits by permanently applied color bands. Color code shall follow base building schedule. Color code all conduit couplings orange, with orange banding on the conduits.
 - .9 All wiring for terminal equipment controllers including network communications, sensors and actuator wiring must be in conduit.

2.4 Related Accessories

- .1 Provide and install all necessary transducers, interposing relays, interface devices, contactors, starters and EP's to perform control functions required.
- .2 It is the responsibility of the BAS Contractor to identify, at the time of tender submission, all additional items not specified that are required to meet the operational intent specified.

2.5 Thermostats and Room Sensors

- .1 Provide tamper proof guards for the following areas: entrances, public areas, corridors. Guards to be equal to BAPI-Guard.
- .2 Safety low limit protection thermostats shall be manual reset type with 6m (18 ft) elements. Provide multiple thermostats for large duct cross-sectional areas. Mount thermostats on the outside of the ductwork and no higher than 1500mm (5 ft) above the floor. Provide DPDT contacts for connection to SCU or ASC.

2.6 Duct Mount Sensors

- .1 Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.
- .2 Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
- .3 For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.

2.7 Differential Pressure Transmitters

- .1 General Air Pressure Transmitter Requirements:
 - .1 Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage, and to hold calibrated accuracy when subject to a momentary 40% over-range input.

-
- .2 Pressure transmitters shall transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal.
 - .2 Low Differential Air Pressure Applications (0" to 5" w.c.)
 - .1 The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.
 - .2 The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
 - .1 (0.00 - 1.00" to 5.00") w.c. input differential pressure ranges. (Select range appropriate for system application.)
 - .2 4-20 mA output.
 - .3 Maintain accuracy up to 20 to 1 ratio turndown.
 - .4 Reference Accuracy: +0.2% of full span

2.8 Status and Safety Switches

- .1 General Requirements
 - .1 Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the BAS when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.
- .2 Current Sensing Switches
 - .1 The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.
 - .2 Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.
 - .3 Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.

3. Execution

3.1 Installation

- .1 Verify location of sensors and other exposed control sensors with drawings before installation. Locate room temperature sensors 1500mm (5 ft) above floor. CO sensors shall be mounted 1-1.5 m above the floor; NO2 sensors shall be mounted 30 cm – 1m from ceiling.
- .2 Wire "hand/off/auto" selector switches such that only automatic operating controls and not safety controls and electrical over current protection shall be overridden when switch is in the "hand" position.
- .3 Unless specified otherwise, install all outdoor air sensors on the north exposure of the building.
- .4 Install all safety limits at the operator's level.
- .5 Control System Power
 - .1 Provide power to all BAS components as necessary to provide continued monitoring and control.
 - .2 Power for all transducers and other instrumentation associated with a controller shall come from the same circuit that is feeding the digital controller.
 - .3 Identify in the record drawings the panel and circuit number serving each controller.

END OF SECTION

1. General

- .1 This section is a module which specifies the Field Instrumentation, Sensing Devices and Actuators.
- .2 For general requirements relating to all sections see Section 23 09 00 – Instrumentation and Control for HVAC.

2. Products**2.1 General**

- .1 Provide analog or digital field instrumentation devices as applicable which measure temperature, humidity, pressure, flow, current, voltage, equipment states, etc., and which input signals to the ASC and/or SCU terminal strip that conform to the input requirements.
- .2 Provide output devices and actuators which convert the digital or analog output signal from the ASC and/or SCU to activate relays or open and close valves, dampers, etc.
- .3 The end to end accuracy called for in Subsection 2.2 includes the combined effect of sensitivity, hysteresis, linearity and repeatability between the measured variable and the input to the analog-to-digital convertor in the ASC and/or SCU or between the ASC and/or SCU input to the digital-to-analog convertor and the controlled variable for the full sensing range.
- .4 The letter under the "Type" column in Subsection 2.2 is the same used in the points list.
- .5 Acceptable manufacturers of sensors are indicated in Section 3.0.

2.2 Analog Input Sensors

- .1 Temperature

<u>Application</u>	<u>Type</u>	<u>Operating Range</u>	<u>End to End Accuracy</u>	<u>Remarks</u>
Duct Mounted	Tp	0°C to 60°C (32°F to 140°F)	±0.5°C	
Pipe Well	Tw	0°C to 50°C (32°F to 122°F)	±0.5°C	c/w thermal wells
Mounted		0°C to 100°C (32°F to 212°F)	±0.5°C	
		50°C to 150°C (122°F to 300°F)	±0.5°C	
Averaging	Ta	-30°C to 60°C (-20°F to 140 °F)	±0.5°C	Length to suit duct side

Space Temp.	Tr	10°C to 301°C (50°F to 572°F)	±0.5°C	c/w tamper-proof cover
Outside Air	To	-50°C to 50°C (-58°F to 122°F)	±1.0°C	c/w solar-shield
Surface Temp	Ts	0°C to 50°C (32°F to 122°F)	±0.3°C	

.2 Relative Humidity

Acceptable Manufacturers: Hy-Cal, General Eastern

<u>Application</u>	<u>Type</u>	<u>Operating Range</u>	<u>End to End Accuracy</u>	<u>Remarks</u>
Duct mounted	Hp	5 - 90% RH 0°C to 60°C (32 °F to 140 °F)	±5%	
Space	Hr	5 - 90% RH	±5%	c/w tamper-proof cover
Outside air	Ho	5 - 100% RH	±5%	c/w solar-shield

.3 Pressure

Acceptable Manufacturers for Sp and Vp Sensors: Modus, Setra.

<u>Application</u>	<u>Type</u>	<u>Operating Range</u>	<u>End to End Accuracy</u>	<u>Remarks</u>
Static-water	Ps	0 to 104 kPa (0 to 15 psi)	±2%	
		0 to 208 kPa (0 to 30 psi)	±2%	
		0 to 689 kPa (0 to 100 psi)	±2%	
		0 to 2,000 kPa (0 to 300 psi)	±2%	
Static-air	Sp	0 to 500 Pa (0 to 2" WG)	±2%	
		0 to 1,250 Pa (0 to 5" WG)	±2%	
		0 to 2,500 Pa (0 to 10" WG)	±2%	
Instrument	Ia	0 to 150 kPa (0 to 20 psi)	±2%	
Velocity	Vp	0-62.5 Pa	±1.0%	-multi-point static &

pressure monitoring station – air		(0-0.25" WG) 0-125 Pa (0-0.5" WG) 0-250 Pa (0-1" WG)		total pressure sensing element manifold -self-averaging manifold -air equalizer & straightener -max. pressure loss 36 Pa @ 10 m/sec. -lowest sensitivity 1% of range
Flow monitoring station – water, steam	Pv	As required	±2.0%	-Paddle wheel
Fan Inlet- Air Flow Traverse Probes	Vpi	0-62.5 Pa (0-0.25" WG) 0-125 Pa (0-0.5" WG) 0-250 Pa (0-1" WG)	±3.0%	Multiple total and static pressure sensors connected to a self averaging manifold. Provide steady non-pulsating signals of standard total and static pressure. Accuracy of ±3.0% of actual flow over a fan operating range of 6 to 1 capacity turn down.

.4 Electrical

<u>Application</u>	<u>Type</u>	<u>Operating Range</u>	<u>End to End Accuracy</u>	<u>Remarks</u>
Kilowatts	kW	Various voltages		From digital metering systems
Current transmitters	Ct	As required	±0.25% full scale	

2.3 Analog Output Devices

<u>Application</u>	<u>Type</u>	<u>Operating Range</u>	<u>End to End Accuracy</u>	<u>Remarks</u>
To damper motors	De	0 - 10 VDC 4-20 MA	±2% full scale	
To valve actuators	Ve	0 - 10 VDC 4 - 20 MA	±1% full scale	

2.4 Digital Input Devices

<u>Application</u>	<u>Type</u>	<u>Operating Range</u>	<u>End to End Accuracy</u>	<u>Remarks</u>
Pressure Switches	Pd	As required	±1.5% full scale	-adjustable setpoint and differential
Temperature	Td	As required	±1°C	-adjustable setpoint and differential -automatic reset -normal reset for freeze protection
Current Sensing Relays	Ri	As required	N/A	-adjustable trip c/w LED Status indication.
Motor status Relays	St	As required	N/A	-auxiliary contacts
Level	Ls	N/A	N/A	
Misc Inputs	Rc	N/A	N/A	Auxiliary contacts

2.5 Digital Output Devices

<u>Application</u>	<u>Type</u>	<u>Operating Range</u>	<u>End to End Accuracy</u>	<u>Remarks</u>
Relays	Ry	N/A	N/A	Plug-in type with terminal base contacts rated at 5 amp 120 VAC.

2.6 Signal Transmission

- .1 Provide a digital transmission network to communicate between all SCU's as required.
- .2 Digital transmission at 9600 baud minimum.

3. Execution**3.1** General

- .1 Codes and Standards
 - .1 Install all components in accordance with the latest regulations of the Canadian Electrical Code, applicable Municipal and Provincial Codes and Regulations, latest CSA Electrical Bulletins and Division 26.

-
- .2 Current relay modules shall be equal to SENTRY series 100/200 series to provide a 4-20ma or 0-10VDC signal according to the motor current, with frequency variations from 10 to 400 Hz.
 - .3 Current sensing relays shall be equal to Greystone series CS-610-75 with LED and range adjustment and provide a dry contact signal.
 - .4 Air pressure switches shall be mounted in the BAS panel, with the tubing extended out to the unit. Switches shall be equal to Cleveland Controls AFS-460 series with manual reset.
 - .5 Strap on temperature sensors used on small piping, where wells are too large, shall be equal to Enercorp TS-BP series c/w armor leads. The units shall be securely attached to the surface of the pipe, with covering insulation.
 - .6 Static and differential air pressure transmitters shall be equal to Dwyer DM-2000 series, complete with digital display and an analog signal for connection to the BMCS. The units shall be mounted in the BMCS panels and shall be complete with capped connections to allow for a local meter to calibrate and check the units.
 - .7 Static and differential air pressure transmitters out in the spaces shall be equal to Dwyer DPT 264 series, 0.5% accuracy with a 0-10V DC and/or 4-20 ma signal for connection to the BMCS.
 - .8 For each static and/or differential air flow transmitter, air pressure switch, etc. connection into the ductwork provide a standard production Dwyer series 160 pitot tube, or equal, with duct clamp and gasket for sensing the total and/or static pressure. For static pressure measurements extend the second reference line connection from the panel to a point outside and adjacent to the pitot tube. Leave the line open and tag it indicating the line is to be kept open. Provide capped fittings at the pitot tube for connection of a remote gauge.
 - .9 For all the various transducers, supply and install the required transformers, power supplies, fusing, filters, etc. as required to provide the reduced voltage to the devices.

END OF SECTION

1. General

- .1 The control sequences below provide a general description of the intent of the operation of the systems to be controlled. The BAS Contractor shall review individual systems to ensure equipment and life safety interlocks are not overridden.
- .2 Consult with the Engineer during the shop drawing stage to finalize the control sequences for each system
- .3 The BAS Contractor shall ensure that all end devices and sensors are on
- .4 On loss of building power and building power being restored, all equipment, including that on emergency power, shall be reset to nominal start up conditions and shall run through its normal start up sequence prior to returning to required operating conditions. The BAS Contractor shall ensure that all end devices and sensors are on emergency power, if available, as required, to accommodate system operation under normal and emergency conditions.

1.2 Systems

- .1 Make-Up Air Unit
- .2 Exhaust Fans

2. Products

Not Applicable

3. Execution

3.1 General

- .1 Provide data base for all hardware points listed for system operation to meet specification operating sequences.

3.2 Firing Range Ventilation System

- .1 The firing range is served by existing Air Handling Unit AH06 and existing Exhaust Fan AH06-EF. Operation of the air handling unit and exhaust fan is interlocked.
 - .2 A differential pressure sensor shall monitor the pressure between the firing range and control room vestibule.
 - .3 A VFD on the exhaust air fan shall control the exhaust air volume to maintain a pressure differential of -10 Pa (adjustable) in the firing range.
-

3.3 Cleaning Station Air Filtration

- .1 Operation of the cleaning station transfer fan TF-1 and Heat Recovery Ventilator HRV-1 shall be monitored by the BAS.
- .2 The transfer fan and heat recovery ventilator shall be energized by a manual switch located adjacent to the cleaning station.
- .3 Differential pressure sensors shall be provided on the HEPA filters serving the gun cleaning station to monitor the status of the filters.
- .4 A BAS panel shall be located in the firing range control room for to provide status of the HEPA filter. The panel is to have three (3) lights: normal operation, filter change recommended, change filter immediately.

END OF SECTION

POINT DESCRIPTION	*POINT TYPE	POINT TAG (DIAGRAMS)	DIGITAL			ANALOG			REMARKS
			OUTPUT	INPUT	ALARM	OUTPUT	INPUT	ALARM LIMITS	
MUA Unit									2 - Exterior; 1-Interior
Supply Fan Status	Ri	XS		X	X				
Unit Start/Stop	Ry	JZ	X						
Heating Enable	Ry	JZ	X						
Outside Air Temp	To	TT					X		
Supply Air Temp	Tp	TT					X	XX	
Space Temperature	Tr	TT					X	XX	
Supply Air Temp Setpoint	Zt	ZT				X			
Common Alarm	Rc	XS		X	X				
Filter Monitor	Pt	DPT					X	XX	
Exhaust Fan									
VFD Alm	Rc	XS		X	X				
VFD Enable	Ry	JZ	X						
VFD Fbk	Aiv	IT					X		
VFD Control	Aov	IT				X			
Differential Pressure	Dp						X		

POINT DESCRIPTION	*POINT TYPE	POINT TAG (DIAGRAMS)	DIGITAL			ANALOG			REMARKS
			OUTPUT	INPUT	ALARM	OUTPUT	INPUT	ALARM LIMITS	
Gun Cleaning HEPA Filter Differential Pressure	Dp						X	X	
Transfer Fan Status	Ri	XS		X					

1. General

1.1 Scope

- .1 Ductwork and plenums
- .2 Fasteners
- .3 Sealants
- .4 Testing

1.2 Quality Assurance

- .1 Use highest quality materials conforming to the appropriate ASTM and ANSI specifications.
- .2 The codes and standards herein referred to shall be those editions currently in effect or accepted by the authorities in the area of jurisdiction.
- .3 Be guided by “A Manual of Recommended Practice for Industrial Ventilation” issued by the American Conference of Governmental Industrial Hygienists.
- .4 Ductwork shall meet the requirements of NFPA No. 90A - Air Conditioning and Ventilating Systems.
- .5 Fabricate in accordance with SMACNA duct manuals and ASHRAE handbooks as a minimum where more stringent requirements are not identified in the contract documents. Straight tap fittings and dovetail joints are not permitted. Comply with SMACNA Duct Construction Standards for duct pressure rating including requirements for cross breaking, reinforcement, longitudinal seams, transverse joints and sealing. Confirm pressure ratings with consultant prior to fabrication.
- .6 Ductwork used on this project shall be clean and free from scale, corrosion and deposits. All ductwork shall be degreased and wiped clean of all oil and other surface films with appropriate solvents prior to installation.
- .7 All ductwork shall be delivered clean to the site and maintained in clean condition. Dirty ductwork shall be removed from site.
- .8 Test the ductwork installation.

1.3 Definitions

- .1 Low Pressure: Static pressure in duct less than 500 Pa (2” WG) and velocities less than 10 m/s (2000 fpm).
 - .2 Medium Pressure: Static pressure in duct less than 1500 Pa (6” WG) and velocities greater than 10 m/s (2000 fpm).
-

-
- .3 High Pressure: Static pressure over 1500 Pa (6" WG) and less than 2500 Pa (10" WG) and velocities greater than 10m/s (2000 fpm).
 - .4 Duct sizes shown on plans are inside clear dimensions. For acoustically lined or internally insulated ducts, maintain sizes inside ducts.

1.4 Product Options

- .1 Size round ducts installed in place of rectangular ducts indicated from ASHRAE table of equivalent round and rectangular ducts. No variation of duct configuration or sizes permitted except by written permission of the consultant. Extent of options will be limited for example; round duct will not be permitted on ducts downstream of terminal units except where shown.
- .2 Use of a pre-manufactured bolted transverse duct joint/seal connection is permitted on ductwork constructed of material between 1.2mm and 0.8mm inclusive.

1.5 Reference Documents

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE)
 - .2 American Society for Testing and Materials International, (ASTM)
 - .1 ASTM A480/A480M Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
 - .2 ASTM A635/A635M Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot Rolled.
 - .3 ASTM A653/A653M Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
 - .3 Canadian Standards Association (CSA)
 - .1 CAN/CSA-Z317.2 Special Requirements for Heating, Ventilation, and Air Conditioning (HVAC) Systems in Health Care Facilities
 - .4 National Fire Protection Association (NFPA)
 - .1 NFPA 90A Standard for the Installation of Air-Conditioning and Ventilating Systems
 - .5 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
-

-
- .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible
 - .2 SMACNA HVAC Air Duct Leakage Test Manual
 - .3 IAQ Guideline for Occupied Buildings Under Construction
 - .6 National Research Council (NRC)/Institute for Research in Construction
 - .1 National Energy Code of Canada for Buildings (NECB) 2011
 - .7 South Coast Air Quality Management District, California State (SCAQMD)
 - .1 SCAQMD Rule 1168, Adhesive and Sealant Applications

1.6 Related Work Specified in Other Sections

- .1 HVAC Air Distribution System Cleaning Section 23 01 30.51
- .2 Common Work Results for HVAC Section 23 05 00
- .3 Hangers and Supports for HVAC Piping and Equipment Section 23 05 29
- .4 Vibration and Seismic Controls for HVAC Section 23 05 48
- .5 Testing, Adjusting and Balancing for HVAC Section 23 05 93
- .6 HVAC Insulation Section 23 07 00
- .7 Air Duct Accessories Section 23 33 00
- .8 Air Outlets and Inlets Section 23 37 00

1.7 Delivery & Storage

- .1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.8 Waste Management and Disposal

- .1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

2. Products**2.1** Materials

- .1 Make round, oval and rectangular ductwork unless specifically noted otherwise of lock-form quality galvanized steel, ASTM designation A93-59T, with copper bearing base metal having 0.20% copper added and 380 g/m² class zinc coating to ASTM A525-M87. Galvanizing quality must allow sheets to be bent flat upon themselves with no fracture to the coating or base metal.
 - .2 Flexible Duct Liner: line with specified thickness of black matte faced insulation, Manson Akousti-Liner. N.R.C. for 25mm material: minimum of 0.75 absolute
-

roughness not greater than 0.0008 feet, substrate must not be dark in colour. Seal edges and joints with an approved fire resistant mastic. Protect leading and trailing edges with sheet metal edging.

- .3 Rigid Duct Liner: Manson Akousti-Liner-R, N.R.C. for 25mm material of 0.80. Rigid liner to be used in plenums and/or where maximum air velocities do not exceed 24.5 m/sec.
- .4 Duct Liner Protection, High Velocity: perforated galvanized steel meeting ASTM A-527-67. Minimum thickness, ducts, 0.70mm thick to 1200mm duct diameter, 1.0mm over 1200mm fittings 1.0mm thick all sizes.
- .5 Fasteners: Use rivets and bolts throughout, sheet metal screws accepted on low pressure ducts. Fasteners to be corrosion resistant. Kitchen exhaust ducts to be welded.
- .6 Sealants: water based, fire resistive, compatible with mating materials, ULC labeled, MP multi-purpose high velocity sealant.
- .7 Strap Hangers: galvanized steel as ductwork but one (1) gauge heavier.
- .8 Hangers: black steel threaded rod.
- .9 Traverse Supports and Reinforcing: galvanized steel as ductwork or mild steel sections.
- .10 Use aluminum ducts for swimming pool ventilation or handling moisture laden air.

2.2 Ductwork Pressures

- .1 Provide ductwork and plenums fabricated from galvanized steel for the static pressure categories listed below.
 - .1 1500 Pa (6" W.G.) static pressure:
 - .1 All supply air ductwork downstream from supply air handling units discharge, to the upstream side of mixing boxes/air valves.
 - .2 All exhaust and return air ductwork downstream from return/exhaust air valves to the return/exhaust fans and downstream from the return/exhaust fans to the air handling units and/or outdoor relief.
 - .3 500 Pa (2" W.G.) static pressure
 - .1 All supply ductwork downstream from mixing boxes/air valves to terminal air outlets.
 - .2 All supply ductwork on systems without mixing boxes/air valves.
 - .3 All return air ductwork and plenums, except where otherwise specified.
-

.4 All exhaust and relief air ductwork and plenums, except where otherwise specified (welding/sawdust exhaust).

.5 All outdoor air ductwork, except as otherwise specified.

2.3 Fabrication – Ductwork

- .1 Complete metal ducts within themselves with no single partition between ducts. Where width of duct exceeds 450mm (18”) cross break for rigidity. Open corners are not acceptable.
- .2 Lap metal ducts in direction of air flow. Hammer down edges and slips to leave smooth duct interior.
- .3 Construct tees, bends and elbows with radius of not less than 1½ times width of duct on centre line.
- .4 Increase duct sizes gradually not exceeding 15° divergence wherever possible. Maximum divergence upstream of equipment to be 30° and 45° convergence downstream.
- .5 Rigidly construct metal ducts with joints mechanically tight, substantially air-tight, braced and stiffened so as not to breathe, rattle, vibrate or sag. Caulk duct joints and connections with sealant as ducts are being assembled.
- .6 Provide easements where low pressure ductwork conflicts with piping and structure where easements exceed 10% duct area, split into two (2) ducts maintaining original duct area.

2.4 Lined Ductwork

- .1 Comply with SMACNA “Duct Liner Application Standard”.
- .2 Unless otherwise indicated, maintain the net free area of the duct dimensions given on the drawings. Increase metal duct dimensions as necessary to compensate for the addition of the liner.
- .3 Unless otherwise indicated, lining thickness is 25mm (1”).
- .4 Where round ductwork is indicated to be acoustically insulated, it shall consist of two concentric round ducts with 25 mm (1”) thick flexible fibrous glass duct liner between the two ducts. The inner duct shall be perforated and correspond to the duct diameter noted on the drawings. The outer duct shall be suitable for the static pressure and shall be sealed airtight where it joins the adjacent ductwork.
- .5 Provide duct lining where indicated on drawings.

2.5 Duct Sealing

- .1 All supply, return and exhaust duct joints, longitudinal as well as transverse, shall be sealed using,

.1 Low Pressure Ductwork:

- .1 Slip Joints: Apply heavy brush-on high pressure duct sealant. Apply second application after the first application has completely dried out. Where metal clearance exceeds 1.5mm (16 gauge) use heavy mastic type sealant.
- .2 Flanged Joints: Soft elastomer butyl or extruded form of sealant between flanges followed by an application of heavy brush-on high pressure duct sealant.
- .3 Other Joints: Heavy mastic type sealant.

.2 Medium and High Pressure Ductwork: Combination of woven fabrics and sealing compound followed by an application of high pressure duct sealant.

.2 All ducts to be sealed to SMACNA Sealing Class A.

.3 Duct tapes as sealing method are not permitted.

.4 Surfaces to receive sealant should be free from oil, dust, dirt, moisture, rust and other substances that inhibit or prevent bonding.

.5 Prior to sealing all ductwork, demonstrate sealing of a section of each type of duct and obtain approval from the engineer.

.6 Do not insulate any section of the ductwork until it has been inspected and approved of duct sealant application.

2.6 Turning Vanes

- .1 Turning vanes shall be single wall type. Vanes in galvanized sheet metal ducts shall be constructed from galvanized steel, minimum thickness 0.76mm (22 ga). Vanes shall be spaced at 40mm (1-1/2") centers and shall turn through 90 deg., with a radius of 50mm (2"). Vanes shall not include a straight trailing edge. Refer to Figs. 2-3 and 2-4 of the SMACNA Duct Standards. Vanes and runners in aluminum ducts shall be constructed from aluminum. Aluminum vanes shall be 0.86mm thick (18 ga).
 - .2 For 500 Pa (2" WC) pressure systems, install tie rods to limit the maximum unsupported vane length to 914mm (36"). Refer to Fig. 2-4 of the SMACNA Duct Standards.
 - .3 For 750 Pa (3" WC) and greater pressure systems, install tie rods to limit the maximum unsupported vane length to 460 mm (18"). Refer to 2-4 of the SMACNA Duct Standards.
 - .4 When turning vanes are located in acoustically insulated ductwork, provide turning vanes of perforated metal type with fiberglass inside.
-

3. Execution

3.1 General

- .1 The project drawings are diagrammatic and although efforts have been made to provide information regarding the number of offsets and transitions, not all are necessarily shown. Changes may be required in duct routings, elevation and duct shape to eliminate interference with structure and other services. All required adjustments shall be established when coordinating and field measuring the work prior to fabrication and must be provided as part of the contract and all associated costs must be considered and included.
- .2 Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- .3 Prior to the fabrication of ductwork, co-ordinate and field measure all ductwork to ensure a complete installation respecting all other services. Fabricate ductwork from field measurements and not from plans and shop drawings exclusively. Failure to do so will not constitute an extra to the Contract.
- .4 Provide all necessary fittings, offsets, and alternate construction methods to facilitate the installation.
- .5 Proper sized openings shall be arranged for in the correct locations through all slabs and walls. Openings shall be planned to include for the installation of fire dampers at all rated fire separations.
- .6 Where ducts penetrate roofs, install sleeves and roof curb c/w flashing and counterflashing. Pack sleeves in roof with fibreglass insulation.
- .7 During construction, protect openings in ductwork, from dust infiltration, by covering with polyethylene, and protect floor outlet duct openings with metal caps. Clean any ductwork found to be dirty at no extra cost to the Contract.
- .8 Where ductwork is required to pass through open web steel joists, coordinate with the joist fabricator before fabricating ductwork.
- .9 Where a duct contains a fire or smoke damper, construct the duct so that the free area of the duct is maintained through the fire or smoke damper.
- .10 Where a duct is to be internally insulated, enlarge the duct so as not to reduce the duct free area.

3.2 Installation

- .1 Make the taper of diverging transitions less than 20 deg. and the taper of converging transitions less than 30 deg., in accordance with Fig. 2-9 of the SMACNA Duct Standards. Maximum divergence upstream of equipment to be 30 deg. and 45 deg. convergence downstream.
-

-
- .2 Make the inside radius of any rectangular duct elbow at least equal to the duct width, measured in the direction of the radius. If space conditions do not permit a full radius elbow to be installed, use square elbows with multi-blade turning vanes.
 - .3 Install duct necks before grilles, registers and diffusers and cushion heads after diffuser take-offs as required to suit site conditions and maximize acoustic performance of the ductwork.
 - .4 Where indicated, install adjustable air turning devices, where full radius take-off fittings cannot be installed, in accordance with Fig. 2-16 of the SMACNA Duct Standards. Adjustment shall be accessible outside the duct with lockable quadrant operator or through the grille or register with key-operated worm gear mechanism.
 - .5 Cross-break or bead all metal duct panels unless otherwise noted.
 - .6 Do not cross-break duct panels on 750 Pa (3" WC) and greater static pressure systems.
 - .7 Do not cross-break bottom duct panels when ductwork is handling moisture.
 - .8 Roof mounted ducts shall have standing seams and shall be sealed weather tight.
 - .9 Provide moisture collection sections inside all louvres for outside air and exhaust air.
 - .10 Support ductwork using galvanized steel straps, cadmium plated threaded rods, flat bar or angle hangers. Attachments to the structure shall be compatible with the structure and selected for the load of the ductwork. Refer to Section 23 05 29 – Hangers, Supports, Access Doors for HVAC Piping and Equipment.
 - .11 Support duct risers at their base and at each floor and at not greater than 3.7 m (12 ft) intervals.
 - .12 Ducts passing through non-rated fire separations, sound insulated walls and through non-rated walls and floors shall be tightly fitted and sealed on both sides of the separation with silicon sealant to prevent passage of smoke and/or transmission of sound. (U.L.C. approved fire stop sealant is not a requirement). Where ducts are insulated provide a 0.61mm (24 ga) thick galvanized steel band tightly fitted around insulation and then caulk to band.
 - .13 Provide drip pans under piping and shields for protection of electrical panels and equipment.
 - .14 Complete metal ducts within themselves with no single partition between ducts. Where width of duct exceeds 450mm (18") crossbrace for rigidity. Open corners are not acceptable.
 - .15 Construct tees, bends and elbows with radius of not less than 1-1/2 times width of duct on centre line. Where not possible and where rectangular elbows are specified, provide turning vanes. Where acoustical lining is provided, provide turning vanes of perforated metal type with fiberglass inside.
-

-
- .16 Coordinate the location of duct access doors.
 - .17 Arrange access doors so that they open against the airflow and static pressure.
 - .18 Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pitot tube openings where required for testing of systems, complete with metal cap with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
 - .19 Interrupt duct linings at fire, balancing, backdraft and smoke dampers so as not to interfere with operation of devices. Provide sheet metal edge protection over linings on both side of damper device.
 - .20 Protect carbon steel ductwork exposed to weather by painting or coating with suitable weather resistant material.
 - .21 Install ducts associated with fans subject to forced vibration with flexible connections immediately adjacent to equipment. Refer to Section 23 33 13 – Air Duct Accessories.
 - .22 Do not use flexible duct to change direction. Provide a minimum of three (3) duct diameters of straight metal duct between box inlet and flexible connector.
 - .23 Connect diffusers boots to low pressure ducts with 300mm (12”) maximum stretched length of flexible duct. Hold in place with caulking compound and strap or clamp.
 - .24 Prove that ductwork is substantially air tight before covering or concealing.
 - .25 All segmented type elbows shall be spot welded. No adjustable type elbows are allowed.

3.3 Ductwork Tests

- .1 Refer to Section 23 05 00 – Common Work Results for system testing and startup requirements.
 - .2 All ductwork, regardless of service shall be subjected to pressure tests with costs borne under the mechanical construction contract. All duct sections are to be tested except as approved by the consultant.
 - .3 Equivalency of duct quality testing may be granted to the contractor on the following basis, at the consultant’s discretion:
 - .1 The contractor submits to the consultant and obtains approval of a quality control process for ductwork testing.
 - .2 For each duct system (low and high pressure) test one main length for each of, supply, return and/or exhaust air for establishment of base-line quality.
 - .3 If defects are recorded, or if any duct section fails the test procedure established, which, in the opinion of the consultant, are serious, the consultant may request further duct testing to a maximum of 100% of all ductwork joints at his
-

discretion. The contractor shall bear all related costs of the extra testing procedures as an acknowledgement of maintenance of project quality requirements.

- .4 High and medium pressure duct. Test in sections of no more than complete floors. Test to a static pressure of 1½ times the actual working pressure, but no less than 2.0 kPa (8" WG) Maximum leakage shall be no more than ½% of the flow in the section tested, without audible leaks. Test and seal leaks before any ductwork is concealed or covered.
- .5 All low pressure ductwork, leak test at 1½ times the actual working pressure, but no less than 750 Pa (3" WG). Leakage shall be inaudible and not detectable by feel and not to exceed 5% of the flow in the section tested.
- .6 Test equipment shall be supplied for these tests and must be presented for approval of a consultant before use.
- .7 Pressure test kit shall consist of a high pressure blower discharging through a tapered nozzle into an 800mm x 75mm (32"x3") diameter test section. The test section shall be complete with diffuser plate and 22.2mm diameter orifice plate with static pressure connections on each side of the orifice. A U-tube manometer shall be used to measure pressure drop across the orifice in inches water gauge.
- .8 Test procedure shall be as follows:
 - .1 Close off open end of all take-offs (except one) with suitable plugs or cap;
 - .2 Attach pressure kit to open take-off;
 - .3 Rise duct static pressure and hold by adjusting blower inlet area;
 - .4 Measure leakage by manometer reading across orifice plate, reading shall not exceed 0.25 kPa (1" WG).

END OF SECTION

1. General

1.1 Scope

- .1 Access doors (duct and plenum access)
- .2 Fire dampers
- .3 Balancing dampers
- .4 Flexible connections
- .5 Backdraft dampers
- .6 Turning vanes
- .7 Sealants

1.2 Quality Assurance

- .1 Fire dampers shall be ULC listed and constructed in accordance with ULC Standard S112 "Fire Dampers".
- .2 Fusible links on fire dampers shall be constructed to ULC Standard S505.
- .3 Demonstrate re-setting of fire dampers to authorities having jurisdiction and Owner's representative.
- .4 Access doors shall be ULC labelled.
- .5 Accessories shall meet the requirements of NFPA 90A, Air Conditioning and Ventilating Systems. Fabricate in accordance with ASHRAE Handbooks and SMACNA Duct Manuals.
- .6 Flexible air duct shall comply with NFPA 90A and UL181 Standard for Factory-Made Air Ducts and Air Connectors.
- .7 At job completion, demonstrate that all fire dampers operate freely and without binding, and that ratings of fire dampers meet or exceed the rating of the fire wall.

1.3 Reference Standards

- .1 American National Standards Institute/National Fire Protection Association (ANSI/NFPA)
 - .1 ANSI/NFPA 90A Installation of Air Conditioning and Ventilating Systems.
 - .2 American Society for Testing and Materials (ASTM)
-

.1	ASTM A 653M	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process
.3	Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)	
.1	SMACNA - HVAC Duct Construction Standards - Metal and Flexible	
.4	Underwriters Laboratories of Canada (ULC)	
.1	CAN4-S112	Fire Test of Fire Damper Assemblies.
.2	CAN4-S112.2	Fire Test of Ceiling Firestop Flap Assemblies.
.3	ULC-S505	Fusible Links for Fire Protection Service.
1.4	<u>Related Work Specified in Other Sections</u>	
.1	Common Work Results for HVAC	Section 23 05 00
.2	Metal Ducts	Section 23 31 13
.3	Air Outlets and Inlets	Section 23 37 00
1.5	<u>Delivery & Storage</u>	
.1	Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.	
1.6	<u>Waste Management and Disposal</u>	
.1	Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.	
1.7	<u>Submittals</u>	
.1	Submit shop drawings for review.	
2.	Products	
2.1	<u>Acceptable Manufacturers</u>	
1.	Access Doors	: Controlled Air, Nailor, Air-O-Metal, Titus
2.	Backdraft Dampers	: EH Price, Greenheck, NCA, Ruskin, Nailor
3.	Balancing Dampers	: EH Price, Greenheck, NCA, Ruskin, Nailor
4.	Duct Hardware	: Ventlock, Duro-Dyne, Brytex

-
- | | | | |
|----|--------------|---|--|
| 5. | Fire Dampers | : | EH Price, Greenheck, NCA, Ruskin, Nailor |
| 6. | Sealants | : | Ductmate |

2.2 Duct Access Doors

- .1 Square/Rectangular Doors: Frame shall be die-formed of 0.85mm (22 gauge) galvanized steel complete with notched knock-over tabs for installation. Door shall be die-formed 0.85mm (22 gauge) galvanized steel and be of double skin construction with 25mm (1") of insulation fully enclosed within. A positive seal, polyethylene gasket shall be secured to each door for low leakage. Door shall meet SMACNA requirements for systems up to 500 Pa (2" wc) and be hinged on one side with camlock closure. Standard of acceptance: Nailor Series 08S.
- .2 Flat Oval Doors: Frame shall be of oval design, die-formed of minimum 0.70mm (24 gauge) galvanized steel with 5mm (3/16") pre-punched mounting holes. Door shall be die-formed of minimum 0.70mm (24 gauge) galvanized steel and be of double skin construction with 25mm (1") of insulation fully enclosed within. Door shall be complete with safety handle on sizes 200mm x 125mm (8"x5") thru 460mm x 250mm (18"x10"), two safety handles on larger sizes. Door shall be secured with plated steel wing nut fasteners, with bulb type seal integrally fastened to door for positive seal. Standard of acceptance: Nailor Series 0800-5.

2.3 Plenum Access Doors

- .1 600 mm x 1200 mm in air plenums to accommodate total body access to mechanical components.

2.4 Fire Dampers

- .1 Fire dampers shall be ULC listed and labelled. Fire damper assemblies to be fire tested in accordance with CAN4-S112.
 - .2 Fabricate of galvanized steel or prime coated black steel weighted for static application (i.e., non-ducted) and spring operated for dynamic application (i.e., ducted), to close and lock in closed position when released by fusible link.
 - .3 Fire dampers shall be curtain type static weighted for non-ducted systems and dynamic spring operated for ducted systems with damper blades retained out of air stream in a recess so free area of connecting ductwork is not reduced.
 - .4 Fusible links shall be set for 73.9°C (165°F).
 - .5 Fire dampers shall be curtain type with damper blades retained out of air stream in a recess (Type B) so free area of connecting ductwork is not reduced, unless noted otherwise on the drawings.
 - .6 Refer to architectural drawings for ratings of fire walls and provide fire dampers with compatible ratings.
-

2.5 Fire Stop Flaps

- .1 Fire stop flaps to be ULC listed and labelled and fire tested in accordance with CAN4-S112.2.
- .2 Fabricate of heat retardant fabric in galvanized or prime coated black steel frame, spring loaded action to close and lock in closed position when released by fusible link.
- .3 Blanket shall be retained in a recess so free area of connecting ductwork is not reduced.
- .4 Flaps shall be held open with fusible link conforming to ULC-S505. Fusible links shall be set for 73.9°C (165°F).

2.6 Splitter Dampers

- .1 Fabricate splitter dampers of double thickness sheet metal to streamline shape, properly stiffened to avoid vibration.
- .2 Fabricate galvanized steel, minimum 1.6mm (16 gauge), and provide with adjustable rod and locking screw.
- .3 On externally insulated ductwork, install operating mechanisms on a steel bridge type mounting base to permit continuity of insulation under the mechanism.

2.7 Balancing Dampers

- .1 Fabricate of galvanized steel, minimum 1.6mm (16 gauge). Full blade-length shafts of hollow square construction with blades rigidly fastened along entire blade length.
 - .2 Lockable quadrant type operating mechanism with end bearings on accessible rectangular ducts up to 400mm (16") deep and on accessible round ducts.
 - .3 Wide pitch screw operating mechanism with crank operator and end bearings on accessible rectangular ducts 425mm (17") and over in depth and on all inaccessible rectangular and round ducts.
 - .4 On rectangular ducts up to 275mm (11") deep construct of single blade (butterfly) type.
 - .5 On rectangular ducts 300mm to 400mm (12" x 16") deep construct of two opposed blades mechanically interlocked with pivots at quarter points.
 - .6 On rectangular ducts over 425mm (17") deep construct of multiple opposed blades, mechanically interlocked with blades no greater than 200mm (8") deep and pivots equally spaced.
 - .7 On round ducts construct of single blade (butterfly) type. On 500 Pa (2" WG) class and on all dampers over 300mm (12") diameter fabricate with full blade-length shaft.
 - .8 Construct damper blades for medium and high pressure systems to block air passage 70% maximum. Provide complete with locking type handles.
-

-
- .9 Provide over-ride limiting stops on all operating mechanisms.
 - .10 Identify the air flow direction and blade rotation and open and close positions on operating mechanism.
 - .11 On round ductwork, install operating mechanism on a steel mounted base firmly secured to the ductwork.
 - .12 On externally insulated ductwork, install operating mechanisms on a steel bridge type mounting base to permit continuity of insulation under the mechanism.

2.8 Flexible Connections

- .1 Fabricate of ULC approved neoprene coated flameproof glass fabric approximately 0.51mm (0.02") thick, 150mm (6") wide tightly crimped into metal edging strip and attached to ducting and equipment by screws or bolts at 150mm (6") intervals. Flexible connection airtight at 500Pa (2" WG).

2.9 Backdraft Dampers

- .1 Dampers shall be suitable for maximum 7.6m/s (1500 fpm) spot velocities and up to 996 Pa (4" wc) back pressure..
 - .1 Frame shall be constructed of extruded aluminum with a 2.29mm (0.09") minimum wall thickness with 2.75mm (12 gauge) galvanized steel structural braces at each corner.
 - .2 Blades shall be 0.64mm (0.025") minimum roll formed aluminum with extruded vinyl blade edge seals mechanically locked into blade edge. Blades shall include field adjustable, zinc plated steel counter balance weights to allow pressure relief at less than 2.5 Pa (0.01" wc).
 - .3 Bearings shall be corrosive resistant, long life synthetic type for quiet operation.
 - .4 Linkage shall be 12mm (½") wide tiebar concealed in frame.
 - .2 Dampers shall be suitable for maximum 17.8 m/s (3500 fpm) spot velocities and minimum 996 Pa (4" wc) back pressure..
 - .1 Frame shall be constructed of extruded aluminum with a 3.2mm (0.125") minimum wall thickness with 2.75mm (12 gauge) galvanized steel structural braces at each corner.
 - .2 Blades shall be 1.8mm (0.07"), minimum wall thickness, extruded aluminum with extruded vinyl blade edge seals mechanically locked into blade edge. Blades shall include field adjustable, zinc plated steel counter balance weights.
 - .3 Bearings shall be corrosive resistant, long life synthetic type for quiet operation.
 - .4 Linkage shall be 12mm (½") wide tiebar connected to stainless steel pivot pins.
-

2.10 Test Holes

- .1 DuroDyne IP series, complete with extenders for insulation thickness, flat gaskets for rectangular ductwork and molded rubber gaskets for round ductwork. Cut holes with hole saw and deburr edges. Install test holes with rivets or bolts with head on the interior of the ductwork.

2.11 Turning Vanes

- .1 Full radius arc; single blade vanes.
- .2 Acoustic vanes constructed in airfoil pattern with fibrous glass padding, 0.8 mm perforated lining.

2.12 Sealants

- .1 Comply with South Coast Air Quality Management District (SCAQMD) Rule #1168.
- .2 Sealants to contain zero VOC and comply with LEED cr4.1 – Requirements for Low Emitting Materials.

3. **Execution**

3.1 Duct Access Doors

- .1 Provide access door minimum 450mm x 350mm or 50mm (18"x14" or 2") smaller than duct dimension for cleaning and inspection at positions indicated by drawings and as follows:
 - .1 At 6.0m (20'-0") intervals on all horizontal ducts.
 - .2 At 12.0m (40'-0") intervals in all vertical duct systems.
 - .3 At the base of all duct risers.
 - .4 Both sides of turning vanes in all ducts.
 - .5 At each fire damper location.
 - .6 At each side of all heating or cooling coils.
 - .7 At all locations of internally duct mounted devices including automatic dampers, damper motors, duct mounted smoke detectors and heat detectors, and control sensors and devices.

3.2 Plenum Access Doors

- .1 Install plenum access doors where required to service mixing dampers, coils, filters, humidifiers and fans. Install 150mm (6") above floor. Arrange door swing so that fan static holds door in closed position.
-

3.3 Fire Dampers

- .1 Install to manufacturer's instructions and recommendations and to the satisfaction of the authorities having jurisdiction.
- .2 Provide fire dampers at locations shown, where ducts and outlets pass through fire rated components, and where required by authorities having jurisdiction. Install to NFPA 90A and SMACNA Standard "Fire Damper Guide for Air Handling Systems". Refer to drawings for locations.
- .3 Fire dampers shall be complete with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
- .4 Coordinate with the General Contractor for correct size openings and proper fire guard sleeving for fire damper penetration.
- .5 At each point where ducts pass through partitions, the opening around the duct shall be sealed with non-combustible material.
- .6 Ensure openings through gypsum wall-board partitions are protected in accordance with local regulations and ULC Information Bulletin No. 80-2. Maximum fire damper size through gypsum wall-board partitions shall be 1200mm wide x 1500mm high (48"x60").
- .7 All fire dampers and fire stop flaps are to be left in the closed position for balancing contractor to fix open.
- .8 Support ceiling fire stops from the structure above the fire stop and not from air outlets on associated ductwork.
- .9 Recess curtain type fire damper so that free area of connecting ductwork is not reduced.
- .10 Provide curtain type fire dampers in duct systems with pressure greater than 250 Pa (1" WC).
- .11 Provide multi-blade, offset butterfly or recessed curtain blade fire dampers on duct systems with pressure less than 250 Pa (1" WC).

3.4 Fire Stop Flaps and Thermal Blankets

- .1 Install fire stop flaps on all ceiling grilles and diffusers located in rated ceiling assemblies.
 - .2 Provide fire resistant thermal blanket in conjunction with fire stop flaps on ceiling diffusers in fire rated ceiling assemblies to complete the rating from ceiling to fire stop flap.
 - .3 Install to SMACNA Standard.
-

3.5 Balancing Dampers

- .1 Install balancing dampers on each branch of low velocity supply, return and exhaust ducts, including run outs to room air outlets and inlets.
- .2 Provide balancing dampers on medium and high pressure systems where indicated. Splitter dampers shall not be used on medium and high pressure system.
- .3 Single blade dampers permitted on rectangular ductwork up to 300mm maximum duct height.
- .4 Do not install closer than two (2) duct widths to elbows or intersections.

3.6 Flexible Connections

- .1 Install ducts associated with fans and equipment subject to forced vibration with flexible connections, immediately adjacent to equipment and/or where indicated on drawing. Provide for 150mm (6") spacing between ducts and equipment. Install with just sufficient slack to prevent vibration transmission.
- .2 Allow 100mm (4") movement of medium pressure fans and 50mm (2") movement of low pressure fans.
- .3 For connections to medium and high pressure fans, and in potentially wet locations, install 12mm (½") thick neoprene pad over fabric and hold in place with additional metal straps.
- .4 Provide fire retardant flexible connectors on kitchen exhaust systems.

3.7 Backdraft Dampers

- .1 Provide gravity backdraft dampers on all exhaust air outlets to outdoor and exhaust fans where motorized dampers are not indicated, and where shown on drawings.

3.8 Turning Vanes

- .1 Install turning vanes in duct elbows where centerline radius is less than 1¼ times the turning dimension of the duct.

3.9 Test Holes

- .1 Provide at suitable locations on each duct main at the suction and discharge of every fan to facilitate total and static pressure readings.

3.10 Motorized Dampers

- .1 Install dampers furnished by the control trade.
- .2 Ensure suitable clearance is provided for the installation and operation of the damper operator and linkage when setting motorized dampers in place.

END OF SECTION

.3	Variable Frequency Drives for HVAC Equipment	Section 23 05 14
.4	Vibration and Seismic Controls for HVAC	Section 23 05 48
.5	Testing, Adjusting and Balancing for HVAC Systems	Section 23 05 93
.6	Metal Ducts	Section 23 31 13
.7	Air Duct Accessories	Section 23 33 00
1.5	<u>Delivery & Storage</u>	
.1	Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.	
1.6	<u>Waste Management and Disposal</u>	
.1	Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.	
1.7	<u>Job Conditions</u>	
.1	Do not operate fans for any purpose, temporary or permanent until ductwork is clean, filters are in place and bearings are lubricated.	
.2	Refer to Section 23 05 00 – Common Work Results for HVAC.	
1.8	<u>Alternates</u>	
.1	Equivalent fan selections shall not increase motor kilowatts, increase rpm, increase noise level, increase tip speed by more than 10%, or increase inlet air velocity by more than 20%, from that of the specified fan.	
1.9	<u>Submittals</u>	
.1	Submit shop drawings that show, as a minimum, the following:	
.1	Fan size and class for application,	
.2	Fan performance including capacity, external static pressure and fan speed	
.3	Fan curves showing fan performance with fan and system operating point plotted on curves	
.4	Dimensions	
.5	Motor capacity and electrical characteristics	
.6	Acoustical data	

2. Products

2.1 Acceptable Manufacturers

1. Centrifugal Fans : Trane, Chicago, Twin City, PennBarry,
Northern Blower, ACME, Greenheck,
Loren Cook, Delhi

2.2 General

- .1 Statically and dynamically balance fans so no objectionable vibration or noise is transmitted to occupied areas of the building.
 - .2 Provide balanced variable sheaves for motors 11.2 kW (15 HP) and under and fixed sheave for 15 kW (20 HP) and over.
 - .3 Fans are to be capable of accommodating static pressure variations of $\pm 10\%$ with no objectionable operating characteristics.
 - .4 Select and design wheel and shaft so that fan does not pass through any critical speed to reach maximum operating speed.
 - .5 Unless otherwise indicated, equip fans with heavy duty grease lubricated ball or roller bearings of self-aligning type, with ample thrust provision to prevent end play during normal bearing life. Ensure lubricating points are readily and safely accessible after installation.
 - .6 Provide guard screens for fans having exposed inlet or outlets, bolted to permit removal.
 - .7 Supply replacement pulleys and sheaves for fans as required to properly balance the systems to design flows at actual job site static pressure conditions. Obtain requirements from balancing agency.
 - .8 Provide cross linkage for inlet vanes on double inlet fan.
 - .9 Size motors for parallel operating fans for non-overloading operation with only one fan operating.
 - .10 Provide belt guards with tachometer holes.
 - .11 External static pressure means external to the fan cabinet and all accessories such as backdraft dampers, mixing boxes, filters and coils, etc. These accessories if supplied as part of the unit are considered as internal losses for fan.
 - .12 Use ground and polished steel shafts with rust preventative coating.
 - .13 Finish all ferrous parts with primer and baked enamel top coat.
 - .14 Two speed motors shall have separate winding for each speed.
-

2.3 Belted Vent Sets

- .1 Comply generally with requirements of centrifugal fans suitable for pressure to 1750 Pa (7 in. WG).
- .2 Provide sets complete with SWSI centrifugal fan, V-belt or direct drive as indicated, with motor and protective enclosure for motor and drive. Protective hoods to have vents for motor cooling and be readily removable.
- .3 Provide with multi-blade rattle free backdraft damper with felt lined bladed edges as noted on drawings.
- .4 Provide belt guards with tachometer holes. Provide weatherproof housing.
- .5 Provide all cabinets lined with 25mm (1") acoustic insulation.

3. Execution

3.1 Installation

- .1 Where inlet or outlet is exposed, provide safety screen.
- .2 Provide belt guards on belt driven fans complete with tachometer access.
- .3 Supply and install sheaves as necessary for final air balancing.
- .4 Provide 100mm (4") high housekeeping base for floor mounted units.

3.2 Priming

- .1 Prime coat fan wheels and housing factory inside and outside. Prime coating on aluminum parts is not required.
- .2 Provide two additional coats of paint on fans handling air downstream of humidifiers.

3.3 Performance

- .1 Refer to Fan Schedule on drawings.
- .2 Fan performance based on 645m (2115 ft) altitude.

END OF SECTION

1. General

1.1 Scope

- .1 Supply air grilles and diffusers
- .2 Return air grilles
- .3 Exhaust air grilles

1.2 Quality Assurance

- .1 Air flow tests and sound level measurement shall be made in accordance with applicable ADC equipment test codes, ASHRAE Standards and AMCA Standards.
- .2 Unit rating shall be approved by the Air Diffuser Council (ADC) and AMCA.
- .3 Manufacturer shall certify catalogued performance and ensure correct application of air outlet types.

1.3 Reference Standards

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers, Inc. (ASHRAE)
- .2 American Society for Testing and Materials (ASTM)
 - .1 ASTM E90 Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
- .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
- .4 Society of Automotive Engineers (SAE)

1.4 Job Conditions

- .1 Review requirements of outlets as to size, finish and type of mounting prior to submitting shop drawings and schedules of outlets.
- .2 Positions indicated are approximate only. Check locations of outlets and make necessary adjustments in position to conform with Architectural features, symmetry and lighting arrangement.

1.5 Delivery & Storage

- .1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.
-

1.6 Waste Management and Disposal

- .1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.7 Submittals

- .1 Submit diffuser and grille shop drawings that show, as a minimum, the following:
 - .1 Complete catalogue information
 - .2 Materials of construction
 - .3 Dimensions
 - .4 Accessories
- .2 Submit color selection charts of finishes for approval prior to fabrication.
- .3 Comply with requirements of Section 23 05 00 – Common Work Results for HVAC.

2. **Products**

2.1 Acceptable Manufacturers

- 1. Supply Air Grilles & Diffuser : EH Price, Krueger, Nailor, Titus
- 2. Return Air Grilles : EH Price, Krueger, Nailor, Titus
- 3. Exhaust Air Grilles : EH Price, Krueger, Nailor, Titus

2.2 General

- .1 Sizes indicated are nominal. Provide correct standard product nearest to nominal for capacity, throw, noise level, throat and outlet velocity indicated.
 - .2 Co-ordinate actual dimensions of grilles, diffusers and registers with adjacent building elements to result in a neat installation.
 - .3 Base air outlet application on space noise level of NC 30 maximum.
 - .4 Provide supply outlets with sponge rubber seal around the edge.
 - .5 Provide baffles to direct air away from walls, columns or other obstructions within the radius of diffuser operation.
 - .6 Provide anti-smudge frames or plaques on diffusers located in rough textured surfaces such as acoustical plaster.
-

2.3 Grilles and Registers

- .1 Formed shapes of steel or aluminum, fixed single or double deflection, vertical or horizontal face as explicit by the products specified. Provide spring tension or other device to set adjustable blades in place.
- .2 Provide steel frames of cold rolled steel, with exposed joints welded and ground flush and completely closed.
- .3 Provide aluminum frames extruded with mechanical fasteners and completely closed corners.
- .4 Furnish where indicated integral gang operated opposed blade dampers with removable key operator, operable from face for all supply and exhaust grilles and diffusers. Use extractors on short throat connections to duct mains.

2.4 Diffusers

- .1 Provide steel circular, square, rectangular or perforated type, adjustable or fixed pattern as explicit by product schedule, complete with volume controller or radial opposed blade, butterfly combination splitter or lay-in types as appropriate for installation adjustable from diffuser face.
- .2 Provide sectionalizing baffles where indicated.

3. **Execution**

3.1 Installation

- .1 Install in accordance with manufacturer's instructions and SMACNA recommendations.
- .2 Paint ductwork visible behind air outlets matte black.
- .3 Where grilles or registers are on the face of fire separations, provide fire dampers, collars, sleeves, perimeter angles as required to preserve the integrity of the separation.
- .4 Provide enclosures constructed of gypsum wall-board of the same type and thickness as the ceiling to cover the sides and tops of diffusers, mounted in ceilings which form part of a fire rated assembly. Protect the inlet/outlet of the grille or diffuser at the enclosure penetration with a fire stop flap.
- .5 Install goosenecks in accordance with manufacturer's recommendations and in accordance with recommendations to SMACNA.

3.2 Performance

- .1 Refer to Grille & Diffuser Schedule on drawings.

END OF SECTION

1. General

1.1 Scope

- .1 Laminar Airflow Airwall System.

1.2 Related Work Specified in Other Sections

- .1 Division 1 – General Requirements.
- .2 Division 9 – Finishes.
- .3 Division 23 – Heating, Ventilating, and Air Conditioning (HVAC)

1.3 References

- .1 Hew publications no. (NIOSH) 76-130, *Lead Exposure Design Consideration For Indoor Firing Ranges*, December 1975; with the following exception:
 - .1 The airborne inorganic lead concentration limits shall not exceed 50 ug/m3 of air over a time weighted average (TWA) of eight hours as measured at the respiration zone of the shooters and the range officer while shooting from the firing line.
- .2 Crouch, K., Peng, T., Murdock, D., Ventilation Control of Lead in Indoor Firing Ranges: Inlet Configuration and Booth and Fluctuating Flow Contributions, American Industrial Hygiene Association, J. (52), February 1991.
- .3 Navy Environmental Health Center, *Indoor Firing Ranges Industrial Hygiene Technical Guide*, Technical Manual NEHC-TM6290.99-10, Norfolk, VA, December 1999.
- .4 OSHA 29 CFR 1910.1025.
- .5 OSHA 29 CFR 1926.62.
- .6 EPA 40 CFR 50.12.
- .7 Royal Canadian Mounted Police (RCMP) – Indoor Firing Range Design Guidelines
- .8 Royal Canadian Mounted Police (RCMP) – Indoor Firing Range Operations and Maintenance Guidelines
- .9 Royal Canadian Mounted Police (RCMP) – Firing Range Certification Guide

1.4 System Descriptions

- .1 General: Comply with the following standards:
 - .1 NIOSH 76-130 with the following exception:
-

-
- .1 The airborne inorganic lead concentration limits shall not exceed 50 ug/m³ of air over a time weighted average (TWA) of eight hours as measured at the respiration zone of the shooters and the range officer while shooting from the firing line.
 - .2 OSHA 29 CFR 1910.1025.
 - .3 OSHA 29 CFR 1926.62.
 - .4 EPA 40 CFR 50.12.
 - .2 Design Requirements: Provide Laminar Airflow Airwall System which complies with the following design requirements:
 - .1 The Laminar Airflow Airwall System shall be sized to provide an airflow velocity of 75 feet per minute (fpm) on average over the entire cross-sectional area (width x height) at the firing line of an empty range. The airflow shall be laminar or even with minimal velocity variations when measured from floor-to-ceiling and wall-to-wall. The airflow velocity shall meet the following criteria:
 - .1 Average velocity over all shooting positions: 70 to 80 fpm.
 - .2 Average velocity over each shooting position: 50 to 100 fpm.
 - .3 All velocity measurements shall be positive (airflow shall travel downrange).
 - .3 The Laminar Airflow Airwall System specification and/or accompanying drawings shall govern the furnishing of all labor, equipment, material, appliances, tools and operations necessary for the complete and operational installation of the Laminar Airflow Airwall System.

1.5 Submittals

- .1 General: Submit listed submittals in accordance with Conditions of the Contract and Division 1 Submittal Procedures Section.
 - .2 Product Data: Submit manufacturer's product data and installation instructions.
 - .3 Shop Drawings: Provide drawings indicating the following:
 - .1 Plans, elevations, sections, details and attachments to other work.
 - .2 Size of Laminar Airflow Airwall System.
 - .4 Quality Assurance/Control Submittals: Submit the following:
 - .1 Certificates: Submit manufacturer's certificate that products meet or exceed specified requirements.
 - .5 Closeout Submittals: Submit the following:
-

-
- .1 Warranty documents specified herein.

1.6 Quality Assurance

.1 Manufacturer Qualifications:

- .1 The manufacturer must have designed and successfully measured lead levels, via an independent certified industrial hygienist and a NIOSH accredited independent laboratory, not in excess of 50 ug/m³ over a time weighted average (TWA) of eight hours as measured at the respiration zone of the shooters and the range officer while shooting from the firing line per OSHA 29 CFR 1910.1025 and 29 CFR 1926.62 in a minimum of twenty-five (25) military, law enforcement (federal, state, county and local), or commercial indoor shooting ranges.
- .2 The manufacturer must provide a written guarantee, to be included with the contractor's proposal/bid, that the installed system will meet the requirements of OSHA 29 CFR 1910.1025 and 29 CFR 1926.62 when tested by an independent certified industrial hygienist under the following conditions:
- .1 Only one shooter per booth.
- .2 Air samples are taken at the static firing line within 15 feet of the Airwall.
- .3 There are no physical obstructions or non-shooting personal in the firing range during air testing between the back wall and the firing line.
- .4 The firing rate will not exceed normal qualification shooting.
- .5 The range has a negative pressure of 0.04 inches of water column minimum.
- .6 The installed system is installed, maintained, and operated in accordance with the manufacturer's instructions.
- .3 The manufacturer must provide a written guarantee, to be included with the contractor's proposal/bid, that in the event the installed system does not provide the minimum lead concentration levels required by this performance specification, as determined by a certified industrial hygienist's report, they shall at their own expense:
- .1 Bring the installed system into compliance, or
- .2 Replace equipment with that which will meet the performance specification.
- .4 Unless exceptions to this performance specification are specifically listed and submitted in writing by the prospective bidder, and received by the mechanical engineer not less than ten (10) days prior to the bid due date, it is understood that
-

the bidder, if successful, will furnish equipment in strict accordance with this performance specification.

- .2 Installer Qualifications: Utilize an installer having demonstrated experience on projects of similar size and complexity.

1.7 Delivery, Storage & Handling

- .1 General: Comply with Division 1 – General Requirements.
- .2 Delivery: Deliver units in manufacturer's original, unopened, undamaged packaging with identification labels intact.
- .3 Storage and Protection: Store units protected from exposure to harmful environmental conditions and at temperature and humidity conditions recommended by the manufacturer.

1.8 Warranty

- .1 Project Warranty: Refer to Conditions of the Contract for project warranty provisions.
- .2 Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under contract documents.
 - .1 Warranty Period: One year beginning with date of substantial completion.

2. PRODUCTS

2.1 Product Substitutions

- .1 Substitutions: Must be submitted in writing by the prospective bidder and received by the mechanical engineer not less than ten (10) days prior to the bid due date.

2.2 Manufactured Units

- .1 Proprietary Products/Systems: Laminar Airflow Airwall System, including the following:
 - .1 Airwall - All Opaque:
 - .1 All opaque perforated panels shall be 0.063 in. (1.600mm) 3003-H14 aluminum. All opaque 3003-H14 aluminum perforated panels (prior to being perforated) shall weigh 0.898 lb/ft² (4.389 kg/m²). All opaque 3003-H14 aluminum perforated panels shall be incombustible, moisture resistant and dimensionally stable. All perforations shall be round.
 - .2 All opaque solid trim shall be 0.063 in. (1.600mm) 3003-H14 aluminum. All opaque solid trim shall be 2 in. (50.8mm) wide.
-

-
- .3 All structural support framing shall be 2 in. (50.8mm) x 2 in. (50.8mm) x 1/8 in. (3.175mm) tubular steel. All tubular steel shall be factory degreased, cleaned and prime painted. All structural support framing or tubular steel shall be field erected and fastened together with 5 in. (127mm) long x 5 in. (127mm) long x 1 in. (25.4mm) wide x 0.165 in. (4.191mm) thick angle braces or 8 in. (203.2mm) long x 1 1/4 in. (31.75mm) wide x 0.134 in. (3.404mm) thick straight braces. Each angle brace requires six (6) self-drilling screws [no. 10, 18-8 stainless steel, 3/4 in. (19.05mm) long, 10-16 threads, drill point #3 and hex washer head] and each straight braces requires four (4) self-drilling screws [no. 10, 18-8 stainless steel, 3/4 in. (19.05mm) long, 10-16 threads, drill point #3 and hex washer head]. The outer perimeter of the structural support framing shall be fastened to the concrete wall with 3/8 in. (9.525mm) diameter x 4 in. (101.6mm) long masonry / concrete bolts on 36 in. (914.4mm) centers. 3/16 in. (4.763mm) thick foam tape shall be placed between the structural support frame and the concrete wall to ensure an airtight seal.
- .4 All opaque perforated panels shall be field fastened to the structural support frame with self-drilling screws [no. 10, 18-8 stainless steel, 3/4 in. (19.05mm) long, 10-16 threads, drill point #3 and hex washer head] on 12 in. (304.8mm) centers.
- .5 All opaque solid trim shall be field fastened to the opaque perforated panels / structural support framing with self-drilling screws [no. 10, 18-8 stainless steel, 3/4 in. (19.05mm) long, 10-16 threads, drill point #3 and hex washer head] on 12 in. (304.8mm) centers.
- .6 All opaque perforated panels shall maintain the design airflow quantities under a long-term load deflection of up to 1 in. (25.4mm).
- .2 Airwall - All Clear:
- .1 All clear perforated panels shall be 1/4" thick (6.35mm). All clear perforated panels shall be fabricated from General Electric Lexan. All perforations shall be round.
- .2 All opaque solid trim shall be 0.063 in. (1.600mm) 3003-H14 aluminum. All opaque solid trim shall be 2 in. (50.8mm) wide.
- .3 All structural support framing shall be 2 in. (50.8mm) x 2 in. (50.8mm) x 1/8 in. (3.175mm) tubular steel. All tubular steel shall be factory degreased, cleaned and prime painted. All structural support framing or tubular steel shall be field erected and fastened together with 5 in. (127mm) long x 5 in. (127mm) long x 1 in. (25.4mm) wide x 0.165 in. (4.191mm) thick angle braces or 8 in. (203.2mm) long x 1 1/4 in. (31.75mm) wide x 0.134 in. (3.404mm) thick straight braces. Each angle brace requires six (6) self-drilling screws [no. 10, 18-8 stainless steel, 3/4 in. (19.05mm) long, 10-16 threads, drill point #3 and hex washer head] and each straight braces requires four (4) self-drilling screws [no. 10, 18-8 stainless steel, 3/4 in. (19.05mm) long, 10-16 threads, drill point #3 and
-

hex washer head]. The outer perimeter of the structural support framing shall be fastened to the concrete wall with 3/8 in. (9.525mm) diameter x 4 in. (101.6mm) long masonry / concrete bolts on 36 in. (914.4mm) centers. 3/16 in. (4.763mm) thick foam tape shall be placed between the structural support frame and the concrete wall to ensure an airtight seal.

- .4 All clear perforated panels shall be field fastened to the structural support frame with self-drilling screws [no. 10, 18-8 stainless steel, 3/4 in. (19.05mm) long, 10-16 threads, drill point #3 and hex washer head] on 12 in. (304.8mm) centers.
- .5 All opaque solid trim shall be field fastened to the clear perforated panels / structural support framing with self-drilling screws [no. 10, 18-8 stainless steel, 3/4 in. (19.05mm) long, 10-16 threads, drill point #3 and hex washer head] on 12 in. (304.8mm) centers.
- .6 All clear perforated panels shall maintain the design airflow quantities under a long-term load deflection of up to 1 in. (25.4mm).

.3 Airwall - Opaque with Clear Viewing Window

- .1 All opaque perforated panels shall be 0.063 in. (1.600mm) 3003-H14 aluminum. All opaque 3003-H14 aluminum perforated panels (prior to being perforated) shall weigh 0.898 lb/ft² (4.389 kg/m²). All opaque 3003-H14 aluminum perforated panels shall be incombustible, moisture resistant and dimensionally stable. All perforations shall be round.
- .2 All clear perforated panels shall be 1/4" thick (6.35mm). All clear perforated panels shall be fabricated from General Electric Lexan. All perforations shall be round.
- .3 All opaque solid trim shall be 0.063 in. (1.600mm) 3003-H14 aluminum. All opaque solid trim shall be 2 in. (50.8mm) wide.
- .4 All structural support framing shall be 2 in. (50.8mm) x 2 in. (50.8mm) x 1/8 in. (3.175mm) tubular steel. All tubular steel shall be factory degreased, cleaned and prime painted. All structural support framing or tubular steel shall be field erected and fastened together with 5 in. (127mm) long x 5 in. (127mm) long x 1 in. (25.4mm) wide x 0.165 in. (4.191mm) thick angle braces or 8 in. (203.2mm) long x 1 1/4 in. (31.75mm) wide x 0.134 in. (3.404mm) thick straight braces. Each angle brace requires six (6) self-drilling screws [no. 10, 18-8 stainless steel, 3/4 in. (19.05mm) long, 10-16 threads, drill point #3 and hex washer head] and each straight braces requires four (4) self-drilling screws [no. 10, 18-8 stainless steel, 3/4 in. (19.05mm) long, 10-16 threads, drill point #3 and hex washer head]. The outer perimeter of the structural support framing shall be fastened to the concrete wall with 3/8 in. (9.525mm) diameter x 4 in. (101.6mm) long masonry / concrete bolts on 36 in. (914.4mm) centers. 3/16 in. (4.763mm) thick foam tape shall be placed between the structural support frame and the concrete wall to ensure an airtight seal.

-
- .5 All opaque and clear perforated panels shall be field fastened to the structural support frame with self-drilling screws [no. 10, 18-8 stainless steel, 3/4 in. (19.05mm) long, 10-16 threads, drill point #3 and hex washer head] on 12 in. (304.8mm) centers.
 - .6 All opaque solid trim shall be field fastened to the opaque and clear perforated panels / structural support framing with self-drilling screws [no. 10, 18-8 stainless steel, 3/4 in. (19.05mm) long, 10-16 threads, drill point #3 and hex washer head] on 12 in. (304.8mm) centers.
 - .7 All opaque and clear perforated panels shall maintain the design airflow quantities under a long-term load deflection of up to 1 in. (25.4mm).
- .4 Airdoor - Opaque:
- .1 Door shall be 16 gauge (1.5875mm) steel. Door shall be factory degreased, cleaned and prime painted. Door shall be incombustible, moisture resistant and dimensionally stable.
 - .2 Door shall have honeycomb core construction.
 - .3 Door shall have counter-sunk mounting screwholes.
 - .4 Door shall be 36 in. (914.4mm) wide x 84 in. (2133.6mm) high and compatible with range entrance door. Verify exact airdoor size.
 - .5 Door shall have a maximum border of 4 in (101.6mm) on the top, 4 in. (101.6mm) on the hinge side, 6 in. (152.4mm) on the doorknob side and 6 in. (152.4mm) on the bottom.
 - .6 Door shall have an "open area" of 26 in. (660.4mm) wide x 74 in. (1879.6mm) high. Verify exact "open area" size that is compatible with airdoor size given above requirements.
 - .7 The "open area" of the door shall be filled with the following panel:
 - .1 Opaque perforated panel shall be 0.063 in. (1.600mm) 3003-H14 aluminum. Opaque 3003-H14 aluminum perforated panel (prior to being perforated) shall weigh 0.898 lb/ft² (4.389 kg/m²). Opaque 3003-H14 aluminum perforated panel shall be incombustible, moisture resistant and dimensionally stable. All perforations shall be round.
 - .8 Door / Frame shall have doorknob.
 - .9 Door / Frame shall have self-closing hinge (air pressure may prevent door from self closing however).
 - .10 Door / Frame shall have threshold and sweep to minimize air leakage.
-

-
- .11 Frame shall have a “closed” profile.
 - .12 Frame shall be 16 gauge (1.5875mm) steel. Steel frame material shall be incombustible, moisture resistant and dimensionally stable.
 - .13 Frame shall have a welded construction.
- .5 Airdoor - Clear:
- .1 Door shall be 16 gauge (1.5875mm) steel. Door shall be factory degreased, cleaned and prime painted. Door shall be incombustible, moisture resistant and dimensionally stable.
 - .2 Door shall have honeycomb core construction.
 - .3 Door shall have counter-sunk mounting screwholes.
 - .4 Door shall be 36 in. (914.4mm) wide x 84 in. (2133.6mm) high and compatible with range entrance door. Verify exact airdoor size.
 - .5 Door shall have a maximum border of 4 in (101.6mm) on the top, 4 in. (101.6mm) on the hinge side, 6 in. (152.4mm) on the doorknob side and 6 in. (152.4mm) on the bottom.
 - .6 Door shall have an “open area” of 26 in. (660.4mm) wide x 74 in. (1879.6mm) high. Verify exact “open area” size that is compatible with airdoor size given above requirements.
 - .7 The “open area” of the door shall be filled with either of the following panel:
 - .1 Clear perforated panel shall be ¼” thick (6.35mm). Clear perforated panel shall be fabricated from General Electric Lexan. All perforations shall be round.
 - .8 Door / Frame shall have doorknob.
 - .9 Door / Frame shall have self-closing hinge (air pressure may prevent door from self closing however).
 - .10 Door / Frame shall have threshold and sweep to minimize air leakage.
 - .11 Frame shall have a “closed” profile.
 - .12 Frame shall be 16 gauge (1.5875mm) steel. Steel frame material shall be incombustible, moisture resistant and dimensionally stable.
 - .13 Frame shall have a welded construction.
-

2.3 Finishes

- .1 Factory Priming: All structural support framing / tubular steel shall be factory degreased, cleaned and prime painted.

3. **EXECUTION**

3.1 Examination

- .1 Site Verification of Conditions:
 - .1 Verify that site conditions are acceptable for installation of the Laminar Airflow Airwall System.
 - .2 Do not proceed with installation of the Laminar Airflow Airwall System until unacceptable conditions are corrected.

3.2 Installation

- .1 Comply with the instructions and recommendations of the Laminar Airflow Airwall System manufacturer.
 - .2 Interface with Other Work:
 - .1 Install Laminar Airflow Airwall System with adequate clearance for equipment maintenance and service.
 - .3 CMU wall within or behind the Laminar Airflow Airwall System shall be sealed or finished per Section 09900 - Paints and Coatings PRIOR TO THE INSTALLATION OF THE LAMINAR AIRFLOW AIRWALL SYSTEM. Architect shall specify finish color.
 - .4 Laminar Airflow Airwall System shall extend across the entire width of the range (sidewall to sidewall).
 - .5 Laminar Airflow Airwall System shall be fastened to wall behind the firing line.
 - .6 Final finish shall be field applied (sprayed) per Section 09900 - Paints and Coatings. All metal surfaces shall be degreased and cleaned prior to coating. Architect shall specify finish color.
 - .7 The Laminar Airflow Airwall System, acoustical ceiling (acoustical ceiling per Section 09500 – Ceilings) and ballistic safety ceiling shall have a minimum height of 96 in. (2438.4mm) above the finished floor (A.F.F.).
 - .8 The Laminar Airflow Airwall System shall have a recommended depth of 24 in. (609.6mm).
 - .9 Laminar Airflow Airwall System shall be air balanced to achieve the specifications / tolerances by increasing the perforations in size or blocking off perforations as needed with 2 in. (50.8mm) foil duct tape and 2 in. (50.8mm) clear heavy duty tape on the inside or high pressure side of the Laminar Airflow Airwall System. Air balance shall be
-

performed by a firm who has expertise in Laminar Airflow Airwall System balancing and who has balanced a minimum of twenty-five (25) Laminar Airflow Airwall Systems. Two (2) copies of the air balance report shall be submitted to the owner and include the following:

- .1 Three (3) velocity measurements in feet per minute (fpm) shall be taken at 1'0", 2'6", 4'0", 5'6" AND 7'0" feet above the finished floor for each shooting position (15 total measurements). If velocity fluctuations are observed with a real-time analog or digital instrument, take the average reading of the instrument over a five second period for each measurement. The range shall be empty. If the shooting positions are not clearly defined then assume each shooting position is four feet wide at the firing line. The measurements shall meet the following criteria:

- .1 Average velocity over all shooting positions: 70 to 80 fpm.
- .2 Average velocity over each shooting position: 50 to 100 fpm.
- .3 All velocity measurements shall be positive (airflow shall travel downrange).

- .10 Once the Laminar Flow Air Wall System has been installed and coated, all surfaces shall be cleaned with 100% cotton rags (to minimize surface scratching). USE SPECIAL CARE WHEN CLEANING ANY CLEAR PERFORATED PANELS.

3.3 Demonstration

- .1 Demonstrate to the owner's personnel the proper operation and maintenance of the Laminar Airflow Airwall System.

3.4 Protection

- .1 Protect installed work from damage due to subsequent construction activity on the site.

END OF SECTION

1. General

1.1 Summary

- .1 Materials, components and installation for packaged heat reclaim devices.

1.2 References

- .1 Air Conditioning, Heating, & Refrigeration Institute (AHRI)
AHRI Standard 1060 Performance Rating of Air to Air Exchangers for Energy Recovery Ventilation Equipment
- .2 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ASHRAE 84 [1991] Method of Testing Air to Air Heat Exchangers (ANSI approved).
- .3 Canadian Standards Association (CSA)
 - .1 CAN/CSA-C22.2 General Requirements – Canadian Electrical Code, Part II

1.3 Related Work

- .1 Common Work Results for HVAC Section 23 05 00

1.4 Quality Assurance

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

1.5 Submittals

- .1 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.
 - .2 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Shop drawings shall indicate, as a minimum, the following:
 - .1 Supply and exhaust air flows
 - .2 Supply and exhaust air static pressures
-

-
- .3 Electrical information including voltage, phase and amperage
 - .4 Electrical wiring diagrams
 - .5 Controls wiring diagrams
 - .6 Accessories
 - .7 Dimensions, including weights
- .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.
 - .2 Instructions: submit manufacturer's installation instructions.
- .4 Closeout Submittals:
- .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 – Closeout Submittals.
- .5 Certificates:
- .1 Catalogued or published ratings: obtained from tests carried out by manufacturer or those ordered from independent testing agency signifying adherence to codes and standards in force.
 - .2 Provide confirmation of testing.
- 1.6** Delivery & Storage
- .1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.
- 1.7** Waste Management and Disposal
- .1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.
- 2. Products**
- 2.1** General
- .1 Factory packaged, self-contained and pre-wired unit, CSA certified (bearing CSA sticker).
-

2.2 Unit Construction

- .1 Unit construction to be suitable for indoor applications.
- .2 Unit casing shall be minimum 16 aluminum with white powder coat finish.
- .3 All interior cabinet surfaces shall be lined with 25mm (1") thick, 3 lbs/ft³ density foil faced insulation with seems foil taped.
- .4 Access doors and center partitions to be lined with 6mm (¼") thick foil faced polyethylene bubble insulation with seam foil taped.

2.3 Air to Air Fixed Plate Heat Exchanger

- .1 Casing: 0.8 mm thick galvanized.
- .2 Heat transfer surfaces: Polypropylene core, edge sealed and bonded to casing.
- .3 Condensate drain connection(s).
- .4 Removable access panels.

2.4 Fans

- .1 Supply and exhaust fans shall be forward curved double inlet with ball bearings. Fan drive shaft shall be polished with keyways for drive pulley mounting. Unit fans with machined flats on fan shafts for drive pulley mounting will not be accepted. Fans shall have ball bearings suitable for operation in ambient temperatures of -54° to 157°C (-65°F to 250°F).
- .2 Fan ratings are based on tests made in accordance with AMCA Standard 210.
- .3 Fans must be selected to operate on a stable, efficient part of the fan curve when delivering air quantities scheduled against static of the system.
- .4 Fan blades shall be statically and dynamically balanced and tested prior to shipment.
- .5 Fan shall be provided with internal vibration isolation mounts.
- .6 Motors shall be continuous duty, ball bearing construction, Class F insulation, permanently lubricated and matched to the fan loads. Motor selection shall include a 15% service factor.
- .7 The unit electrical box shall include a factory installed, non-fused disconnect switch and a 24 VAC, Class II transformer/relay package.

2.5 Filters

- .1 The supply entering and exhaust entering sides of the recovery wheel shall be complete with 25mm (1") deep MERV 8 medium efficiency pleated filters throwaway type.
-

2.6 Exhaust Only Frost Control

- .1 The exhaust air after the core shall be monitored by the unit, when below freezing, a defrost cycle will be activated.
- .2 The supply fan shall shut down while the exhaust fan continues to move warm air through the core.
- .3 The unit shall revert to exchange mode when the exhaust air rises above 7°C (45°F).

2.7 Electrical

- .1 The unit shall be provided with a single point electrical connection..
- .2 Unit controls shall include:

Supply and exhaust fan motor fuses, contactors and manual reset thermal overloads

- .1 Control transformers with primary and secondary fusing
- .2 Color coded terminal strip for low voltage wiring and field connections
- .3 Unit shall have single point power input terminals.

2.8 Controls

- .1 All service connectors shall be quick disconnect type.
- .2 Unit circuitry shall allow the following operational characteristics:
 - .1 Dry contacts for start/stop
 - .2 General alarm
 - .3 Freeze stat
 - .4 BACNet integration with building DDC system
 - .5 Dirty filter pressure differential switches.
 - .6 Duct mounted smoke sensor with controller for field installed control of fan operation.

3. Execution

3.1 Manufacturer's Instructions

- .1 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 manufacturer's recommendations.
- .2 Provide rubber or spring type isolators appropriately sized for corner weights of the specific unit.
- .3 Provide flexible duct connections at unit duct flanges
- .4 Test and Balancing may not begin until 100% of the installation is complete and fully functional.
- .5 Follow National Comfort Institute (NCI) air test and balance procedures specific to Heat Recovery Ventilator Balancing Procedure including standard reports to the owner's representative.
- .6 Start-up Energy Recovery Ventilators in accordance with manufacturer's start-up instructions. Provide start-up report to the Consultant, and include in O & M manual.

EN OF SECTION

1. General

1.1 Scope

- .1 Electric coils
- .2 Coil installation

1.2 Reference

- .1 Canadian Standards Association (CSA)
 - 1. CAN/CSA-C22.2 General Requirements – Canadian Electrical Code, Part II
- .2 Underwriters Laboratories (UL)
 - 1. UL 1996 Standard for Electric Duct Heaters

1.3 Quality Assurance

- .1 Coils shall be the product of manufacturer regularly engaged in production of coils who issues complete catalogue data on such products.

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. Include product characteristics, performance criteria, and limitations.
 - .2 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Shop drawings shall indicate, as a minimum, the following:
 - .1 Materials of construction
 - .2 Heating capacity (kW)
 - .3 Coil dimensions (mm)
 - .4 Air pressure drop across coil (Pa)
 - .5 Electrical voltage and phase
 - .6 Electrical wiring diagram
-

.7 Accessories

.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.

.2 Instructions: submit manufacturer's installation instructions.

.4 Closeout Submittals:

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

.5 Certificates:

.1 Catalogued or published ratings: obtained from tests carried out by manufacturer or those ordered from independent testing agency signifying adherence to codes and standards in force.

.2 Provide confirmation of testing.

1.5 Delivery & Storage

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.6 Waste Management and Disposal

.1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

2. Products

1.1 Acceptable Manufacturers

.1 Electric Heating Coils: Chromalox, EH Price, Greenheck, Nailor

1.2 Electric Heating Coils

.1 Electric heaters shall be manufactured using galvanized steel of appropriate gauge and will provide proper rigidity and resistance to corrosion.

.2 Heaters shall be manufactured and approved for zero clearance for all combustible materials.

.3 Heating elements shall be manufactured with a grade C nickel chrome alloy (NiCr60)

.4 Modulating heaters shall be supplied with an electronic sensor on each side of the heater to measure the temperature and airflow. A controller will adjust the output temperature in

accordance with the measured parameters. The heater shall shutoff when there is no airflow.

.5 Electrical

.1 Electric heaters shall be supplied with a control panel with electric components adapted to the required voltage of the system.

.2 The control panel shall be manufactured for indoor conditions and will provide safety features against accidental contact with internal components (NEMA 1).

.3 The control panel will include a removable, hinged door for access.

.4 Connection terminals shall be clearly identified, and a corresponding wiring diagram will be affixed to the control panel.

.5 The following standard components will be installed:

.1 Transformer with secondary fuse

.2 Magnetic contactor

.3 Automatic thermal cutout

.4 Manual thermal cutout (when required by code)

.5 Airflow switch

.6 Solid state relay

.6 Accessories

.1 Proportional duct mounted temperature sensor.

.6 The heater shall be capable of being mounted in either a horizontal or vertical position.

3. Execution

1.1 Installation

.1 Install as per manufacturer' recommendations.

.2 Electrical connections by Electrical Contractor.

1.2 Performance

.1 Refer to Electric Heating Coil Schedule on drawings.

END OF SECTION

DIVISION 26 ELECTRICAL

Section 26 05 00 11	Electrical General Requirements.....	14
Section 26 05 19 00	Wires and Cables 0 - 1000 V	5
Section 26 05 19 10	Wire and Box Connectors 0 B 1000 V	2
Section 26 05 19 11	Wiring Devices	2
Section 26 05 29 00	Fastenings and Supports.....	4
Section 26 05 31 00	Splitters, Junction Boxes, Pull Boxes and Cabinets	3
Section 26 05 32 00	Outlet Boxes, Conduit Boxes and Fittings	5
Section 26 05 34 00	Conduits, Conduit Fastenings and Conduit Fittings	6
Section 26 05 43 00	Direct Buried Underground Cable Ducts	3
Section 26 05 43 10	Installation of Cables in Trenches and in Ducts	2
Section 26 08 00 10	Starting of Electrical Equipment and System.....	2
Section 26 08 00 11	Testing, Adjusting and Balancing of Electrical Equipment and Systems	4
Section 26 24 02 10	Disconnect Switches Fused and Non-Fused up to 600 V - Primary.....	2
Section 26 24 16 00	Panelboards - Breaker Type	3
Section 26 24 16 01	Panelboards	4
Section 26 24 16 10	Moulded Case Circuit Breakers	2
Section 26 24 19 22	Motor Starters to 600 V	5
Section 26 24 19 23	Connections to Mechanical Equipment	2
Section 26 50 00 00	Lighting Equipment	8
Section 26 53 00 00	Exit Lights.....	1

DIVISION 27 COMMUNICATIONS

Section 27 10 05 00	Structured Cabling	11
Section 27 10 05 10	Telecommunications Raceway System	1

DIVISION 28 ELECTRONIC SAFETY AND SECURITY

Section 28 31 02 00	Addressable Fire Alarm System.....	10
---------------------	------------------------------------	----

1. GENERAL

1.1 Work Included

- .1 Complete and operational electrical system as required by the drawings and as herein specified.

1.2 Related Work

- .1 General Requirements Division 01
- .2 Equipment Division 11
- .3 Mechanical Division 21, 22 and 23

1.3 Designation of Parties and Definition

- .1 The following defines various items used within the Electrical Specification Division 26:
 - .1 ‘Engineer or Electrical Engineer’: This refers to Owner or Owner appointed representative.
 - .2 ‘Electrical Trade or Contractor’: The Contractor undertaking to do the electrical work described in the Electrical Specification and on the electrical drawings.
 - .3 ‘General Contractor or General Construction Trade’: The Contractor that has the agreement with the Owner for the construction of the project.
 - .4 ‘Mechanical Trade or Mechanical Contractor’: Sub-contractors undertaking to do the work described in the mechanical specifications and/or on the mechanical drawings.
 - .5 ‘Provide’: Means supply and install or supply labour and materials required for the installation of.
 - .6 ‘Approved Equal’: Items listed under Approved Manufacturer’s in specification or addendum that shall be included in base bid.
 - .7 ‘Concealed’: Where used in connection with the installation of electrical raceways and wiring, means that they are hidden from sight as in furred out spaces, ceiling spaces, etc.
 - .8 ‘Exposed’: Where used in connection with the installation of electrical raceways and wiring and electrical equipment, means that they are visible to persons within the building.

1.4 Drawings and Specifications

- .1 All work is to comply with the 2010 National Building Code and the 2014 Alberta Building Code. The most stringent requirements/interpretations to be followed.
- .2 The General Conditions, Supplementary Conditions and Division 01 are a part of this specification and shall apply to this Division.
- .3 The intent of the drawings and specifications is to include all labour, products and services necessary for complete work, tested and ready for operation. Drawings and specifications are complementary each to the other and what is called for by one shall be binding as if called for by both.
- .4 Symbols used to represent various electrical devices often occupy more space on the drawing than the actual device does when installed. In such instances, do not scale locations of devices from electrical symbols. Install these devices with primary regard for usage of wall space, convenience of operation and grouping of devices.
- .5 These specifications and the drawings and specifications of all other divisions shall be considered as an integral part of the accompanying drawings. Any item or subject omitted from either the specifications or the drawings but which is mentioned or reasonably specified in and by the others, shall be considered as properly and sufficiently specified and shall be provided.
- .6 Provide all minor items and work not shown or specified but which are reasonably necessary to complete the Work. Electrical drawings indicate general location and route to be followed by conduit and/or wire and do not show all structural and mechanical details. In some cases, conduit or wiring is not as shown on the plans or shown diagrammatically on schematic or riser diagrams. Conduit and wire to be installed to provide a complete operating job and to be installed physically to conserve headroom, furring spaces, etc.
- .7 If discrepancies or omissions in the drawings or specifications are found, or if the intent or meaning is not clear, advise the Consultant for clarification before submitting tender.
- .8 Responsibility to determine which Division provides various products and work rests with the Contractor. Additional compensation will not be considered because of differences in interpretation of specifications.

1.5 Quality Assurances

- .1 Codes, Rules, Permits & Fees
 - .1 Comply with all laws, ordinances, rules, regulations, codes and orders of all authorities having jurisdiction relating to this work.
 - .2 Comply with all rules of the Canadian Electrical Code, CSA Standard C22.1 and the applicable building codes.

-
- .3 Quality of work specified and/or shown on the drawings shall not be reduced by the foregoing requirements.
 - .4 Give all required notices, submit drawings, obtain all permits, licenses and certificates and pay all fees required for this work.
 - .5 Furnish a Certificate of Final Inspection and approvals from inspection authority to the Consultant.
 - .2 Standards of Workmanship
 - .1 Execute all work in a competent manner and to present an acceptable appearance when completed.
 - .2 Employ a competent supervisor (consistency is essential) and a sufficient number of licensed tradesmen to complete the Work in the required time.
 - .3 Arrange and install products to fit properly into designated building spaces.
 - .4 Unless otherwise specified or shown, install products in accordance with recommendations and ratings of manufacturers.

1.6 Submittals

- .1 Within 30 days of award of contract, the contractor shall submit a completed equipment procurement schedule which lists the manufacturer and model of equipment, indicating the projected ordering, shop drawing submittal date and delivery dates of all products to meet the required construction schedule.
- .2 Submit samples as required where specified in Division 26.
- .3 Prior to delivery of any products to job site and sufficiently in advance of requirements to allow ample time for checking, submit shop drawings for review as specified in Division 01. Submit shop drawings for all equipment as required in each section of this specification.
- .4 Prior to submitting the shop drawings to the Consultant, the Contractor shall review the shop drawings to determine that the equipment complies with the requirements of the specifications and drawings.
- .5 The term “shop drawing” means drawings, diagrams, illustrations, schedules, performance characteristics, brochures and other data which are to be provided by the Contractor to illustrate details of a portion of the Work.

Indicate materials, methods of construction and attachment of support wiring, diagrams, connections, recommended installation details, explanatory notes and other information necessary for completion of Work. Where equipment is connected to other equipment, indicate that such items have been coordinated, regardless of the section under which the

adjacent items will be supplied and installed. Indicate cross-references to design drawings and specifications.

Adjustments made on shop drawings by the Consultant are not intended to change the contract price. If adjustments affect the value of the work state such in writing to the Consultant prior to proceeding with the Work.

.6 Manufacture of products shall conform to revised shop drawings.

.7 Keep one complete set of shop drawings at job site during construction.

1.7 Record Drawings

.1 Refer to Section 01 77 00 Closeout Procedures – Operating and Maintenance Manuals and Record Drawings.

.2 The Contractor shall keep one complete set of white prints at the site office, including all addendums, change orders, site instructions, clarifications and revisions for the purpose of record drawings. As the work on site proceeds, the Contractor shall clearly record in Red Pencil all as-built conditions which deviate from the original contract documents. Record drawings to include circuiting of all devices, conduit and feeder runs (complete with conductor size and number) and locations of all electrical equipment. Include actual room names and numbers on these drawings.

.3 Prior to substantial performance, the contractor shall obtain CAD files of all electrical drawings, using AutoCAD, and use the services of a competent CAD operator to transfer all as-built information, including: Addendums, Change Orders, Clarifications, Revisions, Site Instructions and shop drawings. Upon completion, the contractor shall certify, in writing, that the as-built record drawings are complete and that they accurately indicate all electrical services, including exposed as well as concealed items.

.4 Contractor to forward letter of certification and as-built CAD drawings to the Consultant for final review. As-Built drawings to be submitted in the form of one set of CAD files on CD discs. Contractor is also to forward the hard copy red-lined as-built drawing to the consultant.

.5 The contractor may borrow copies of the electrical contract drawings on disc from the Consultant.

1.8 Operation and Maintenance Manuals

.1 Refer to Section 26 05 00 11 General Requirements.

.2 Provide hard copy and electronic copies of both Operating & Maintenance Manuals and Record Drawings.

.3 Within 30 days prior to substantial performance, the Contractor shall submit a draft copy of the proposed contents of each maintenance manual to the Consultant for review. Once the draft copy is approved, the Contractor will supply 4 copies in suitably labelled, hard back, D-Ring type commercial binders, each complete with an index and tabbed title

sheets for each section. Final copies of manuals to be received by Consultant not less than 7 days prior to substantial performance.

- .4 All maintenance manual data shall be printed on 8 1/2" x 11" heavy bond, indexed, tabbed, punched and bound in the binders. each manual shall have a title sheet which is labelled "Operation & Maintenance Manual", and lists the Project name, Contractor's & Consultant's names, date submitted, and a Table of Contents for each volume. If a manual exceeds 75 mm in thickness, provide additional manuals as required.
- .5 Provide an electronic version of complete manual.
- .6 Each section of the manual shall contain the following information:
 - .1 Systems Descriptions. A brief synopsis of each system typed and inserted at the beginning of each section. Include sketches and diagrams where appropriate.
 - .2 Descriptive and technical data.
 - .3 Maintenance and operating instructions for all electrical equipment and controls. (These operating instructions need not be manufacturer's data but may be typewritten instructions in simple language to guide the Owner in the proper operation and maintenance of his installation.)
 - .4 Servicing intervals recommended.
 - .5 A copy of all wiring diagrams complete with wire coding.
 - .6 List of spare parts of all electrical equipment complete with names and addresses of sales, service representatives and suppliers.
 - .7 Copy of data testing.
 - .8 Include type and accuracy of instruments used to obtain test data.
 - .9 Copy of final inspection certificate.
 - .10 Copy of the purchase order, showing equipment make and model numbers issued to the manufacturer complete with all addendums. All cost details may be hidden.
 - .11 Copy of all warranty certificates.
 - .12 Set of final reviewed Shop Drawings.
 - .13 Names, addresses, phone numbers and facsimile numbers of Contractor, Consultants, sub-contractors and suppliers used on the Work together with a specification reference of the portion of the Work they undertook.

1.9 Product Handling

- .1 Use all means necessary to protect the products of this Division before, during and after installation and to protect products and installed work of all other trades.
- .2 Immediately make good any damage by repair or replacement at no additional cost to the Owner and to the approval of the Consultant.
- .3 Remove advertising labels from all electrical equipment. Do not remove identification of certification labels.
- .4 Remove dirt, rubbish, grease, etc. resulting from this work from all surfaces, including the inside of all cabinets, equipment enclosures, panelboard tubs, etc.

1.10 Alternate and Separate Prices

- .1 In accordance with the Instructions to Bidders, state on the Tender Form in the space provided, the amount to be added or deleted from the base bid tender amount for the use and installation of equipment as an alternate to those specified.

1.11 Guarantee

- .1 Furnish a written guarantee to the Owner prior to final contract payment, which will be in effect for one year from the date of final acceptance of the complete work. Replace or repair at no cost to the Owner any defective material or workmanship except where, in the opinion of the Consultant, such defects are due to the misuse or neglect by the Owner.
- .2 This general guarantee shall not act as a waiver of any specified or special equipment guarantees, which cover a greater length of time.
- .3 Note: Certain sections of this Electrical Specification are subject to the following warranty clause:

In the event of an emergency failure during the warranty period of any product(s), material(s) or system(s) installed under this Section, and the issuer of the warranty is unable to or chooses not to respond to a request by the owner for immediate emergency repair/replacement of the affected product, material or system, then the owner reserves the right to recover, from the issuer of the warranty, all costs incurred by the owner or owner engaged forces in effecting the immediate repair/replacement.

1.12 Progress Claims

- .1 Within thirty (30) days after award of contract, a breakdown of material and equipment items including labour and expense components shall be compiled on the Consultant format. Subsequent requests for payment shall be documented accordingly.

1.13 Waste Management and Disposal

- .1 Separate and recycle waste materials.

-
- .2 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with the Waste Management Plan.
 - .3 Fold up metal banding, flatten and place in designated area for recycling.
 - .4 Ensure emptied containers are sealed and stored safely for disposal away from children.
 - .5 Place materials defined as hazardous or toxic waste in designated containers.
 - .6 Collect, package and store any salvaged or remaining materials such as wire, conduit, busbars, wireways, copper ground straps and other associated components for recycling and reuse.

2. PRODUCTS

2.1 Selected Products & Equivalents

- .1 Products and materials provided shall be new and free from all defects. Defective products or materials will be rejected, regardless of previous inspections. The Contractor shall be responsible to remove and replace defective products at their expense, and shall be responsible for any resulting delays and associated expenses, which result from defective products being rejected. Related materials shall be of the same manufacturer throughout the project.
- .2 Products and materials referred to in the specifications by trade names, manufacturer's name and catalogue reference are those which shall be used as the basis for the Tender.
- .3 The design has been based on the use of the specified product.

2.2 Alternative Products

- .1 All product substitutions must be approved by the Consultant. Failure to obtain approval from the Consultant will result in the alternative product being rejected, in which case the Contractor shall provide an approved product at no additional cost to the owner.
- .2 The Contractor shall assume full responsibility for ensuring that when providing alternative products or materials, all space, weight, connections, power and wiring requirements etc. are considered. Any costs incurred for additional components, changes to services, structural or space requirements, layouts and plans, etc. that may be necessary will be borne by the contractor.
- .3 Suppliers to submit all requests for alternative product approval to the Consultant. Submissions must be received by the Consultant not less than seven (7) working days prior to the close of tenders. Submissions received after the "Cut-Off" date will not be reviewed.

All submissions, which are approved by the Consultant, shall be identified as "Approved Alternatives" in an Addendum. Alternative products not listed in the Addendum will be rejected.

-
- .4 Approval of an alternate is not intended to change the original specifications unless specifically stated in the addenda. The submitter is responsible for all costs incurred by other trades as well as his own, to install the product/system in accordance with the contract documents.
 - .5 All submissions to be provided with technical data and whatever pertinent information that may be required by the Consultant to evaluate equivalency to the specified product. The responsibility to provide sufficient technical data with respect to submissions will remain solely with those making the submission.

2.3 Quality of Products

- .1 All products provided shall be CSA Approved, Canadian Underwriters' Laboratory approved where applicable, and new, unless otherwise specified.
- .2 If products specified are not CSA approved, obtain special approval from the local regulatory authority. Pay all applicable charges levied and make all modifications required for approval.
- .3 Products provided, if not specified, shall be new, of a quality best suited to the purpose required and their use subject to approval by the Consultant.

2.4 Uniformity of Manufacture

- .1 Unless otherwise specifically called for in the Specifications, uniformity of manufacture shall be maintained for similar products throughout the work.

2.5 Product Finishes

- .1 Touch up all damaged painted finishes with matching lacquer, or, if required by the Consultant, completely repaint damaged surface.

2.6 Use of Products During Construction

- .1 Any equipment used for temporary or construction purposes shall be approved by the Construction Manager and in accordance with the General Conditions, "Use of Premises." Clean and restore to "as new" condition all equipment prior to the time of substantial completion.
- .2 The warranty period shall not begin until the date of substantial performance of the work.

3. EXECUTION

3.1 Site Examination

- .1 Examine the site of work and become familiar with all features and characteristics affecting this work before submitting tender.

- .2 No additional compensation will be given for extra work due to existing conditions, which such examination should have disclosed.
- .3 Report to the Consultant any unsatisfactory conditions, which may adversely affect the proper completion of this work.

3.2 Co-ordination with Other Divisions

- .1 Examine the drawings and specifications of all divisions and become fully familiar with their work. Before commencing work, obtain a ruling from the Consultant if any conflict exists, otherwise no additional compensation will be made for any necessary adjustments.
- .2 Lay out the work and equipment with due regard to architectural, structural and mechanical features. Architectural and structural drawings take precedence over electrical drawings regarding locations of walls, doors and equipment.
- .3 Do not cut structural members without approval of the Consultant.
- .4 Coordinate with all Division installing equipment and services, and ensure that there are no conflicts.
- .5 Install anchors, bolts, pipe sleeves, hanger inserts, etc. in ample time to prevent delays.
- .6 Examine previously constructed work and notify the Consultant of any conditions, which prejudice the proper completion of this work. Commencement of this work without such notification shall constitute acceptance of other work.

3.3 Location of Outlets

- .1 Electrical drawings are, unless otherwise indicated, drawn to scale and approximate distances and dimensions may be obtained by scaling. Figured dimensions shall govern over scaled dimensions. Where exact dimensions and details are required, refer to Architectural drawings.
- .2 Equipment locations shown on the drawings are approximate. Locations may be revised up to 3 meters to suit construction and equipment arrangements without additional cost to the Owner, provided that the Contractor is notified prior to the installation of the outlets, or equipment.
- .3 Unless otherwise specified or shown, install products in accordance with recommendations and ratings of manufacturers.

3.4 Separation of Services

- .1 Maintain separation between electrical wiring system and building piping, ductwork, etc. so that wiring system is isolated (except at approved connections to such systems) to prevent galvanic corrosion.

- .2 In particular, contact between dissimilar metals, such as copper and aluminium, in damp or wet locations is not permitted.
- .3 Do not support wiring from pipes, ductwork, etc. Hangers for suspended ceilings may be used for the support of wiring only when approval is obtained from the Consultant and the ceiling installer, and approved clips or hangers are used.

3.5 Equipment Identification

- .1 3 mm thick plastic lamacoid name plates, coloured face to match system colour, white core, mechanically attached with self tapping screws, 6 mm high lettering, to be attached to the front face of the following equipment:

.1 Starters, Contactors, Disconnects (Designation, voltage, load controlled)

- .2 Colour code concealed conduits (including conduits above T-bar ceilings and under raised floor), concealed junction and pull boxes, and metallic sheathed cables with paint or plastic tape (25 mm wide band) at 15 metre intervals and at both side of transition through walls. All conduit, junction boxes and pull boxes in service rooms to be colour coded. Colour coding to be as follows:

SYSTEM	MAJOR BAND	MAJOR BAND
277/480V Normal	Bronze	
Standby Power	Voltage Color with 'SB' identification	White
120/208V Normal	Grey	
Fire Alarm System	Red	
Telephone	Lt. Green	
Building Alarm	Pink	
Commercial Television	Dk. Brown	
AV/TV Systems	Lt. Brown	
Clock System	Yellow	
Security Systems	Dk. Green	Lt. Brown
Door Intercom/Video	Purple	Yellow
Computers	Black	Yellow

- .3 Provide neatly typed circuit directories in panelboards to indicate the area or equipment controlled by each branch circuit.
- .4 All conductors shall be identifiable by coloured insulation and permanent markers at every terminal and accessible points throughout its entire run.

Conductors:

Equipment Grounding - Green
 Neutral Conductor – White
 277/480 Volt System 120/208 Volt System

Phase A - Orange	Phase A - Red
Phase B - Brown	Phase B - Black
Phase C - Yellow	Phase C - Blue
Fire Alarm System	

Neutrals	White
Switch Legs	Phase Colour with White Tracer
Speaker Cct.	Blue with Yellow Tracer
Box Circuit	Black with Yellow Tracer
Annunciator	Brown with Yellow Tracer

- .5 Low Voltage Wiring: per manufacturer's standard, i.e. CGE low voltage relay switching system.
- .6 Install yellow plastic warning tape, 300 mm below grade, above all underground ducts.
- .7 Provide permanent, corrosion resistant warning markers, suitable to the local inspection authority, imbedded in the surface of concrete slabs which are directly above high voltage cables and duct banks.
- .8 All housekeeping receptacles to be labelled with 'HK' on the cover plate.

3.6 Wiring to Equipment Supplied by Others

- .1 Equipment supplied by the Owner or under other Division will be moved to the installation site by others. However, the electrical connection to the equipment shall be done by this Division.

3.7 Instructions to Owner's Personnel

- .1 Refer to Section 26 08 00 12 - Electrical Equipment and Systems Demonstration and Instruction.

3.8 Access Panels

- .1 Where electrical equipment, junction boxes, remote ballasts or the like are concealed, access panels shall be supplied. Panels shall be of adequate size for servicing of the electrical work and complete with necessary frames and hinged doors held closed with captive fasteners. Coordinate type and size of panels with the Consultant.
- .2 In removable ceiling areas, provide markers on ceiling tile to locate equipment requiring access. Markers shall be of a type approved by the Consultant.

3.9 Mounting Heights

- .1 Unless a conflict exists, use the following as mounting heights from finished floors to center of device.

Receptacles in Mechanical Rooms	1000 mm
Receptacles & communication outlets	450 mm
Light Switches	1370 mm
Fire Alarm Manual Stations	1400 mm
Fire Alarm Horn/Strobes	2100 mm (300 mm below finished ceiling)
Clocks	2100 mm (300 mm below finished ceiling)
Television & Computer Outlets	450 mm
Intercom	1400 mm
Thermostats	1400 mm
Door Entry PushButtons	1400 mm
Wall mounted speakers	2100 mm (300 mm below finished ceiling)
Panelboards, starters and disconnects(to top of cover)	2000 mm
End of Line Resistors	2100 mm (300 mm below finished ceiling)
Outlets above Counters	175 mm above counter top or backsplash
Wall mounted Telephone outlets	1400 mm
Wall mounted Classroom Help Phone outlets	1100 mm

Note: Refer to Architectural Drawings for further mounting height details. Architectural Drawings take priority where conflicts exist with values indicated in this section.

3.10 Sealing of Wall and Floor Openings

- .1 All conduit and cable entries through outside walls of buildings, through partition walls separating electrical rooms from other areas, through fire separations, and through floors above grade shall be sealed to prevent passage of moisture, dust, gasses, flame, or to maintain pressurization.
- .2 Openings shall be sealed when all wiring entries shown on the drawings have been completed.
- .3 Sealing material shall be fire resistant and shall not contain any compounds, which will chemically affect the wiring jacket or insulating material. Cable penetrations through fire separations to be sealed.

3.11 Sprinkler Proof Equipment

- .1 Electrical equipment installed where sprinklers are also installed shall be constructed so that water from the sprinkler heads shall not impair the effectiveness of the equipment.

This will include, but not be limited to: Distribution Centres, Equipment Enclosures, Cabinets, Transformer enclosures, Panelboards.

- .2 A separate and complete roof shall be provided on free-standing or surface mounted equipment. An overhang at the front, rear and sides shall prevent the entrance of water either at the top or through projecting face plates, meters, etc.
- .3 Where conduits or cables are required to penetrate sprinkler proof roofs, rain tight connectors shall be used in conjunction with T & B 5260 Series sealing rings. Connectors shall be equal to:
 - .1 Rigid Conduit - T & B Bullet Hubs
 - .2 EMT - T & B 5123 Series (steel)
 - .3 Teck Cable - T & B 10460 Series
- .4 Louvres shall be of the outdoor type.

3.12 Sleeves

- .1 Provide sleeves of galvanized steel pipe with machine cut ends of ample size to accommodate conduits passing through walls, partitions, ceilings, floors, etc.
- .2 For wall, partitions and ceilings the ends shall be flush with the finish on both sides but for floors they shall extend 4" above finished floor level.
- .3 The space between the sleeve and the conduit shall be filled with Dow Corning silicone RTV foam for fire stop and caulked around the top and bottom with approved permanently resilient, non-flammable and weatherproof silicone base compound and ensure that the seal is compatible with the floor and ceiling finishes.
- .4 Locate and position sleeves exactly prior to construction of walls, floors.
- .5 Failure to comply with the above requirements shall be remedied at this Division's expense.

3.13 Electrical Conduit in Slabs

- .1 Electrical Trade Contractor to submit a drawing indicating the proposed layout for any electrical or other conduit to be cast into a structural slab or slab on grade.
- .2 Locate conduit to be cast into a structural slab within the center third of the slab thickness only; arrange crossovers to ensure that all conduits are contained within the center third of the slab thickness. Maximum outside diameter of conduit is to be one quarter of the slab thickness.
- .3 Do not displace reinforcing steel in order to place conduit; do not secure conduit in place by tying parallel to reinforcing bar.

-
- .4 Place conduit with minimum spacing between parallel conduits equal to four (4) conduit diameters.

3.14 Temporary Power

- .1 Provide grounded extension cords and temporary lights required for electrical work.
- .2 Co-ordinate with General Contractor for obtaining temporary power service.
- .3 If Owner's operations will be affected by any power outage required for this work, give adequate notice to the Owner and do not interrupt power until approval has been obtained.
- .4 Give adequate notice to Contractor of any power outage required for this work. Schedule outages to provide least interference with other work.

3.15 Insulation Resistance Testing

- .1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
- .2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
- .3 Check resistance to ground before energizing.
- .4 Carry out tests in presence of Consultant.
- .5 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
- .6 Submit test results for Consultant's review.

3.16 Load Balance

- .1 Measure phase current to panelboards with normal loads operating at time of acceptance. Adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
- .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
- .3 Submit, at completion of work, report listing phase and neutral currents on panel boards, dry-core transformers and motor control centers, operating under normal load. State hour and date on which each load was measured, and voltage at time of test.

3.17 Neutral Wiring

- .1 Provide a separate white neutral conductor for each circuit in the offices. Unless specified otherwise.

3.18 Ground Wiring

- .1 Provide a separate green ground conductor for each conduit run.

END OF SECTION

1. General

1.1 Work Included

- .1 Provide a complete system of wiring, making all connections necessary for the installation shown on drawings.

1.2 References, Codes and Standards

- .1 CSA C22.2 No. 0.3, Test Methods for Electrical Wires and Cables.
- .2 Install and rate power cables in accordance with the Canadian Electrical Code requirements, or in accordance with ICEA requirements where permissible.

1.3 Waste Management and Disposal

- .1 Refer to Section 26 05 00 11 – Electrical General Requirements.

1.4 Product Data

- .1 Submit product data in accordance with Section 26 05 00 11 - Electrical General Requirements.

1.5 Warranty

- .1 In the event of an emergency failure during the warranty period of any product(s), material(s) or system(s) installed under this Section, and the issuer of the warranty is unable or chooses not to respond to a request by the Owner for immediate emergency repair/replacement of the affected product, material or system, then the Owner reserves the right to recover, from the issuer of the warranty, all costs incurred by the Owner engaged forces in effecting the immediate repair/replacement.

2. Products

2.1 Building Wires

- .1 Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.
 - .2 Copper conductors: size as indicated, with 600 V insulation of chemically cross-linked thermosetting polyethylene (XLPE) material rated RW90.
 - .3 Control circuits: No. 14 AWG or larger as required.
 - .4 Low voltage systems: size in accordance with manufacturers recommendations for proper operation of the equipment.
 - .5 Video cable: 75 ohm RG-6 100% shielded.
-

- .6 AC90 (BX) cable may only be utilized for recessed tee bar fixture drops from ceiling mounted outlet boxes. Length of drops not to exceed 3.0 m (6'). Do not loop between fixtures.

- .7 Fire alarm cable: FAS

2.2 Teck Cable

- .1 Conductors:

- .1 Grounding conductor: copper.

- .2 Circuit conductors: copper, size as indicated.

- .2 Insulation:

- .1 Chemically cross-linked thermosetting polyethylene rated type RW90, 600 V.

- .3 Inner jacket: polyvinyl chloride material.

- .4 Armour: interlocking galvanized steel.

- .5 Overall covering: thermoplastic polyvinyl chloride material.

- .6 Fastenings:

- .1 One hole zinc straps to secure surface cables 50 mm and smaller. Two-hole steel straps for cables larger than 50 mm.

- .2 Channel type supports for two or more cables at 600 mm centers.

- .3 6 mm diameter threaded rods to support suspended channels.

- .7 Connectors:

- .1 Watertight, approved for TECK cable.

2.3 Armoured Cables

- .1 Conductors: insulated, copper, size as indicated.

- .2 Type: AC90.

- .3 Armour: interlocking type fabricated from aluminium strip.

- .4 Type: ACWU90-PVC flame retardant jacket over thermoplastic armour meeting requirements of Vertical Tray Fire Test of CSA C22.2 No. 0.3 with maximum flame travel of 1.2 m.

2.4 Control Cables

- .1 Type LVT: 2 soft annealed copper conductors, sized as indicated, with thermoplastic insulation, outer covering of armour of closely wound aluminium wire.
- .2 Low energy 300 V control cable: solid annealed copper conductors sized as indicated, with PVC insulation type.

3. **Execution**

3.1 General

- .1 Minimum conductor size #12 AWG.

3.2 Installation of Building Wires

- .1 Install wiring as follows:
 - .1 In conduit systems in accordance with Section 26 05 33.

3.3 Installation of Teck Cable 0 - 1000 V

- .1 Install cables.
- .2 Group cables wherever possible on channels.
- .3 Terminate cables in accordance with Section 26 05 19 10 - Wire and Box Connectors - 0 - 1000 V.

3.4 Installation of Armoured Cables

- .1 Group cables wherever possible.
- .2 Terminate cables in accordance with Section 26 05 19 10 - Wire and Box Connectors - 0 - 1000 V.
- .3 For ACWU cable, use non-magnetic connectors, ground armour and ground conductor at supply and only use non-metallic cable entrance plates. Support runs on steel or aluminium channels with spacers and clamps. Space cables to provide free air ampacity ratings unless otherwise shown.

3.5 Installation of Control Cables

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

3.6 Workmanship

- .1 Before pulling wire, ensure conduit is dry and clean. If moisture is present, thoroughly dry out conduits; vacuum if necessary. To facilitate pulling, recognized specially
-

manufactured wire pulling lubricants may be used. Do not use grease. Employ suitable techniques to prevent damage to wire when ambient temperature is below the minimum permitted for each insulation type. Do not pull wires into incomplete conduit runs.

- .2 Installation to be free of opens and grounds. Before energization, measure insulation resistance and comply with the Canadian Electrical Code. Submit data sheet with values measured.
- .3 Do not install any conductor smaller than #12 AWG, except where specifically indicated otherwise, i.e. for fire alarm system station circuits, etc.
- .4 Provide sizes of conductors as shown on drawings. Voltage drop from lighting panels to farthest outlet must not exceed 2% at full load in any case. Advise Consultant if problem is foreseen.
- .5 Exercise care in stripping insulation from wire. Do not nick conductors.
- .6 Conductor length for parallel feeders to be identical.
- .7 Lace or clip groups of feeder conductors at all distribution centres, pull boxes, and termination points.
- .8 All grounding conductor and straps to be copper. All ground conductors to have green insulation jacket except where specified to be bare copper.

3.7 Identification, Coding and Balancing

- .1 For branch circuit wiring, follow identification system shown on the drawings and as specified in Section 26 05 00 11 - Electrical General Requirements.
- .2 Connect single-phase equipment to minimize imbalance on feeders. Adjust branch circuiting shown as required for optimum balancing. Record all changes on "record" drawings.
- .3 Colour code all feeders at all terminations, at all points where taps are made, and at all panelboards, switchboards, motor control centres, etc. Use two wraps of 3M #471 plastic film tape 48 mm wide.
- .4 Conductors sized No. 10 and smaller are required to be factory coloured, not taped on site.
- .5 For direct current wiring use red for positive and black for negative.

3.8 Testing

- .1 All power and control wiring shall be tested for insulation resistance value with a 1000 volt megger. Resistance values shall be as recommended by the cable manufacturer.
 - .2 All wire test results shall be properly tabulated, signed, dated, and submitted to the Consultant.
-

GOVERNMENT OF CANADA

Existing Building Renovation

Alberta, Canada

Project No.: 144202775.215

Section 26 05 19 00

WIRES AND CABLES 0 -1000V

Page **5** of **5**

END OF SECTION

1. General

1.1 Work Included

- .1 Provide a complete system of wiring, making all connections necessary for the installation shown on drawings.

1.2 Special Codes

- .1 Install and rate power cables in accordance with the Canadian Electrical Code requirements, or in accordance with IPCEA requirements where permissible.

1.3 References

- .1 CSA C22.2 No. 65 Wire Connectors.
- .2 EEMAC 1Y-2, Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).

1.4 Waste Management and Disposal

- .1 Refer to section 26 05 00 11 – Electrical General Requirements.

2. Products

2.1 Materials

- .1 Pressure type wire connectors: with current carrying parts same material as conductors sized to fit the conductors as required.
- .2 Fixture type splicing connectors: with current carrying parts same material as conductors sized to fit the conductors 10 AWG or less.

2.2 Wire Connectors

- .1 Use self-insulated connectors for hand twist wire joints for lighting, small power, and control wiring, or approved equal.
- .2 Use non-insulated ring type compression lugs for terminating #10 AWG and smaller motor connections. Tape with rubber and scotch tape. Lugs to accept ten - 32 x 3/8" machine bolts.
- .3 Terminate conductors #8 AWG and larger with Colour-Keyed compression connectors or on lugs provided with equipment.

3. Execution

3.1 Installation

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

3.2 Wire Connectors

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

END OF SECTION

1. GENERAL

1.1 Work Included

- .1 Provide and connect all wiring devices for the complete installation.

1.2 Waste Management and Disposal

- .1 Refer to Section 26 05 00 11 – Electrical General Requirements.

2. PRODUCTS

2.1 Manufacturer

- .1 Wiring devices to be of one manufacture throughout project.
- .2 Manufacturers shall be Hubbell, Bryant or Arrow Hart.

2.2 Devices

- .1 The catalogue numbers shown below are for the particular manufacturer's series and all necessary suffixes shall be added for the requirements as stated. All devices shall be specification grade minimum and wherever possible shall be of the same manufacture.
- .2 Devices to be white with stainless steel, type 302 or 304 c/w No. 4 finish 1-mm thick coverplates in all but mechanical areas (and Electrical Rooms) unless noted otherwise. Use galvanized steel coverplates in mechanical areas (and Electrical Rooms) and for surface mounted devices. UPS power to be orange.

2.3 Coverplates

- .1 Use sheet steel utility box cover for wiring devices installed in surface mounted utility boxes.
- .2 Use stainless steel 1 mm thick coverplates on all wiring devices mounted in flush-mounted outlet boxes unless otherwise specified.
- .3 Weatherproof double lift spring - loaded cast aluminum coverplates, complete with gaskets for single receptacles or switches.
- .4 Weatherproof spring - loaded cast aluminum coverplates complete with gaskets for single receptacles or switches.
- .5 Use gasketed DS cast covers on FS and FD type boxes.

3. EXECUTION

3.1 Installation

- .1 Install single throw switches with handle in the "UP" position when switch closed.
- .2 Install switches vertically in gang type outlet box when more than one switch is required in one location.
- .3 Mount switches on the latch side of the doorway as close as possible to door frame unless otherwise indicated on drawings.
- .4 Install receptacles vertically in gang type outlet box when more than one receptacle is required in one location.
- .5 Protect cover plate finish with paper or plastic film until all painting and other work is finished, then remove paper.
- .6 Install suitable common coverplates where wiring devices are grouped. Do not distort plates by tightening screws excessively.
- .7 Do not use coverplates meant for flush outlet boxes on surface mounted boxes.
- .8 Wherever possible, mount equipment in a straight line at a uniform mounting height, coordinated with other equipment and materials.
- .9 Mounting dimensions are to the centre of the devices. Final instructions on mounting heights shall be given by the Consultant's representative at the site. The above shall be used as a guide, but shall be subject to final verification prior to installation.
- .10 Supply and install a separate neutral conductor for each branch circuit.

END OF SECTION

1. GENERAL

1.1 Work Included

- .1 Supply and install all hangers and supports for the installation shown on the drawings and specified herein, as necessary to fasten electrical equipment securely.

1.2 Related Work

- .1 Material and Equipment - Fastenings and supports. Section 26 05 29

1.3 Waste Management and Disposal

- .1 Refer to Section 26 05 00 11 – Electrical General Requirements.

2. PRODUCT

2.1 Framing and Support System

.1 Materials:

- .1 Intermediate duty supporting structures shall employ P1000 Unistrut or equal together with the manufactures connecting components and fasteners for a complete system.
- .2 Heavy duty supporting structures to be fabricated and welded from steel structural members and prime painted before installation.

.2 Finishes:

- .1 Outdoors, wet locations: Hot dipped galvanized.
- .2 Indoors, dry locations: Galvanized when available, prime painted if not available.
- .3 Nuts, bolts, machine screws: Cadmium plated.

.3 Unistrut:

- .1 Section P1000 or as required for load and span, with mounting screws, or approved. P1000 or equal is a minimum standard for supporting conduits 50 mm and larger.

2.2 Concrete and Masonry Anchors

- .1 Materials: Hardened steel inserts, zinc plated for corrosion resistance. All anchor bolts must be galvanized.

- .2 Components: non-drilling anchors for use in predrilled holes, sized to safely support the applied load with a minimum safety factor of four.

- .3 Manufacturer: Hilti (Canada) Limited or approved equal.

2.3 Non-Metallic Anchors

- .1 Material: Plastic anchors for sheet metal screws.

- .2 Manufacturer: Fischer.

2.4 Conduit Supports

- .1 General: Malleable iron one-hole conduit straps where exposed to weather. Stamped steel two-hole straps indoors.

- .2 Structural Steel: Crouse-Hinds “Wedgetite” supports or equivalent manufactured by Appleton.

- .3 Masonry, concrete, stone, etc.: Anchors.

- .4 Title: Toggle bolts.

- .5 Metal studs, ceiling hangers, etc.: “Caddy-Clips”.

- .6 Unistrut: Unistrut conduit clamps.

2.5 Cable Supports and Clamps

- .1 General: As per conduit supports, except that for single conductor cables, suitable non-ferrous, or approved stainless steel or aluminum clamps shall be used.

3. **Execution**

3.1 General

- .1 Do not cut or drill beams, joists or structural steel unless written permission of the Consultants is obtained.

- .2 Distance between conduit or cable supports not to exceed code requirements.

- .3 Supports to be suitable for the real loads imposed by equipment.

- .4 Supports to be securely fastened, free from vibration and excessive deflection or rotation. Maximum deflections are 4 mm over a 1 meter span and 8 mm over a 2 meter span.

- .5 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer’s installation recommendations.

- .6 Provide conduit rack with 25% spare capacity for multiple runs.
- .7 Provide channel support with fittings for vertical runs of conduit and cables.

3.2 Installation

- .1 Secure equipment to solid 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 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .5 Fasten exposed conduit or cables to building construction or support system using straps.
 - .1 One-hole malleable iron or 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.
- .6 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.
- .7 Use plastic anchors for light loads only. Use metal anchors for all other loads.
- .8 Shot driven pins may only be used with written approval of the structural engineer.
- .9 Use round or pan head screws for fastening straps, boxes, etc.
- .10 Do not support heavy loads from the bottom chord of open web steel joists.
- .11 Support outlet boxes, junction boxes, panel tubs, etc., independent of conduits running to them. Support conduits within 600 mm of outlet boxes. Support surface mounted panel tubs with a minimum of four 6 mm fasteners.
- .12 For surface mounting of two or more conduits use channels at 1.5 m oc spacing.
- .13 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.

-
- .14 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
 - .15 Do not use wire lashing or perforated strap to support or secure raceways or cables.
 - .16 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of the Consultant.
 - .17 Support lay-in T-bar ceiling light fixtures with T-bar.

END OF SECTION

1. GENERAL

1.1 Work Included

- .1 Provide a complete system of splitters boxes and cabinets for the installation of wiring and equipment.

1.2 Shop Drawings and Product Data

- .1 Submit shop drawings and product data for cabinets in accordance with Section 26 05 00 11 Electrical General Requirements.

1.3 Warranty

- .1 In the event of an emergency failure during the warranty period of any product(s), material(s) or system(s) installed under this Section, and the issuer of the warranty is unable or chooses not to respond to a request by the Owner for immediate emergency repair/replacement of the affected product, material or system, then the Owner reserves the right to recover, from the issuer of the warranty, all costs incurred by the Owner or Owner engaged forces in effecting the immediate repair/replacement.

1.4 Waste Management and Disposal

- .1 Refer to Section 26 05 00 11 – Electrical General Requirements.

2. PRODUCTS

2.1 Junction Boxes and Pull Boxes, Weatherproof

- .1 Materials:
 - .1 Cast steel

2.2 Junction Boxes and Pull Boxes, Indoor Dry Locations

- .1 Materials:
 - .1 Code gauge sheet steel, welded construction, phosphatized and factory paint finish.
 - .2 Components:
 - .1 For flush mounting, covers to overlap box by 25 mm minimum all around with flush head cover retaining screws.
 - .2 Use rolled edges for surface boxes.
 - .3 Junction boxes mounted in exterior walls shall be complete with box vapour barriers.
-

2.3 Cabinets

.1 Materials:

- .1 Cabinets: Code gauge sheet steel, welded construction, phosphatized and factory paint finish, suitable for field painting.
- .2 Locks: to match panelboards.
- .3 Backplates: 1.5 mm steel backplate, one piece per cabinet, covering entire cabinet interior.

.2 Components:

- .1 With hinged door and return flange overlapping sides, with handle, lock and catch for surface mounting, size as indicated or to suit.
- .2 Surface or flush with trim and hinged door, latch and lock and two keys, size as indicated or to suit. Keyed to match panelboard keys.

2.4 Splitters

.1 Materials:

- .1 Code gauge sheet steel, welded construction, phosphatized and factory paint finish.

.2 Components:

- .1 Formed hinged cover suitable for locking in the closed position.
- .2 Main and branch lugs to match required size and number of incoming and outgoing conductors as indicated.
- .3 At least three spare terminals on each set of lugs in splitters less than 400 AMP.

2.5 Installation

.1 Junction Boxes and Pull Boxes:

- .1 Supply all pull boxes and junction boxes shown on the drawings or required for the installation. Maximum 30 m (100 feet) spacing.
 - .2 Boxes installed in party walls to be offset by a minimum of one stud space.
 - .3 Install in inconspicuous but accessible locations, above removable ceilings or in electrical rooms, utility rooms or storage areas.
 - .4 Identify with system name and circuit designation as applicable.
 - .5 Size in accordance with the Canadian Electrical Code, as a minimum.
-

.2 Cabinets:

.1 Mount cabinets with top not greater than 1980 mm above finished floor, coordinated with masonry, panelboards, fire hose cabinets and similar items. Securely fasten backboards to cabinet interiors.

.2 Install terminal block where indicated.

.3 Splitters

.1 Install splitters and mount plumb, true and square to the building lines.

.2 Extend splitters full length of equipment arrangement except where indicated otherwise.

.4 Identification

3. Provide equipment identification in accordance with Section 26 05 00 11- Electrical General Requirements.

END OF SECTION

1. GENERAL

1.1 Work Included

- .1 Provide a complete system of boxes for the installation of wiring and equipment.

1.2 References

- .1 CSA C22.1-Canadian Electrical Codes, Part 1.

1.3 Waste Management and Disposal

- .1 Refer to Section 26 05 00 11 – Electrical General Requirements.

2. PRODUCTS

2.1 Outlet and Conduit Boxes General

- .1 Size boxes in accordance with CSA C22.1.
- .2 102 mm square or larger outlet boxes as required for special devices.
- .3 Gang boxes where wiring devices are grouped.
- .4 Blank cover plates for boxes without wiring devices.
- .5 Combination boxes with barriers where outlets for more than one system are grouped.

2.2 Outlet Boxes for Metal Conduit

- .1 Materials:
 - .1 Surface or recessed concealed type: Die formed steel, hot dip galvanized, 1.25 oz/sq. ft. minimum zinc coating.
 - .2 Surface mounting exposed: Cast ferrous for threaded conduit, with attached lugs, corrosion resistant two coats finish.
 - .2 Components:
 - .1 Ceiling outlets, surface mounting, concealed:
 - .1 101 mm square, depth 54 mm, Iberville 52171 series
 - .2 119 mm square, depth 54 mm, Iberville 72171 series
 - .2 Ceiling outlets, concealed mounting in concrete:
 - .1 101 mm octagonal concrete rings, depth from 38 mm to 152 mm Iberville 54521 series.
-

- .2 Wall boxes, concealed in concrete or masonry: for one and two gang applications shall be 101 mm square, 54 mm deep, complete with suitable square cornered raised tile wall cover for proper device and wall surface application. Masonry boxes may be used for line voltage switching.
- .3 Wall outlets, concealed non-masonry construction, with plaster finish: For one or two gangs used with switches, receptacles, etc., use 54 mm deep, with matching plaster covers, depth to suit. Alternately, use 119 mm square boxes, and covers as required. (For more than two gangs use solid boxes, or special boxes as required).
- .4 Covers: Unless wiring devices and plates are mounted, provide blank, round canopy covers to match boxes.
- .5 For 277V switches: Non-interchangeable with 120V switches through special tapped mounting ears, with top and bottom knockouts only.

2.3 Outlet Boxes for Rigid PVC Conduit

- .1 Materials:
 - .1 Rigid PVC boxes and fittings: Unplasticized PVC.

2.4 Masonry Boxes

- .1 Electro-galvanized steel masonry single and multi-gang boxes for devices flush mounted in exposed block walls.

2.5 Concrete Boxes

- .1 Electro-galvanized sheet steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.

2.6 Conduit Boxes

- .1 Cast FS or FD aluminum boxes with factory-threaded hubs and mounting feet for any surface wiring of switches and receptacle.

2.7**2.8** Fittings - General

- .1 Bushing and connectors with nylon insulated throats.
 - .2 Knock-out fillers to prevent entry of debris.
 - .3 Conduit outlet bodies for conduit up to 32 mm and pull boxes for larger conduits.
 - .4 Double locknuts and insulated bushings on sheet metal boxes.
-

2.9 Service Fittings

- .1 'High tension' receptacle fitting made of 2 piece stainless steel with satin aluminum housing finish for 1 duplex receptacles. Bottom plate with two knockouts for centered of offset installation.
- .2 Pedestal type 'low tension' fitting made of 2 piece stainless steel with satin aluminum housing finish to accommodate two amphenol jack connectors.

3. **execution****3.1** Installation

- .1 Support boxes independently of connecting conduits.
 - .2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.
 - .3 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.
 - .4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.
 - .5 Install all outlets flush and surface mounted as required for the installation.
 - .6 Surface mount above suspended ceilings, or in unfinished areas.
 - .7 Adjust position of outlets in finished masonry walls to suit course lines. Coordinate cutting of masonry walls to achieve neat openings for all boxes.
 - .8 Do not distort boxes during installation. If boxes are distorted, replace with new boxes.
 - .9 Use plaster rings to correct depth. Use 30 mm on concrete block.
 - .10 Do not use sectional boxes.
 - .11 Provide boxes sized as required by the Canadian Electrical Code.
 - .12 Install vapour barrier material to surround and seal all outlet boxes located on exterior walls of building. Maintain wall insulation.
 - .13 Outlets installed in party walls to be offset by a minimum of one stud space.
 - .14 Ceiling outlet boxes shall be provided for every surface mounted fixture or row of fixtures installed on suspended "hard" ceilings.
 - .15 Primary bushings in termination box for cable connection.
 - .16 Secondary bushings in termination box for bus duct connection.
-

- .17 Control junction box.
 - .18 Stainless steel nameplate and connection diagram.
 - .19 Where outlet boxes penetrate throughout a fire or smoke separation, ensure that they are tightly fitted with non-combustible material to prevent passage of smoke or flame.
 - .20 No sectional or handy boxes to be installed.
- 4. Back boxes for all low voltage systems equipment to be provided in accordance with specific manufacturer's recommendations and as specified in the low voltage sections of these specifications.**

END OF SECTION

1. GENERAL

1.1 Work Included

- .1 Provide a complete system of conduit and fittings for installation of wiring.

1.2 Waste Management and Disposal

- .1 Refer to Section 26 05 00 11 – Electrical General Requirements.

2. PRODUCTS

2.1 Rigid Steel Conduit

- .1 Galvanized with threaded joints and connections.
- .2 Connections in dry locations: steel or malleable iron locknuts inside and outside enclosures.
- .3 Connectors subjected to moisture interior and exterior: liquid and dust tight with insulated throat.
- .4 Fittings: cast metal including gasketed covers in damp locations.
- .5 Expansion joints: cast metal Crouse-Hinds type XJ or approved alternate.
- .6 minimum size to be 19mm.

2.2 E.M.T. Conduit

- .1 Fittings in dry locations: Steel or zinc set screw connectors with insulated throat. Steel or zinc set screw couplings.
- .2 Fittings in wet locations: steel rain tight connectors with insulated throat. Steel rain tight couplings.
- .3 Minimum size to be 19 mm.

2.3 Rigid P.V.C. Conduit

- .1 Conduit: rigid non-metallic conduit of unplasticized polyvinyl chloride as manufactured Schedule 40.
- .2 Fittings: threaded male or female solvent weld connectors and solvent weld couplings, as supplied by conduit manufacturer.
- .3 Solvent: Solvents to have Volatile Organic Compound (VOC) limits of less than 285g/L less water and less exempt compounds as per the State of California's South Coast Air Quality Management District (SCAQMD) current.
-

2.4 Rigid PVC Duct

- .1 Duct: Rigid non-metallic conduit of unplasticized polyvinyl chloride Type DB-2, conforming to CSA Standard.
- .2 Accessories: Bell ends, couplings, adapters, bends and other fittings of same material as duct. Use solvent recommended by manufacturer. Horizontal, vertical and foundation spacers.
- .3 Solvent: Solvents to have Volatile Organic Compound (VOC) limits of less than 285g/L less water and less exempt compounds as per the State of California's South Coast Air Quality Management District (SCAQMD) current.

2.5 Liquid-Tight Flexible Conduit

- .1 Conduit: flexible metal conduit with liquid-tight PVC jacket.
- .2 Connectors: captive sealing jacket and ground cone insulated throat, steel.
- .3 Minimum size to be 19 mm.

2.6 Electrical Non-metallic Tubing (ENT)

- .1 To CSA C22.2 N0. 227.1, Electrical Non-metallic Tubing

3. **EXECUTION****3.1** Rigid Steel Conduit

Use as raceways for following applications:

- .1 In all areas exposed to weather.
- .2 Locations where mechanical damage may occur and in mechanical rooms to a height of 1 metre.
- .3 Three phase motor wiring (Teck cable may also be used for this application where shown on the drawings).

3.2 E.M.T. Conduit

- .1 Use as raceways for following applications:
 - .1 In surface and concealed areas or in poured concrete above ground level.
- .2 It may not be used in damp locations, corrosive atmosphere, underground, outdoors, nor in areas exposed to mechanical damage.

3.3 E.N.T. Conduit

- .1 Use as raceways for following applications:
-

-
- .1 In concrete floor slabs and where not subject to mechanical injury either during or after construction. Minimum size shall be 25mm (1")In surface and concealed areas or in poured concrete above ground level.

3.4 Rigid P.V.C. Conduit

- .1 Use as raceways for following applications
 - .1 In poured concrete floors and walls and on underground runs exterior to the buildings unless otherwise noted.
 - .2 Wiring installed in areas subject to intermittent or continuous moisture but not surface mounted.
 - .3 Rigid PVC conduit shall not be surface mounted.
- .2 Use strictly in accordance with the Canadian Electrical Code. Do not use in return air plenums and for exit and fire escape lights.
- .3 Provide insulated ground wire in all rigid PVC conduits in accordance with the Canadian Electrical Code.
- .4 Where rigid PVC conduit is set in poured concrete, solvent joints must be completed and allowed to set as per manufacturer's instructions.
- .5 Bend rigid conduit in strict accordance with manufacturer's directions. Distorted bends will not be accepted.

3.5 Rigid PVC Duct

- .1 Provide a separate green insulated copper ground wire in all ducts sized as required by the Code.
 - .2 Arrange ducts in a horizontal layer separated by plastic spacers to provide spacing between duct centres, as shown on the drawings.
 - .3 Support duct bank on plastic spacers 35 mm between ducts. Foundation spacers to maintain at least 76 mm clearance between ducts and exterior coverage.
 - .4 Make joints with tapered couplings to provide a secure watertight connection. Stagger all joints to provide 200 mm vertical and horizontal clearance between adjacent couplings. Where needed, use factory bends to provide bends of radius required.
 - .5 When all ducts are installed, brace whole assembly at each spacer group to prevent duct floating when concrete is placed.
 - .6 Terminate ducts with standard bell ends where ducts enter cable pits, junction boxes and building interiors.
 - .7 Cap ends of unused ducts with plug ends of same material as ducts.
-

-
- .8 Seal all joints in ducts with solvent cement.

3.6 Liquid-Tight Flexible Conduit

- .1 Use as raceways for following applications:
- .1 At all motors, pipe mounted control devices, and other devices subject to movement or water.
- .2 At all motors provide a short length before connecting to the motor terminal box. Minimum length shall be 450 mm plus 4 times the conduit diameter.
- .3 Provide a separate ground wire within flexible conduit, bonded to motor frames and system ground.

3.7 Workmanship

- .1 Install all conduit and wiring concealed, unless otherwise shown on the drawings. Do not recess conduit in columns, except as noted, without permission.
- .2 Where conduit is run exposed, run parallel to building lines. Where conduits are grouped (two or more), space evenly, make bends concentric.
- .3 Reuse existing concealed conduit in ceiling concrete slab as much as possible for feeding of power to lighting fixtures and to avoid surface run conduit as the existing slab will be exposed and there will be not dropped ceiling system.
- .4 Lay out conduit to avoid interference with other work. Maintain a minimum clearance of 150 mm from steam or hot water piping, vents, etc.
- .5 Slabs on grade: Install rigid PVC conduit in the gravel base below concrete slabs. Provide mechanical protection around stub-ups through slab and extend 150 mm beyond concrete. When rigid steel conduit is installed in contact with earth it shall be protected by Polykin #940 tape. Extend taping 300 mm above finished grade.
- .6 Metal conduit installations in concrete pours: Tie down conduit to prevent shifting. All joints are to be made up tight to ensure ground continuity. To prevent concrete entry, seal EMT set screw fittings with tape, pack outlet boxes and cap conduit terminations both in boxes and stub-ups. Apply Polykin #940 tape to the conduit 152 mm both sides of the point of leaving slab.
- .7 Do not place conduit in concrete slabs in which slab thickness is less than four times conduit diameter. Place conduits larger than this size under floor. Conduits to have minimum 25 mm concrete cover.
- .8 Organize conduit in slabs to minimize crossovers. Obtain approval and minimum concrete cover required from structural engineer prior to installing conduits in slabs.
- .9 At all recessed panels cap 2 - 25 mm and 4 - 19 mm empty conduits from panel into ceiling above future use.
-

-
- .10 Provide Brady underground warning tapes 300 mm below grade above all underground conduits. Tape shall be yellow warning tape, 150 mm wide.
 - .11 Where conduits or ducts enter or exit concrete structures below grade provide 16 mm x 1500 mm steel reinforcing dowels to prevent shearing. Extend dowel 1000 mm beyond concrete and band conduit to dowel. The first 3 meter length of conduit extending from the structure to be Polykin wrapped rigid steel.
 - .12 Where conduit is installed in floor slabs to run up at equipment or motors, carefully check all conduit locations. Verify conduit locations for mechanical equipment from shop drawings or detail drawings. Brace all stub-ups. Stub-ups shall be rigid steel.
 - .13 Where steel conduit is required to be bent, do not heat, and do not bend conduit in such a way as to reduce pipe cross section area at any point. Radii of bends shall be as per Canadian Electrical Code.
 - .14 For all runs of conduits, do not include more than equivalent of 4 - quarter bends. Provide conduit fittings, pullboxes and junction boxes where necessary. Pulling elbows shall not be used except by special permission.
 - .15 Where possible, install conduits so that they are not trapped, cap turned up conduits to prevent the entrance of dirt or moisture during construction. Swab out conduit and thoroughly clean internally before wires and cables are pulled.
 - .16 Take extreme care in reaming ends of all conduit to ensure a smooth interior finish that will not damage the insulation of the wires.
 - .17 Use insulated non-metallic bushings on all conduit terminations.
 - .18 Ensure electrical continuity in all conduit systems.
 - .19 All conduits shown exposed in finished areas is to be free of unnecessary labels and trade marks.
 - .20 Install a 90 lb. test line in all conduits left empty by this contractor including those which others will pull cables, wires, etc.
 - .21 Conduits and ducts crossing building expansion joints shall have conduit expansion fittings to suit the type of conduit used, and shall be Crouse-Hinds, Sceptre, or approved fitting.
 - .22 Seal conduits with duct seal where conduits are run between heated and unheated areas. Where conduits, cables, or cable trays pierce fire separations, seal openings with Dow Corning 3-6548 sealant or approved equal.
 - .23 Where conduits pass through walls, they shall be grouped and installed through openings. After all conduits shown on the drawings are installed, wall openings shall be closed with material compatible with the wall construction. Review size and quantity of conduit sleeves with the Consultant.
-

-
- .24 Where drawings show conduit designations, these conduits shall be identified at each point of termination with Thomas & Betts "Ty-Rap" No. TY532M labels.
 - .25 Where conduit finish is damaged, repair or replace.
 - .26 Use "Condulet" fittings for power and telephone type conduit terminations in lieu of boxes where support is not provided.
 - .27 All branch circuit wiring and home-runs to be a minimum of 19 mm and communication and data to be minimum 25 mm diameter unless otherwise stated.
 - .28 Where possible install conduit in equipment roof curbs. If roof penetrations are required, provide necessary flashing and pitch pockets, making watertight joints where conduits pass through roof or watertight membranes.
 - .29 Where panelboard branch circuit conduits are amalgamated, size shall not exceed 38 mm diameter.
 - .30 Where conduits pass through fire separations, seal with approved fire sealing compound.
 - .31 Maximum run of conduit shall not exceed 30 m. Provide pull boxes at a minimum of every 30 m.
 - .32 Allow no more than a maximum of two (2) 90 degree bends between pull boxes.
 - .33 All telecommunications conduits shall be bonded to ground.
 - .34 All conduit bends shall be sweep type bends with the inside radius not less than six (6) times the diameter for conduits 50 mm and smaller and ten (10) times the diameter for conduits 65 mm and larger.
 - .35 All conduits stubbed into telecom rooms shall be turned up or down as appropriate and terminated at the edge of the plywood backboards. Terminate conduit stubs with an insulated grounding bushing and cap.

4. Provide a separate ground conductor in each conduit.

END OF SECTION

1. GENERAL

1.1 Work Included

- .1 Provide complete system of underground ducts, fittings and turn-ups for the installation indicated on the drawings.

1.2 Related Work

- .1 Excavation and backfilling: Division 2
- .2 Concrete Work: Division 3
- .3 Plumbing and Drainage: Division 3

1.3 Waste Management and Disposal

- .1 Refer to Section 26 05 00 11 – Electrical General Requirements.

2. Products

2.1 Rigid P.V.C. Duct

- .1 Duct: Rigid non-metallic conduit of unplasticized polyvinyl chloride type EB-1 requiring concrete encasement, type DB-2 heavier wall for direct burial without concrete encasement, conforming to CSA Standard B196.1, manufactured by Canron Plastics Ltd, or IPEX inc. Nominal length 6 m plus or minus 12 mm with minimum wall thickness at any point of 3.0 mm.
- .2 Accessories: Bell ends, couplings, reducers, plugs, caps, adaptors, bends and other fittings of same materials as duct. Use solvent weld compound as recommended by manufacturer. Horizontal, vertical and foundation spacers as manufactured by IPEX inc.
- .3 Expansion Joints as required.

2.2 Cable Pulling Equipment

- .1 6 mm stranded nylon pull rope tensile strength 5 kN.

2.3 Duct Spacers

- .1 Plastic spacers to suit installation shown, manufactured by IPEX. Minimum distance between conduits shall be 190mm centre-to-centre.

2.4 Markers

- .1 Concrete type cable markers: As indicated, with words; “cable”, “joint” or “conduit” impressed in top surface, with arrows to indicate change in direction of duct runs.
-

2.5 Solvents

- .1 Solvent: Solvents to have Volatile Organic Compound (VOC) limits of less than 285g/L less water and less exempt compounds as per the State of California's South Coast Air Quality Management District (SCAQMD) current edition.

3. **Execution**

- .1 Install underground ducts for wiring systems as shown on the drawings and as per manufacturer's instructions.
 - .2 Clean inside of duct before laying.
 - .3 Provide a separate green insulated copper ground wire in all ducts, even if not shown, except for conduits from a utility transformer into service entrance equipment. Use Canadian Electrical Code to size ground wire.
 - .4 Furnish minimum of 85% of total footage of each size in standard lengths of 6 meters or 3 meters. Remainder of each size may be furnished in random lengths, but not less than 1.5 meters.
 - .5 Arrange ducts in horizontal layers separated by plastic spacers to provide horizontal and vertical spacing between duct centres, as shown on drawings. Stack spacers vertically above each other and install in at least two groups per 10' length of duct. Minimum distance between conduits shall be 190mm centre-to-centre.
 - .6 Support duct bank on plastic foundation spacers on same centre lines as tier separators. Foundation spacers to maintain at least 75 mm clearance between ducts and trench bottom or mud mat. Ensure full, even support every 1.5 m throughout duct length.
 - .7 Make joints with tapered couplings to provide a secure watertight connection. At locations where coupling is loosely fitted to produce a slight change of direction of the duct run, thoroughly waterproof joint with a coating of solvent compound. Stagger all joints to provide 200 mm vertical and horizontal clearance between adjacent couplings. Where needed, use bender to provide bends of radius required.
 - .8 Make bell and spigot joints. Drive ducts together as recommended by manufacturer to produce a solid watertight connection. Stagger all joints to provide 200 mm vertical and horizontal clearance between adjacent couplings. Where needed, use manufactured bends to provide bends of radius required.
 - .9 When all ducts are installed, brace whole assembly at each spacer group to prevent duct floating when concrete is placed.
 - .10 Use adaptors and connect duct to a 90-degree rigid, heavy-wall, steel conduit bend where conduit rises above ground.
 - .11 Terminate ducts with standard bell ends where ducts enter manholes, cable pits, junction boxes and building interiors.
-

-
- .12 Pull through each duct steel, wooden or plastic mandrel not less than 300 mm long and of diameter 6 mm less than the internal diameter of duct, following by stiff bristle brush to remove sand, earth and other foreign matter. Pull stiff bristle brush through each duct immediately before pulling in cables.
 - .13 In each duct install pull rope continuous throughout each duct run with 3 m spare rope at each end.
 - .14 Plug ends of unused spare ducts with plugs of same material as ducts.
 - .15 Seal all joints in ducts with solvent cement.
 - .16 Install marker as required.
 - .17 Ensure lines and levels for underground ducts are set to obtain proper drainage, coverage, separation, etc. Ensure such conditions are met prior to proceeding with work.
 - .18 Construct duct runs to provide at least 750 mm from top of concrete encasement to finished surface above. Grade duct runs between manholes, vaults, cable pits and buildings to ensure proper drainage. Minimum slope shall be 75 mm per 30 m. Provide grades and slopes shown on drawings. Depths of cover shown on electrical drawings are minimum; greater depths may result from grading of ducts.
 - .19 Install ducts in accordance with additional requirements of utility or service company having jurisdiction.

END OF SECTION

1. GENERAL

1.1 Related Work

- .1 Excavation and Backfilling: Division 02

1.2 Waste Management and Disposal

- .1 Refer to Section 26 05 00 11 – Electrical General Requirements.

2. PRODUCTS

2.1 Cable Protection

- .1 38 x 140 mm planks pressure treated with clear copper naphenate or 5% pentachlorophenol solution, water repellent preservative.

2.2 Markers

- .1 Concrete type cable markers: 600 x 600 x 100 mm with words: “cable”, “joint” or “conduit” impressed in top surface, with arrows to indicate change in direction of cable and duct runs.

3. EXECUTION

3.1 Cable Installation in Ducts

- .1 Install cables as indicated in ducts.
- .2 Do not pull spliced cables inside ducts.
- .3 Install multiple cables in duct simultaneously.
- .4 Use CSA approved lubricants of type compatible with cable jacket to reduce pulling tension.
- .5 To facilitate matching of colour coded multiconductor control cables reel off in same direction during installation.
- .6 Before pulling cable into ducts and until cables properly terminated, seal ends of cables with moisture seal tape.
- .7 After installation of cables, seal duct ends with duct sealing compound.

3.2 Markers

- .1 Mark cable every 150 m along duct runs and changes in direction.
- .2 Where markers are removed to permit installation of additional cables, reinstall existing markers.
-

3.3 Field Quality Control

- .1 Perform tests in accordance with Section 26 08 00 11 - Testing, Adjusting and Balancing of Electrical Equipment and Systems.
- .2 Perform tests using qualified personnel. Provide necessary instruments and equipment.
- .3 Check phase rotation and identify each phase conductor of each feeder.
- .4 Check each feeder for continuity, short circuits and grounds. Ensure resistance to ground of circuits is not less than 50 megohms.
- .5 Pre-acceptance test.
 - .1 After installing cable but before splicing and terminating, perform insulation resistance test with 1000 V megger on each phase conductor.
 - .2 Check insulation resistance after each splice and/or termination to ensure that cable system is ready for acceptance testing.
- .6 Acceptance Tests
 - .1 Ensure that terminations and accessory equipment are disconnected.
 - .2 Ground shields, ground wires, metallic armour and conductors not under test.
 - .3 High Potential (Hipot) Testing.
 - .1 Conduct hipot testing in accordance with manufacturer's recommendations.
 - .4 Provide Consultant with list of test results showing location at which each test was made, circuit tested and result of each test.

4. Remove and replace entire length of cable if cable fails to meet any of test criteria.

END OF SECTION

1. GENERAL

1.1 Related Work

.1 Testing, Adjusting and Balancing of Electrical Equipment
and Systems Section 26 08 00 11

.2 Electrical Equipment and Systems Demonstration and
Instruction Section 26 08 00 12

1.2 Coordination

.1 Coordinate starting of electrical equipment and systems with testing, adjusting and
balancing, and demonstration and instruction of:

.1 Electrical equipment and systems specified in Division 26.

.2 Mechanical equipment and systems specified in Division 21, 22 and 23.

.3 Other equipment and systems specified in other Divisions.

.2 Where any equipment or system requires testing, adjusting or balancing prior to starting,
ensure that such work has been completed prior to starting of electrical equipment and
systems.

2. products

(Not used)

3. execution

3.1 Energizing Electrical System

.1 Prior to energizing main electrical system:

.1 Verify supply authority voltage and phase rotation.

.2 Close and open all devices to ensure proper mechanical operation.

3.2 Starting Motors

.1 Prior to starting motors:

.1 Verify phase rotation at motor control centres.

.2 Confirm motor nameplate data with motor starter heater overloads.

3.3 Energizing Equipment

- .1 Prior to energizing equipment provided under other Sections and equipment provided by others. Confirm equipment nameplate data with characteristics of power supply.

END OF SECTION

- ## PART 1 - GENERAL

- .2 If requirements of any of the foregoing conflict, notify Consultant before proceeding with test and obtain clarification.

1.6 Manufacturer's Site Services

- .1 Arrange and pay for the site services of qualified manufacturer's representatives where site testing, adjusting, or balancing of electrical equipment or systems' performed by Manufacturer's representatives is:
 - .1 Specified, or
 - .2 Otherwise required to ensure that electrical equipment and systems are operational in full compliance with the Contract Documents

1.7 Sequencing and Scheduling

- .1 Except where otherwise specified, perform all testing, adjusting, balancing and related requirements specified herein prior to Interim Acceptance of the Work.
- .2 Perform voltage testing and adjusting after user occupancy or utilization of facility.

PART 2 - PRODUCTS

2.1 Test Equipment

- .1 Provide all equipment and tools necessary to perform testing, adjusting and balancing specified herein and as otherwise required.

PART 3 - EXECUTION

3.1 Fused and Unfused Disconnect Switches

- .1 Visually inspect and clean.
- .2 Ductor test across switch blade contact surfaces.
- .3 Megger test.
- .4 Mechanical function test.

3.2 Lighting

- .1 Function test all light switches, luminaires, dimmers and lighting control equipment such as photo-cells, daylight sensors, occupancy sensors and time clock settings.
- .2 Prior to energizing line and low voltage lighting control system, ensure manufacturer has checked all equipment and wiring for proper installation and termination. Manufacturer to check that all pre-set levels are set and operate as specified.
- .3 Check operation of all emergency lighting units and exit lights.

-
- .4 Record all settings for all lighting control devices such as time clock, sensors, etc.

3.3 Communications Cabling

- .1 Check installation of all equipment.
- .2 Ensure all cables are properly identified at each end and correctly terminated prior to testing.

3.4 Testing of Wiring and Wiring Devices

- .1 Test conductors at distribution centres and panelboards for insulation resistance to ground (megger test).
- .2 Test service grounding conductors for ground resistance.
- .3 Test all wiring devices for correct operation and circuitry.

3.5 Communication Cabling Testing

- .1 Test all runs upon completion of permanent terminations as described in Section 27 10 05.

.

3.6 Fire Alarm System Testing - General

- .1 Refer to Section 26 05 00 11 - Electrical General Requirements.
- .2 Consultant will be responsible for directing verification of fire alarm system installation in accordance with:
 - .1 CAN/ULC-S537, Standard for Verification of Fire Alarm System Installations, and Requirements of authority having jurisdiction.
- .3 Contractor shall be responsible for:
 - .1 Performing prerequisites to verification procedure; and
 - .2 Assisting and cooperating with Consultant in verification procedure

3.7 Fire Alarm System Testing - Prerequisites to Verification

- .1 Prior to requesting verification by Consultant, do the following:
 - .1 Inspect system to ensure that the following items are completely installed, connected and fully operational in accordance with requirements of the Contract Documents and Manufacturer's recommendations:
 - .1 All new fire detection and signaling devices
 - .2 All other auxiliary equipment connected to fire alarm system

-
- .2 Ensure that operation and maintenance data has been submitted.
 - .2 Submit written request to Consultant for verification, certifying that the above prerequisites have been fulfilled and specifying known exceptions in the form of a list of items to be completed, corrected or submitted.
 - .3 Consultant will, within two (2) weeks after receipt of written request:
 - .1 Proceed with verification, or
 - .2 Advise contractor that prerequisites are not adequately fulfilled

3.8 Fire Alarm System Testing - Verification

- .1 The contractor and manufacturer shall assist and cooperate with Consultant in verification procedure. The contractor shall provide and pay for the following:
 - .1 Provide the following equipment:
 - .1 Voltmeter
 - .2 Sound pressure level meter
 - .3 Smoke generator or aerosol test smoke
 - .4 Four (4) portable communication devices
 - .5 Scaffolding and ladders
 - .6 Heat Bucket for setting off heat detectors
 - .2 Arrange and ensure that the following parties are present at all times during verification procedures:
 - .1 Electrical Subcontractor
 - .2 Fire alarm system manufacturer's representative
 - .3 Disassemble and reassemble system components
 - .4 Disconnect and reconnect wiring
 - .5 Perform required field adjustments
 - .6 Repair defective work and replace defective components
 - .7 Perform all work and tests on system required by verification procedure.
- .2 Do not proceed with verification unless Consultant's representative responsible for directing verification procedure is present.

END OF SECTION

1. general**1.1 Description**

- .1 Provide disconnect switches for 120/208 volt distribution as indicated on the drawings, as manufactured by Cutler Hammer, Schnieder or Square D.

1.2 Waste Management and Disposal

- .1 Refer to Section 26 05 00 11 – Electrical General Requirements.

2. products**2.1 Disconnect Switches**

- .1 Ratings: 240 volts for 120/208 volt distribution. Unless otherwise shown, 3 pole for 3 phase, 3 wire distribution, 3 pole and solid neutral for 3 phase 4 wire distribution. Ampere ratings as shown on the drawings or to suit load requirements. For motors, use disconnect switches with HP ratings at least equal to motor HP.
- .2 Enclosures: CSA code gauge galvanized steel, hinged doors, external operating handles. Disconnect switches in dry locations shall be EEMAC-1 and EEMAC-3 where exposed to weather. Provide ON-OFF switch position indication on switch enclosure cover.
- .3 Finish: One primer coat and one finish coat on all metal surfaces, colours as per Section 26 05 00 11 - Electrical General Requirements.
- .4 Switch mechanisms: Quick make and quick break action with self wiping contacts, solderless pressure lug connectors. For switches 100 amperes and over, provide non-tracking arc shrouds. All switch poles to operate together from a common operating bar. Provide for padlocking disconnect switches in "Off" position. Doors to be interlocked and complete with defeat mechanism, to prevent opening when handle in ON position.
- .5 Neutral Bars: Where distribution system has grounded neutral conductor, provide neutral bar where required with ampere rating equal to switch rating, in enclosure. Provide ground bar for terminating ground conductors.
- .6 Fuse Holders: Provide fuse holders (relocatable and suitable without adapters) on load side of switches, ampere rating equal to switch ratings, suitable for fuses specified.

2.2 Fuses

- .1 All fuses to be 100,000 ampere (minimum) interrupting capacity of the current limiting type. In addition, fuses feeding motors to be of the time delay type. Provide one full set of spare fuses, three for each different ampere rating used, stored in suitable enclosure.

3. execution

3.1 Disconnect Switches

- .1 Mounting: Provide supports independent of conduits. Wall mounts where possible, otherwise provide Unistrut frame support. Where switches are grouped, mount in uniform arrangement.
- .2 Wiring: Connect line and load cable to all switches.
- .3 Fuse Rating: Install so that rating is visible.
- .4 Identification: Provide lamacoid plate in accordance with Section 26 05 00 11 - Electrical General Requirements, on each switch showing voltage, source of supply and load being fed, for example:
 - .1 Door Controller
 - .2 120/208 Volts
 - .3 Fed from PPA

END OF SECTION

1. General

1.1 Related Work

- .1 Rough Carpentry - Fire Rated Plywood Backboard Division 26

1.2 Shop Drawings

- .1 Submit shop drawings in accordance with Section 26 05 00 11 - Electrical General Requirements.
- .2 Drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.

1.3 Waste Management and Disposal

- .1 Refer to Section 26 05 00 11 – Electrical General Requirements.

2. Products

2.1 Panelboards

- .1 Panelboards: product of one manufacturer.
- .1 Install circuit breakers in panelboards before shipment.
- .2 In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.
- .2 208V panelboards: bus and breakers rated interrupting capacity as indicated on drawings.
- .3 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.
- .4 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.
- .5 Two keys for each panelboard and key panelboards alike.
- .6 Copper bus with neutral of same ampere rating as mains.
- .7 Mains: suitable for bolt-on breakers.
- .8 Trim with concealed front bolts and hinges.
- .9 Trim and door finish: baked grey enamel.

2.2 Custom Built Panelboard Assemblies

- .1 Double stack panels as indicated.
- .2 Contactors in mains as indicated.
- .3 Feed through lugs as indicated.
- .4 Isolated ground bus.

2.3 Breakers

- .1 Breakers: to Section 26 24 16 10 - Moulded Case Circuit Breakers.
- .2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.
- .3 Main breaker: separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.
- .4 Lock-on devices for 10% of 15 to 30A breakers installed as indicated. Turn over unused lock-on devices to Owner.

2.4 Equipment Identification

- .1 Provide equipment identification in accordance with Section 26 05 00 11 - Electrical General Requirements.
- .2 Nameplate for each panelboard size 4 engraved as indicated.
- .3 Nameplate for each circuit in distribution panelboards size 2 engraved as indicated.
- .4 Complete circuit directory with typewritten legend showing location and load of each circuit.

3. **Execution**

3.1 Installation

- .1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.
- .2 Install surface mounted panelboards on plywood backboards. Where practical, group panelboards on common backboard.
- .3 Mount panelboards to height specified in Section 26 05 00 11 - Electrical General Requirements or as indicated.
- .4 Connect loads to circuits.

-
- .5 Connect neutral conductors to common neutral bus with respective neutral identified.

END OF SECTION

1. GENERAL

1.1 Description

- .1 This section covers the providing and installation of distribution panelboards.

1.2 Related Documents

- .1 All sections of the Bidding Requirements, contract Conditions and Division 1 are part of this section.
- .2 Applicable sections of Division 16 are part of this section of the Specifications.

2. PRODUCTS

2.1 Panelboards, Circuit Breaker Type, 208/120 Volt, 3 Phase 4 Wire

- .1 Manufacturers: Square D, Siemens, General Electric, or Cutler-Hammer
- .2 Shall be dead front type with flush or surface mounted steel cabinet as required and an internal assembly of circuit breakers. Trims shall have hinged and locked doors with glass or heavy plastic covered circuit directories. All locks shall be keyed alike. Boxes shall be galvanized, and front assembly shall be painted with a prime and a finish coat of manufacturer=s standard finish. Panels shall have 3 phase, 4 Wire, solid neutral mains of capacities indicated on the Drawings with main lugs or main circuit breaker as required.
- .3 Panelboards shall have suitable gutter space to accommodate separate neutrals conductors for all branch circuits.
- .4 Circuit breakers shall be molded plastic case type, quick-make, quick-break, with trip free common operating handle, position indication and common trip from thermal-magnetic trip device. Trip ratings shall be as indicated on the Drawings and minimum interrupting capacity shall be 22,000 RMS symmetrical amperes at 240 volts.

2.2 Distribution Switchboards

- .1 Manufacturers: Square D, Siemens, General Electric, or Cutler-Hammer
- .2 Ratings
- .1 The assembly shall be rated to withstand mechanical forces exerted during short-circuit conditions when connected directly to a power source having available fault current 65,000 amperes symmetrical at 240 volts.
- .2 The switchboard shall operate at 208 volts a.c., three-phase, four-wire. The main bus shall be rated as noted on the drawings. Each switchboard shall have both a neutral and ground bar

.3 Construction

- .1 Switchboards shall consist of the required number of vertical sections bolted together to form a rigid assembly. All edges of front covers or hinged front panels shall be formed. Provide adequate ventilation within the enclosure
- .2 All sections of the switchboard shall be front and rear aligned. All protective devices shall be group mounted. Devices shall be front removable and load connections front accessible.
- .3 The assembly shall be provided with adequate lifting means.

.4 Bus

- .1 All bus bars shall be silver-plated copper. Main horizontal bus bars shall be mounted with all three phases arranged in the same vertical plane. Bus sizing shall be based on NEMA standard temperature rise criteria of 65 degrees C over a 40 degrees C ambient (outside the enclosure).
- .2 A copper ground bus (minimum 1/4 x 2 inch), shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchboard.
- .3 All hardware used on conductors shall be high-tensile strength and zinc-plated. All bus joints shall be provided with conical spring-type washers.

.5 Wiring/Terminations

- .1 Mechanical-type terminals shall be provided for all line and load terminations suitable for copper or aluminum cable rated for 75 degrees C of the size as indicated on the drawings.
- .2 Lugs shall be provided in the incoming line section for connection of the main grounding conductor. Additional lugs for connection of other grounding conductors shall be provided as indicated on the drawings.
- .3 Each switchboard shall have a neutral bar with incoming terminations equal to the phase terminations and load side terminations equal to the terminations of the switchboard load switches.

.6 Quick-Make/Quick-Break Fusible Switches

- .1 Protective devices shall be quick-make/quick-break fusible switches. Fusible switches 30 amperes through 600 amperes frames shall be furnished with rejection class "R" or "J" type fuse clips unless otherwise scheduled. Fusible switches 800 amperes through 1600 amperes shall be furnished with class L fuse clips. Switches shall incorporate safety cover interlocks to prevent opening the cover with the switch in the ON position or prevent placing the switch in the ON position with the cover open. Provide defeater for authorized personnel. Handles

shall have provisions for padlocking and shall clearly indicate the ON or OFF position. Front cover doors shall be padlockable in the closed position.

.7 Circuit Breakers

- .1 Circuit breakers shall be molded plastic case type, quick-make, quick-break, with trip free common operating handle, position indication and common trip from thermal-magnetic trip device. Trip ratings shall be as indicated on the Drawings and minimum interrupting capacity shall be 65,000 RMS symmetrical amperes at 240 volts.

.8 Enclosures

- .1 NEMA 1 Enclosure

.9 Nameplates

- .1 Engraved nameplates, mounted on the face of the assembly, shall be furnished for all main and feeder circuits as indicated on the drawings. Nameplates shall be laminated plastic, black characters on white background. Characters shall be 3/16-inch high, minimum. Nameplates shall give item designation and circuit number as well as frame ampere size and appropriate trip rating. Furnish master nameplate giving switchboard designation, voltage ampere rating, short-circuit rating, manufacturer's name, general order number, and item number.

.10 Finish

- .1 All exterior and interior steel surfaces of the switchboard shall be properly cleaned and provided with a rust-inhibiting phosphatized coating.

.11 Metering

- .1 Each switchboard shall have a microprocessor based meter installed complete with current transformers. The meter shall read and display all line-to-line and line-to-neutral voltages, current in each phase, power factor, power in kW, apparent power in kVA, kW demand, current peak demand, kW peak demand, kVA peak demand. The demand time shall be adjustable and the peak demand readings shall be resettable with a password. The unit shall be able to communicate via Ethernet. Provide three licensed copies of any software required to read the meter.
- .2 A terminal strip shall be provided for the termination of the data cable.
- .3 The meter shall be powered from the 208 volts in the switchboard.

.4 Provide a disconnect means to disconnect the phase leads to the meter from the power source.

.5 Provide fuses in a fuse holder for the power into the meter.

2.3 Fuses

.1 Fuses shall be Bussman, Low Peak sized according to the drawings.

.2 Provide three spare fuses of each size and type.

3. EXECUTION

3.1 Installation

.1 Panelboards shall be surface mounted in electrical rooms or flush mounted where indicated on plan drawings.

.2 Mount panelboards directly to concrete walls.

.3 Mount panelboards to finished walls using unistrut channels, minimum two channels per box.

.4 Install panelboards plumb and level.

.5 Install all switchboards on 4" concrete housekeeping pads.

3.2 Grounding

.1 Bond all panelboards per N.E.C.

3.3 Identification

.1 Provide name plates.

.2 Paint panelboards.

3.4 Fault And Coordination Study

.1 The manufacturer of the switchboards shall provide a fault and coordination study of the distribution system down to the load side of all distribution panels. The manufacturer shall use this study to select fuses and circuit breakers so that they coordinate. This study shall be provided with the shop drawing submittals. The engineer reserves the right to request changes in the devices at shop drawing time.

END OF SECTION

PART 1 - GENERAL

1.1 Product Data

- .1 Submit product data in accordance with Section 26 05 00 11 - Electrical General Requirements.
- .2 Include time-current characteristic curves for breakers with interrupting capacity of 22,000 A symmetrical (rms) and over at system voltage.

1.2 Waste Management and Disposal

- .1 Refer to Section 26 05 00 11– Electrical General Requirements.

PART 2 - PRODUCTS

2.1 Breakers General

- .1 Bolt-On Moulded Case Circuit Breaker: Quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40°C ambient.
- .2 Common-Trip Breakers: With single handle for multi-pole applications.
- .3 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting. Trip settings on breakers with adjustable trips to range from 3 to 8 times current rating.
- .4 Circuit breakers with interchangeable trips as indicated.
- .5 Provide solid-state tripping system for all breakers larger than 225 amps with long, short, instantaneous function and ground fault protection.

2.2 Thermal Magnetic Breakers

- .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.

2.3 Optional Features

- .1 Include where indicated on drawings:
 - .1 Shunt trip.
 - .2 Auxiliary switch.
 - .3 On-off locking device
 - .4 Handle mechanism.
 - .5 Non-auto.

PART 3 - EXECUTION

3.1 Installation

- .1 Install circuit breakers as indicated.
- .2 Identification: Provide lamicoid plate on CDP cover housing the breaker showing voltage and load being fed. Example - 120/208 V, 3 phase, 4W to Splitter Trough No. 1.

END OF SECTION

1. General

1.1 References

- .1 IEC 947-4-1, Part 4: Contactors and motor-starters.

1.2 Related Work

- .1 Connections to Mechanical Equipment Section 26 24 19 23

1.3 Starter Requirements

- .1 In general, there are categories of starting equipment for three phase motors.
 - .1 Integral Mounted Starters: Some items of mechanical equipment such as boilers, have the starter mounted as part of the equipment. For this equipment, supply disconnects and wire to the terminals of the equipment.
 - .2 Separately Mounted Starters: For motors without integral mounted starters, supply separately mounted starters as indicated on the Drawings and wire the equipment.
- .2 Provide manual starters for all single phase motors unless otherwise indicated on the motor schedule.
- .3 Provide interlocking between starters where required.
- .4 All starter accessories such as pilot lights, Hand-Off-Auto, Start-Stop, etc. whether integrally or remote mounted shall be heavy duty oil tight, unless otherwise specified.

1.4 Shop Drawings and Product Data

- .1 Submit shop drawings in accordance with Section 26 05 00 11 - Electrical General Requirements.
- .2 Indicate:
 - .1 Mounting method and dimensions.
 - .2 Starter size and type.
 - .3 Layout of identified internal and front panel components.
 - .4 Enclosure types.
 - .5 Wiring diagram for each type of starter.
 - .6 Interconnection diagrams.

1.5 Operation and Maintenance Data

- .1 Provide operation and maintenance data for motor starters for incorporation into manual specified in Section 26 05 00 11 - Electrical General requirements.
- .2 Include operation and maintenance data for each type and style of starter.

1.6 Maintenance Materials

- .1 Provide maintenance materials in accordance with Division 01 Maintenance Materials, Special Tools and Spare Parts.
- .2 Provide listed spare parts for each different size and type of starter:
 - .1 3 contacts, stationary.
 - .2 3 contacts, movable.
 - .3 1 contacts, auxiliary.
 - .4 1 control transformer[s].
 - .5 1 operating coil.
 - .6 2 fuses.
 - .7 10% indicating lamp bulbs used.
 - .8 1 spare starter c/w wrapper for each size used.

1.7 Waste Management and Disposal

- .1 Refer to Section 26 05 00 11 – Electrical General Requirements.

2. **Products**

2.1 Materials

- .1 Starters: to IEC 947-4 with AC4 utilization category.
- .2 Starter to be supplied by Westinghouse, Cutler Hammer, Square D or Allen Bradley.

2.2 Enclosure

- .1 All individually mounted motor starters shall be enclosed in a general purpose sheet steel enclosure unless in wet areas where they shall be watertight EEMAC 4.
- .2 For all motors 22.4 KW and above, the starters shall contain thermistor control relay and accessories.

2.3 Manual Motor Starters

- .1 Manual motor starters of size, type, rating, and enclosure type as indicated, with components as follows:
 - .1 Switching mechanism, quick make and break.
 - .2 Overload heaters, manual reset, trip indicating handle.
 - .3 Rated volts and poles to suit application.
- .2 Accessories:
 - .1 Toggle switch: heavy duty labeled as indicated.
 - .2 Indicating lights: heavy duty type and colour as indicated.
 - .3 Locking tab to permit padlocking in "ON" or "OFF" position.

2.4 Full Voltage Non Reversing (FVNR) Magnetic Starters

- .1 Combination magnetic starters of size, type, rating and enclosure type as indicated with components as follows:
 - .1 Contactor solenoid operated, rapid action type.
 - .2 Motor overload protective device in each phase, manually reset from outside enclosure.
 - .3 Wiring and schematic diagram inside starter enclosure in visible location.
 - .4 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.
- .2 Combination type starters to include circuit breaker with operating lever on outside of enclosure to control circuit breaker, and provision for:
 - .1 Locking in "OFF" position with up to 3 padlocks.
 - .2 Independent locking of enclosure door.
 - .3 Provision for preventing switching to "ON" position while enclosure door open.
- .3 Accessories:
 - .1 HOA Selector switches: heavy duty labeled as indicated. Reset button, convertible to off/auto or stop/start.

- .2 Indicating lights: heavy duty type and red pilot light to indicate energized motor circuit and where called for, green pilot light to indicate de-energized motor circuit. Pilot lights to be push-to-test transformer type.
- .3 In addition to standard, 2-N/O and 2-N/C spare auxiliary contacts unless otherwise indicated.
- .4 Control transformer 120 V of sufficient VA to handle coil and associated controls.
- .5 120 V holding coil.

2.5 Control Transformer

- .1 A control transformer of sufficient VA capacity, dry type, with primary voltage as indicated and 120V secondary, complete with primary and secondary fuses (HRC Form J), installed in with starter as indicated.
- .2 Size control transformer for control circuit load plus 20% spare capacity.

2.6 Finishes

- .1 Apply finishes to enclosure in accordance with Section 26 05 00 11 - Electrical General Requirements.

2.7 Equipment Identification

- .1 Provide equipment identification in accordance with Section 26 05 00 11 - Electrical General Requirements.
- .2 Manual starter designation label, white plate, black letters, size 1, engraved as indicated.
- .3 Magnetic starter designation label, white plate, black letters, engraved as indicated.

3. Execution

3.1 Installation

- .1 Install starters, connect power and control as indicated.
- .2 Ensure correct fuses and overload devices elements installed.

3.2 Starter Verification

- .1 Field check motor starters supplied prior to commissioning equipment. As a minimum, verify the following:
 - .1 Check of control circuits

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

3.3 Overload Relays

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

3.4 Field Quality Control

- .1 Perform tests in accordance with Section 26 08 00 11 - Testing, Adjusting and Balancing of Electrical Equipment and Systems and manufacturer's instructions.
- .2 Operate switches, 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.

END OF SECTION

1. GENERAL

1.1 Related Work

- .1 Mechanical Division 21, 22 and 23
- .2 Motor Starters Section 26 24 19 22

1.2 Requirements

- .1 Provide a complete system of wiring to motors and controls as specified herein and as shown on the drawings.
- .2 Unless specifically noted otherwise, wire and leave in operation all electrically operated equipment supplied under all contracts related to this project. Examine the drawings and shop drawings of all Divisions for the extent of electrically operated equipment supplied under other contracts.
- .3 All control wiring diagrams shown on the drawings illustrate typical control circuits applicable to the equipment. Control circuits may vary with different manufacturers of equipment. Verify all control circuits with the suppliers of the equipment and make any corrections that may be required.
- .4 Unless specifically noted otherwise, supply all pushbuttons, relays, starters, etc., necessary for the operation of equipment. Check all starters, relay coils and thermal elements to ensure that they provide the necessary protection for motors.
- .5 Do not operate motors and controls until approval is obtained from the trade providing equipment.
- .6 Examine drawings and shop drawings of other Divisions to obtain exact location of motors and equipment shown on drawings. Where necessary, obtain conduit locations from other trades' drawings and shop drawings.
- .7 Assist in placing in operation all mechanical equipment having electrical connections.
- .8 Provide three phase starters with fused 120 volt control transformers and overload relays.
- .9 Provide all power wiring for all motors and control wiring as indicated on the drawings.
- .10 In general, wiring for freezestats, firestats, E.P. switches, P.E. switches, dampers, temperature controllers, flow switches, solenoid valves, etc., for heating ventilating and air conditioning equipment will be under a separate contract. Provide terminations in starters and MCC's for control wiring so that starter control circuits may be extended. Where 120 volt power is required for mechanical equipment, i.e. roll type filters, refrigerated aftercoolers, control cabinets, etc. wiring to the equipment terminals is the work of this Division.

.11 Refer to Motor Control Equipment Schedule.

.12 Some specific definitions of equipment wiring responsibilities are as follows:

.1 Fans

.1 Provide all 120V and 208V power wiring. Except where specifically noted otherwise, all control for fans is to be supplied, installed and wired from the starter control circuits to the equipment under Division 21, 22 and 23. Fire alarm and smoke detection systems shall be wired to shut down fans by this Division.

2. products

2.1 3 Phase Motor Disconnect Switches

.1 Industrial Type "A", having quick make, quick break visible blade mechanism, cover interlocks and padlocking switch in the closed or open position. Use EEMAC 4 enclosures outdoors, and EEMAC 1 indoors switches to be H.P. rated, Westinghouse heavy duty type.

2.2 120 Volt, 1 Phase Disconnect Switches

.1 Manual starter without overload relay.

3. execution

3.1 Installation

.1 Provide disconnect switches adjacent to all motors.

.2 Provide all wiring between all force flow and unit heaters and their thermostats. Install wiring between all flow switches and valve monitors and the fire alarm panel.

.3 Do control wiring as indicated on the drawings and the motor control schedules.

END OF SECTION

1 General

1.1 Related Work

1.1.1 General Electrical Requirements Section 26 05 00 11

1.1.2 Exit Lights Section 26 53 00

1.2 Documents

1.2.1 This section of the specifications forms part of the Contract Document and is to be read, interpreted, and co-ordinated with all other parts.

1.3 Work Includes

1.3.1 Supply and installation of luminaires complete with supports and accessories, and for the supply and installation of plaster frames, trim rings and back boxes for plaster or dry wall ceilings or concrete. The luminaire schedule is shown on the drawings.

1.4 General Requirements

1.4.1 All lighting fixtures will be purchased by the Contractor unless noted otherwise. Include in the tender price administration of all shop drawings, receiving fixtures on site, uncrating of all the lighting fixtures and clean up.

1.4.2 Install lighting as shown on Architectural and Electrical Drawings and as indicated in Contract Documents.

1.4.3 Provide and install all materials, components, and services necessary for a complete power and distribution system for lighting.

1.4.4 Substitutions for the specified lighting products are not acceptable and will not be considered. Failure to include one of these specified products as part of the Base Bid may, at the discretion of the Owner, invalidate the entire lighting product bid and exclude the contractor from further consideration.

1.4.5 Within seven (7) working days of contract award, successful Contractor shall submit a complete list of lighting products he intends on furnishing with manufacturer and catalogue designations, along with currently quoted lead times for delivery of same. Should the Contractor anticipate that the delivery schedule of any specified product may adversely impact the construction schedule, he shall bring it to the attention of the Owner at this time.

1.5 Related Sections

1.5.1 Section 26 05 00 11: General Electrical Provisions

1.5.2 Section 26 05 33: Conduits, Conduit Fastenings, and Conduit Fittings

1.5.3 Section 26 05 19: Wires and Cables

1.5.4 Section 26 05 32: Outlet Boxes, Conduit Boxes, and Fittings

1.5.5 Section 26 05 19 11: Wiring Devices

1.5.6 Section 26 05 29: Fastenings and Supports

1.6 References

1.6.1 National Fire Protection Association (NFPA) Standard, current edition.

1.6.2 Underwriters' Laboratories Canada (ULC).

1.6.3 Illuminating Engineering Society of North America (IES).

1.6.4 Canadian Standards Association (CSA).

1.6.5 CGSB 31-GP-103Ma, heavy Phosphate conversion coatings for Iron and Steel (for Corrosion Resistance).

1.6.6 CGSB 31-GP-105Ma, Zinc Phosphate Conversion Coatings for Paint Base.

1.6.7 CGSB 31-GP-106M, coating, Conversion, Iron Phosphate, for Paint Base.

1.6.8 Installation of lighting equipment to conform to the current edition of the Canadian Electrical Code as amended and supplemented by provincial, municipal or other regulatory agencies having jurisdiction.

1.6.9 Luminaires to conform to CSA C22.2 No. 9, ballasts to CSA C22.2 No. 74, ANSI C82.1 and lamps.

1.7 Submittals, Shop Drawings, and Product Data

1.7.1 Submittals

1.7.1.1 Submit shop drawings, samples and product data in accordance with Section 26 05 00 11 General.

1.7.1.2 Provide the required number of submittals promptly and deliver through appropriate channels, leaving sufficient time for adequate review and possible resubmittals without jeopardizing Project Schedule.

1.7.1.3 Contractor is responsible for all verification and actual field dimensions, quantities, co-ordination, and compliance with Contractor Documents.

1.7.1.4 Submit driver shop drawings with each applicable fixture shop drawing.

1.7.2 Contractor shall provide fully dimensioned shop drawings for all fixture types and all custom mounting hardware.

1.7.2.1 No release of orders for lighting equipment shall be made until review of submittals is complete.

1.7.2.2 Submit shop drawings for all products as follows:

- 1.7.2.2.1 Provide complete, fully dimensioned detail drawings including all major components and details of fabrication.
- 1.7.2.2.2 Provide requisite schematics and plans indicating assembly and installation of components.
- 1.7.2.2.3 Provide inventory of all equipment to be supplied including types, quantities, and reference to applicable drawings and schematics.
- 1.7.2.3 Submit a list of fixture types and quantities and catalogue cuts for all product data. Such data shall show both technical and pictorial detail, marked specifically to show the optional or alternate components required, the exact catalogue number, and type designation corresponding to the type indicated in the Fixture Schedule. Include this data also with Maintenance Manual with the Consultant's review stamp.
- 1.7.2.4 Manufacturer's product data shall be marked clearly to indicate all technical information that indicates conformance to all specified requirements in Contract Documents. Include the following information for all fixtures not listed as pre-approved in the light fixture schedule:
 - 1.7.2.4.1 Manufacturer's catalogue sheets of standard fixtures, indicating materials, gauges, dimensions, standard finishes available, weights, CSA approval
 - 1.7.2.4.2 Photometrics from an independent testing laboratory calculated according to IES standards.

1.8 **Delivery & Storage**

- 1.8.1 Equipment shall be individually wrapped and sealed and substantially crated for shipment. All handling and shipping shall be performed in accordance with Manufacturer's recommendations. Store products in unopened cartons in a protected location.

1.9 **Warranty**

- 1.9.1 Provide Contractor warranties as well as factory warranties. All equipment and labour in this Contract shall be free from defects in products or workmanship for 12 months after date of acceptance by the Owner, unless otherwise noted or approved by Owner.

1.10 **waste management and disposal**

- 1.10.1 Refer to section 26 05 00 11 – Electrical General Requirements.

2 **Products**

2.1 **General**

- 2.1.1 Provide all products with CSA labels or appropriate approvals for all mounting conditions.

-
- 2.1.2 Provide lighting fixtures new and complete with mounting accessories, junction boxes and trims.
 - 2.1.3 All products of the same specified type are to be of the same manufacturer.
 - 2.1.4 Fixture type catalogue number does not necessarily denote required mounting equipment or accessories. Provide all appropriate mounting accessories for all mounting conditions.
 - 2.1.5 All fixtures shall have the appropriate frame that is compatible with the ceiling type into which they are installed. Verify all ceiling types at the shop drawing review. Coordinate with the architectural reflected ceiling drawings.
 - 2.1.6 Provide appropriate accessories for proper mounting of all fixtures. For example, include plaster frames for plaster ceiling. For fixtures in rated ceiling, provide firestop protection as specified elsewhere. For fixtures suspended from ceiling, provide pendants or aircraft cables complete with accessories to complete the installation as indicated on the drawings.
 - 2.1.7 Recessed luminaires shall be of the pre-wired type with the junction box and, where applicable, the ballast forming an integral part of the assembly with satisfactory access.
 - 2.1.8 Where light fixture or light fixture suspension apparatus penetrates Ballistic ceiling or canopies, an approved copy of the shop drawings of those fixtures shall be provided to the ceiling manufacturer. Apertures in the ceiling or openings for suspension cables shall be pre-cut by the ceiling manufacturer to suit light fixtures. Instruct the manufacturer accordingly.
 - 2.1.9 General
 - 2.1.9.1 Fixtures in non-accessible ceilings and in columns shall be accessible by utilizing junction boxes through fixture apertures.
 - 2.1.9.2 No metal clips, screws, angles, etc. shall be visible when the fixture is viewed from below.
 - 2.1.9.3 Sheet metal fixture housings shall be of welded construction with seams filled and ground smooth. Any exceptions shall be noted under individual fixture types.
 - 2.1.9.4 All adjustable fixtures shall have locking rotation and tilt devices.

2.2 STANDARD LEDS LUMINAIRES

3 Execution

3.1 Verification of Conditions

- 3.1.1 Confirm all ceiling depths against the final architectural ceiling plans and sections to ensure that recessed fixtures can be installed in all ceiling conditions and advise the Consultant immediately of any discrepancies prior to ordering of the fixtures or proceeding with the work. Prior to order of modified fixtures for non-standard ceiling depths, confirm with the Consultant(s).

3.2 Installation - General

- 3.2.1 Lighting fixtures shall be installed as indicated on architectural reflected ceiling plans, Electrical Drawings and per approved shop drawings.
- 3.2.2 Lighting fixtures are indicated in the Luminaire Schedule by means of type numbers that correspond to similar numbers on the plans.
- 3.2.3 Lighting fixtures shall be installed in accordance with fixture manufacturer's written instructions, applicable requirements of CED, applicable authorities, and with recognized industry practices.
- 3.2.4 Verify locations and spacing of lighting fixtures with reflected ceiling plans and notify Consultant of any variance or conflict between the plans and field conditions. Do not proceed until conflict has been resolved.
- 3.2.5 Work shall be co-ordinated with other trades. Lighting fixture locations shall have priority over location of ducts, diffusers, sprinklers, smoke detectors and other non-structural obstructions. Identify conflicts to designer for assistance in resolving.
- 3.2.6 All fixtures shall be supported directly from the building structural members or from bridging attached to the structural members by rod hangers and inserts. Provide all necessary hardware and blocking to ensure that fixtures hang true.
- Install recessed luminaires to permit removal from below, unless noted otherwise, to gain access to outlet or pre-wired luminaire box. Make final connection from boxes to luminaires with flexible conduit. AC-90 (with No. 12 AWG conductors) may be used but shall be independently supported, (e.g. not from connectors), and have anti-shorts installed. With either type of connection method, the length of the flexible connection shall not exceed 2 meters.
- 3.2.7 For recessed luminaires, support luminaires independent of suspended ceiling system to comply with seismic requirements.

-
- 3.2.8 Where luminaires are surface-mounted on T-bar ceilings, support unit from structure and stabilize luminaires with sheet metal screws into a T-bar at both ends.
 - 3.2.9 When luminaires are installed in valances with solid lens, ensure presence of adequate ventilation openings into ceiling space to dissipate heat.
 - 3.2.10 Fixtures installed in suspended T-bar ceiling shall be equipped with T-bar clips. Clips shall be securely fastened to suspended T-bar ceiling system framing members. The light fixture shall be centered in the ceiling grid opening. Provide a minimum of two clips, one on each diagonal opposite corners, and provide more clips if required by local authority having jurisdiction. Clips shall be reusable and not closed down with rivets. Four wire hangers are to be installed for each fixture, one at each corner of each fluorescent fixture location.
 - 3.2.11 Effectively ground all fixtures.
 - 3.2.12 For exact location of ceiling mounted lighting fixtures refer to Architectural reflected ceiling plan.
 - 3.2.13 Install lighting fixtures true to the surface in or to which they are mounted, and except where otherwise indicated on the Drawings, align correctly with building or room walls as the case directs. Mount wall fixtures at elevations specified or as shown on Architectural or Electrical Drawings. Where no elevation is shown, confirm mounting height with the Consultant prior to rough-in.
 - 3.2.14 All fixtures shall be installed with the bottom of the fixture housing aligned with the finished ceiling line unless otherwise noted in the manufacturer's installation instructions.
 - 3.2.15 Ceiling insulation shall be a minimum of 75 mm (3") away from fixture.

3.3 Workmanship

- 3.3.1 Provide suitable extension couplings for wall mounted luminaires.
- 3.3.2 Hang and mount luminaires to prevent distorting frame, housing, sides or lens frame and permit correct alignment of several luminaires in a row.
- 3.3.3 Support luminaires as indicated on the drawings, level and plumb, and turn with structure and other equipment in horizontal or vertical position as intended. Install wall or side bracket mounted luminaire housings rigidly, and adjust to neat flush fit with mounting surface.
- 3.3.4 Install ceiling canopies to cover suspension attachments and fit tightly to ceiling without restricting alignment of hanger.
- 3.3.5 Where luminaires are required to be supported from the building structure, use a minimum of 2 - 6.35 mm rods per luminaire.

3.4 Installation of Recessed Fixtures

- 3.4.1 Holes in ballistic ceiling shall be pre-cut by ceiling manufacturer based on approved shop drawings of the light fixtures located in these areas. Electrical contractor shall be responsible for co-ordination between Division 26 and metal ceiling manufacturer(s) for the installation of light fixtures in areas with ballistic ceilings.
- 3.4.2 Provide plaster frames or plaster trim as required and turn same over to the ceiling section for installation.
- 3.4.3 Installation of trims shall be tight with no gaps or light leaks. Reflector cones, baffles, aperture plates and decorative elements shall be installed after completion of plastering, ceiling tile work painting, and general clean up in areas. Caulking or sealing fixture trim cones to ceiling to eliminate light leaks or gaps shall not be acceptable.
- 3.4.4 Where fixtures are recessed into non-accessible ceiling space and the fixtures specified are not pre-wired, wire to an outlet box adjacent to each fixture and visible only when the fixture is removed. Connect to the fixture with suitable high-temperature wire in at least 1200 mm (48") of flexible conduit. Install fixtures so that they may be readily removed to gain access to these outlet boxes.

3.5 Installation of Linear Fixtures

- 3.5.1 Linear fixtures, surface mounted or suspended, shall not have more than 6 mm (1/4") variation in alignment for any 5 metre (17 feet) run.

3.6 Field Quality Control

- 3.6.1 Operate each fixture after installation and connection. Each fixture shall be inspected for proper connection and operation.
- 3.6.2 Perform testing of operation of temporary or emergency power systems.
- 3.6.3 Verify that all lenses, louvres, baffles, fixture trim cones, diffusers and other parts are thoroughly cleaned in a manner recommended by the manufacturer.

3.7 Luminaire Wiring

- 3.7.1 Connect recessed luminaires to outlet boxes with maximum 10-mm (0.4") flexible conduit and 90° C wire.

3.8 Branch Circuit Wiring

- 3.8.1 Where the drawings do not show conduit routing or conduit sizes and wire counts, supply and install a complete system of conduit and wire for the lighting system. Make all connections and install all conductors for the switching and branch circuiting indicated as required. Run conduit parallel to major building lines.
- 3.8.2 Conductors shall be #12 R90 XLPE minimum.

3.8.3 Provide a neutral for each circuit (phase conductor).

3.8.4 Conduits shall be sized in accordance with code requirements for wire count installed. In no case shall conduit less than 19 mm be used for home runs. Base conduit fill on maximum of six phase conductors per conduit, resulting in a de-rating of 70% as per Canadian Electrical Code.

3.9 Adjustments

3.9.1 All adjustable fixtures shall be aimed as instructed by the Consultant. Personnel, lifts, and ladders shall be provided by contractor as required.

3.9.2 Adjust exit sign directional arrows, if required.

3.10 Cleaning

3.10.1 Co-ordinate project close out with Section 01 00 10 General Requirements.

3.10.2 Remove all plastic bags from light fixtures after construction is finished and prior to final acceptance.

3.10.3 All necessary equipment, materials, wiring, and fixtures shall be removed from those areas affected by the construction. Materials that are not part of the lighting or electrical distribution system shall be removed from the Site.

3.10.4 All lighting fixtures shall be cleaned in a manner approved by the manufacturer and shall be free of dirt and debris upon completion of installation.

3.11 Demonstration

3.11.1 Co-ordinate project close out with Section 01 00 10 General Requirements.

3.11.2 Building personnel shall be trained to operate lighting control system.

3.12 Protection

3.12.1 Lighting fixtures, once installed, shall be protected from damage during the remainder of the construction period.

END OF SECTION

1. General

1.1 Product Data

- .1 Submit product data in accordance with Section 26 05 00 11 - Electrical General Requirements.

1.2 Waste Management and Disposal

- .1 Refer to Section 26 05 00 11 – Electrical General Requirements.

2. Products

2.1 Standard Units

- .1 Acceptable product or material: as indicated on drawings.

3. Execution

3.1 Installation

- .1 Install exit lights.
- .2 Connect fixtures to exit light circuits, voltage as specified on the drawings, single circuit operation.
- .3 Ensure that exit light circuit breaker is locked in on position.
- .4 Where exit lights are mounted on T-bar ceilings, support exit light independent of ceiling tile. Support from tile only will be rejected.

END OF SECTION

1. General

1.1 Summary of Work

- .1 The work includes: Supply and installation of copper backbone cabling, supply and installation of Augmented Category 6 (Category 6A) Voice and Data Horizontal Distribution Cabling. Fire rating: plenum rated overall CMP (FT-6) compliant
- .2 The voice/data communication systems shall comprise all components specified, implied or otherwise necessary to constitute a fully operational system. The work includes, but is not necessarily limited to, the following:
 - .1 Provision of Voice/data outlets indicated in various locations. Required hardware includes, but is not limited to, cross-connection system, termination blocks, fastening devices, system patch cords and all required accessories to comply with this Specification.
 - .2 Provision of direct horizontal runs of unshielded twisted pair (UTP) Category 6A cables in star configuration from Communications Rooms/Closets to the outlets for all data and voice circuits identified on drawings.
 - .3 Provision of all cable supports and ties required to support the cabling system for this installation.
 - .4 Testing certification and warranty of all cabling and components which are within the scope of this Contract.
 - .5 Provision of as-built AutoCAD drawings fully documenting the cabling.

1.2 Work Not Included

- .1 The work not included in this contract is the supply of communications hub and switching equipment. Testing and energization of hub equipment and LAN communications to be carried out by others.

1.3 References

- .1 All workmanship and materials supplied shall be in full conformance with applicable building, electrical, and other codes, as determined by the authority having jurisdiction.
 - .2 All cabling system components shall be Underwriters Laboratories (UL) Listed and shall be marked as such. In cases where UL has no published standards for a component, any equivalent national independent testing standard shall apply and the item shall be appropriately marked.
-

.3 The product specifications, design considerations, and installation guidelines provided in this document are in part derived from recommendations found in recognized telecommunications industry standards. The following are used as reference:

1. Spaces and Pathways

TIA-569-B (2004) – *Commercial Building Standard for Telecommunications Pathways and Spaces*

2. Grounding

ANSI-J-STD-607-A (2002) – *Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications*

3. Cabling Systems

TIA/EIA-568-B.1 (2002) – *Commercial Building Telecommunications Cabling Standard, Part 1: General Requirements*

TIA/EIA-568-B.2 (2001) – *Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted-Pair Cabling Components*

ANSI/TIA-568-B.2-10-2008 – *Transmission Performance Specifications for 4-pair 100 Ω Augmented Category 6 Cabling*
ANSI/TIA/EIA-568-B.3-2000 -
Optical Fiber Cabling Components Standard

ANSI/TIA/EIA-568-B.3-1-2002 - Optical Fiber Cabling Components Standard
Addendum 1 – Additional Transmission Performance Specifications for 50/125 μm Optical Fiber Cables

TIA/EIA-862 (2002) – *Building Automation Systems Cabling Standard for Commercial Buildings*

4. Cabling Administration

TIA/EIA-606-A (2002) – *Administration Standard for Commercial Telecommunications Infrastructure*

5. Networking

IEEE Standard 802.3an (2006) – *10GBASE-T* (10 Gb/s Ethernet operations over balanced twisted-pair cabling)

6. Design

BICSI *Telecommunications Distribution Methods Manual (TDMM)* –
11th edition

7. Installation

BICSI *Information Transport Systems Installation Manual (ITSIM)* –
4th edition (2004)

1.4 System Description

- .1 Structured system of communication cables, copper Augmented Category 6 UTP installed within the building for distributing voice and data.
- .2 Connect each communication outlet in physical star configuration to communications closet.
- .3 To avoid network problems caused by impedance balance, and attenuation differences, all passive equipment being installed in the horizontal network shall be of the same type and from the same manufacturer.

1.5 Qualifications

- .1 The Telecommunications Contractors shall be experienced and trained by the manufacturing company, in all aspects of the placement; terminating, connecting and testing of products described herein and provide certified proof prior to start of work.
- .2 The Contractor shall be a Belden Certified System Vendor (CSV) experienced and trained by the manufacturing company, in all aspects of the placement, terminating, connecting and testing of products described herein and provide certificate of proof prior to start of work.
- .3 The Contractor shall have a minimum of one (1) RCDD "Registered Communications Distribution Designer" recognized by BICSI "Building Industry Consulting Services International" on staff at local offices (the term "Local offices" as applied to RCDD, Registered Communications Distribution Designers, refers to anywhere in the Province of Alberta) and provide certificate of proof prior to start of work.
- .4 Communications contractor shall supply and install a complete system for voice and data.
- .5 The Contractor shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size. The Contractor shall demonstrate proven expertise in the implementation of network cabling. Expertise can be illustrated through the inclusion of details of at least three projects involving the design and installation of a Category 5e, Category 6, or Augmented Category 6 (Cat 6A) balanced twisted-pair cabling system within the past two-year period. Names and contact information for each of the three projects shall be included. The Contractor shall own and maintain tools and equipment necessary for successful installation and testing of optical and proposed Augmented Category 6A metallic premise distribution systems and have personnel who are adequately trained in the uses of such tools and equipment.
- .6 The communications installer shall be a Communications Cabling Specialist and obtain all required permits.

1.6 Shop Drawings

- .1 Submit shop drawings and product data, for:
-

-
- .1 UTP communication cable
 - .2 Cable management
 - .3 Patch panels and patch cords
 - .4 Communication Outlets
 - .5 Bix mounts, connectors, adapters.

1.7 Warranty

- .1 The warranty period with regard to the project is for 25 years from the date of Substantial Performance of the Work or those periods specified in the Contract Documents for certain portions of the Work of Products.
 - .2 The Contractor shall be responsible for the proper performance of the Work.
 - .3 The Contractor shall correct promptly, at the Contractor's expense, defects or deficiencies in the Work which appear prior to and during the warranty periods specified in the Contract Documents.
 - .4 The Owner shall promptly give the Contractor notice in writing of observed defects and deficiencies that occur during the warranty period.
 - .5 The Contractor shall correct or pay for damages resulting from corrections made under the requirements of paragraph 1.8.3.
 - .6 The Contractor shall be responsible for obtaining Product warranties in excess of one year on behalf of the Owner from the manufacturer. These product warranties shall be issued by the manufacturer to the benefit of the Owner.
 - .7 The Contractor shall provide a twenty-five (25) year Extended Product Warranty and Lifetime Application Assurance Warranty for the Communications Network. This warranty shall be backed up by the manufacturer and taken over by the manufacturer or his representative if the Contractor fails to follow through with the requirements of the warranty.
 - .8 The Communications Network is defined as all required passive equipment and cabling, including hardware, terminations, and jacks, configured to provide data and voice connectivity from each data or voice outlet provided by the Contractor in this Contract.
 - .9 The System Assurance shall cover the applications that the installed system is designed to support for a twenty-five (25) year period.
 - .10 The copper system shall be constructed to conform to ANSI/TIA-568-B.2-10-2008 – Transmission Performance Specifications for 4-pair 100 Ω Augmented Category 6 Cabling Commercial Building Telecommunications Cabling Standards.
-

-
- .11 The Extended Product Warranty and the Systems Assurance together comprise the Structured Cabling System Quality Assurance Program.
 - .12 Upon successful completion of the Structured Cabling System installation and subsequent testing by certified technical personnel the Contractor shall provide to the Owner a numbered certificate registering the installation.

2. Products

2.1 General Description

- .1 The Government of Canada Building will be served by Augmented Category 6 Data cabling. This tender includes provision of all copper systems for the project. Cabling to be plenum rated, overall CMP (FT-6) compliant.
- .2 All Horizontal Augmented Category 6 UTP Cable will be installed in conduit and cable tray as indicated. The principal cross-connection point for the riser system and for the voice network will be the LAN/Tel room.
- .3 All horizontal voice and data distribution cables shall be terminated at the user end on a communications (single, dual or quad, as specified in drawings) outlet. The Data RJ-45 jack shall be appropriately numbered and identified with a Belden or equal computer label; the voice RJ-45 jack shall be appropriately numbered and identified with a Belden or equal telephone label.
- .4 All products must be accompanied with 3rd party test results stating that each component is Augmented Category 6 compliant, and 3rd party test results that show the components when tested in a worst case channel configuration will exceed Category 6A channel requirements with additional margin (Clause 3.2.2,2) at both maximum length of 100 meters and minimum length of 12 meters as per ANSI/TIA-568-B.2-10-2008 – *Transmission Performance Specifications for 4-pair 100 Ω Augmented Category 6 Cabling*

2.2 Horizontal communications cable

- .1 4 pair, Augmented Category 6 , #23 AWG insulated copper conductor, 100 ohm, Unshielded Twisted Pair (UTP) riser cable (CMR) in separate outer jacket for voice/data service distribution to communications cabinets and all outlets. All cable to have a minimum FT-6 fire rated jacket, white colour for voice & data.
 - .2 Provide Belden **10GX** 4-pair Augmented Category 6 cable
 - .3 Augmented Category 6 cable shall be installed for all horizontal communications data and voice requirements. The balanced twisted-pair cabling system shall support 10 Gb/s networking and shall provide guaranteed performance up to 625 MHz for a 4-connector, 100 m (328 ft) channel.
 - .4 All Augmented Category 6 cables shall conform to ANSI/TIA-568-B.2-10-2008 – *Transmission Performance Specifications for 4-pair 100 Ω Augmented Category 6*
-

Cabling, CAN/CSA T529-95 Commercial Building Telecommunications Cabling Standard, and Horizontal Cable Section.

2.3 Communications Outlets

- .1 Voice/Data Outlets to be: Augmented Category 6, modular, 8 pin for voice and data; single, dual or four port c/w SS face plates and mounting frame. Spare ports to be blanked off.
 - .1 Flush mounted. Belden 10GX or approved equal.
- .2 Provide labelling as specified.

2.4 Patch Cables

- .1 Patch cables shall be provided for all terminated voice and data ports, for both ends of each line. The cordage shall use 23 AWG solid copper conductors in a bonded pair configuration for reliable long-term channel performance to 625 MHz. The transmission characteristics of the cordage will be guaranteed to 625 MHz. The patch cables shall support 10 Gb/s, FT-4, 23 AWG copper, Belden 10GX or approved equal.
- .2 The quantity of patch cables for connection between switches and patch panel in LAN room is to be at least the same amount as the number of ports on the horizontal patch panels. Length of the patch cables should be 7ft or 2 m.
- .3 The quantity of patch cables for connection at the workstation end is to be at least the same amount as the number of ports on the horizontal patch panels. Length of the patch cables should be 15ft or 4.5 m.

2.5 Standard of Acceptance

- .1 Belden IBDN Certified Structured Cabling System is specified as Standard of Acceptance.

3. Execution

3.1 Installation of Cables

- .1 General
 - .1 Install communication cables in accordance with Manufacturer's recommendations and guidelines.
 - .2 Place all communication cables in conduits or cable tray as required, except within closets use conduits as available.
 - .3 Cable Labels:
 - .1 Electrovert Type "Z" cable markers sized to fit cables snugly.
 - .2 Self laminating, heat-shrink, one-piece, custom printed cable labels.
-

Cable labels can be self laminating embossed type in lieu of heat shrink.

- .4 EMT type conduit “wall-stub” c/w flush installed device box shall be located in walls/partitions. Stubs shall be turned out into accessible ceiling space.
- .5 Single and multi-gang type raised 4” square “tile” rings are also acceptable for use in new dry-wall type construction. Secure directly to face of metal studs. Multi-gang “tile” rings are to be adequately secured within partitions, on “both” left and right hand sides of same.
- .6 Where the “grouping” of various systems outlets or multi type outlets in dry-wall type construction is desirable, the use of “box mounting brackets” are to be installed between, and secured to, both metal studs. To install suitably sized 4” square and/or 4 11/16” boxes c/w raised tile rings as may be required.

.2 Installation of Unshielded Twisted Pair (UTP) Cable

- .1 Connect each outlet directly to a communications closets by a continuous UTP cable. There shall be no connector in the cable run between the communication outlet and the cable termination in the closet. Transition points between the communications closet and the communications outlet are disallowed.
 - .2 Horizontal cables shall be bundled in groups of no more than 50 cables. Cable bundle quantities in excess of 50 cables may cause deformation of the bottom cables within the bundles, which will degrade the performance of those cables
 - .3 The maximum horizontal cable distance for data and voice circuits to be 90 m (295 ft.). This is the cable length from the mechanical termination of the UTP cable in the communications closet to the communications outlet. In establishing maximum distance, an allowance to be made for 3 additional meters (9.8 ft.) from the communications outlet to computer and 2 meters for patch cords at the closet.
 - .4 The following applies to cables installed in return air plenums without the use of tray.
 - .1 Where air plenum is accessible, adjustable cable straps may be used. Routing shall follow building grid lines.
 - .2 Where air plenum in not accessible, conduit raceway shall be provided to span inaccessible ceiling space.
 - .3 Cables crossing power cables or fluorescent light fixtures (outside conduit) must do so at right angles.
 - .5 Install coaxial cables and outlets in accordance with manufacturer’s recommendations.
 - .6 When installing UTP cable, follow the separation distances from EMI sources detailed in the table:
-

Source of Electro-Magnetic Interference (EMI)	Minimum Separation Distance from a source Carrying:	
	< 2 kVA	2 – 5 kVA
Unshielded power lines, electrical equipment near open/non-metal pathways.	12.7 cm 5 in.	30.5 cm 12 in.
Unshielded power lines, electrical equipment near grounded metal pathways.	6.4 cm 2.5 in.	15.2 cm. 6 in.
Power lines enclosed in grounded conduit.	5.0 cm 2.0 in.	7.6 cm. 3 in.
Transformers and electric motors.	1.02 m 40 in.	
Fluorescent lights.	30.5 cm 12 in.	

- .7 When terminating cables, the length of cable twist (twist/cm) shall be identical to that of the remainder of the cable. This twist shall be maintained up to 10 mm from the termination point of the cable at the patch panel and the receptacle.
- .8 UTP Cable Terminations
- .1 Terminate UTP cables at the work area outlet with an RJ 45 female connector.
 - .2 The cable colour code/jack pin assignments shall match (TIA jack-pin pair assignment) T568A.
 - .3 Terminate data cables directly to RJ-45 patch panels on equipment racks at the communications closet end and, connected to data hubs via patch chords.
 - .4 Maximum untwisted length of conductors shall not exceed 12mm (0.5 inch).
- .9 Identify each cable with a permanent indelible identification band which indicates the room and outlet number to which the cable is connected. Both ends of each cable must have identical identifier bands.
- .10 Identify each communication outlet with a permanent indelible label using standard numbering scheme.
- .11 Identify each patch panel position with the room and outlet number to which the cable is connected.

3.2 Acceptable Testing and Certification

- .1 Category 6A performance tests shall be in accordance with ANSI/TIA-568-B.2-10-2008 and must be performed with the wall plates in place.
- .2 Augmented Category 6A system testing.
 - .1 For connecting hardware with modular interface components (i.e. Plug and jack connectors) transmissions tests shall be performed with both components in a mated state on all 4 pairs, and shall meet the following performance criteria

PSANEXT	70 dB @ 100 MHz
Insertion Loss	0.2 dB @ 100 MHz 0.45 dB @ 100 MHz
Return loss	28 dB @ 100 MHz
TCL	34 dB @ 100 MHz
NEXT	54 dB @ 100 MHz 40 dB @ 500 MHz

- .2 At a minimum, the balanced twisted-pair cabling system will exceed the key performance parameters for Augmented Category 6A found in ANSI/TIA-568-B.2-10-2008 – *Transmission Performance Specifications for 4-pair 100 Ω Augmented Category 6 Cabling* over the specified frequency ranges by the values listed below.

Parameter	Worst Case Margin (1 – 500 MHz)	Worst Case Margin (500 – 625 MHz)
Insertion loss	3%	Beyond Standard (*)
Return loss	2.0 dB	Beyond Standard (*)
NEXT	2.5 dB	Beyond Standard (*)
PSNEXT	3.5 dB	1.5 dB(*)
PSANEXT	2.0 dB	2.0 dB(*)
PSACRF	10.0 dB	8.0 dB(*)
PSAACRF	Beyond Standard	Beyond Standard (*)

NOTE: The **Margin** is the additional headroom (in dB or %) compared to the minimum specified value for Category 6A at each frequency point over the specified frequency range. The **Worst Case Margin** is determined at the frequency where the measured data point is closest to the limit line. The Category 6A limit line equations are used to determine the **Worst Case Margin** over the frequency range from 500 MHz to 625 MHz.

NEXT = Near-end crosstalk

PSACRF = Power-sum attenuation-to-crosstalk ratio far-end

PSAACRF = Power-sum alien attenuation-to-crosstalk ratio far-end

PSANEXT = Power-sum alien near-end crosstalk

PSNEXT = Power-sum near-end crosstalk

NOTE: The values listed above are characterized as “Margin” or “Guaranteed Headroom” beyond the performance specified in standards, and serve as additional assurance of the cabling system’s performance after installation and over its operational lifespan.

(*) Value proposed or statement represent guaranteed margin against ANSI/TIA-568-B.2-10-2008 – *Transmission Performance Specifications for 4-pair 100 Ω Augmented Category 6 Cabling* extrapolated to 625MHz.

.3 Certification

.1 Certify that all cabling and hardware meets the performance criteria in this specification and is free from any optical, electrical or mechanical defects as a result of the installation and termination practices for a period of twenty-five (25) years from the time of acceptance by the Owner.

.2 Provide two (2) copies of all installation documentation and reports. The minimum documentation set shall include:

.1 As-built drawings in paper format, fully documenting the cabling infrastructure. Copies of the approved drawings in AutoCAD “DWG” format shall be provided by the Owner to form a basis for as-built drawings.

.2 Records of all test procedures and test results in a report format and detailed test results including graphical data in an electronic format.

.4 Upon completion of the Work, the Engineer shall carry out an onsite final inspection.

As a minimum, the following points will be examined:

.1 Is the design documentation complete? Are all cables properly labelled, from end-to-end?

.2 Have all terminated cables been properly tested in accordance with the specifications for the specific category as well as tested for opens, shorts, polarity reversals, transposition and presence of AC and /or DC voltage?

.3 Is the cable type suitable for its pathway? Are the cables bundled in parallel?

.4 Have the pathways manufacturer’s guidelines been followed? Are all cable penetrations installed properly and fire stopped according to code?

.5 Have the Contractors avoided excessive cable bending?

-
- .6 Have potential EMI and RFI sources been considered?
 - .7 Are conduit cable fills correct?
 - .8 Are hanging supports within 1.5 meters (5 feet)?
 - .9 Does hanging cable exhibit some sag?
 - .10 Are telecommunications closet terminations compatible with applications equipment?
 - .11 Have patch panel instructions been followed?
 - .1 Jacket removal point.
 - .2 Termination positions.
 - .3 All pair terminations tight with minimal pair distortions.
 - .4 Twists maintained up to Index Strip.
 - .12 Have modular panel instructions been followed?
 - .1 Cable dressing first.
 - .2 Jackets remain up to the Connecting Block.
 - .3 All pair terminations tight and undistorted.
 - .4 Twists maintained up to the Connecting Block.
 - .13 Are the correct outlet connectors used?
 - .14 Is the jacket maintained right up to the jack?
 - .15 Are all pairs tightly twisted and straight across in the Panel?
 - .16 Are identification markings uniform, permanent and readable?

END OF SECTION

1. General

1.1 System Description

- .1 Empty telecommunications raceways system consists of outlet boxes, cover plates, conduits, pull boxes, sleeves and caps, fish wires, service poles, service fittings.

1.2 Waste Management and Disposal

- .1 Refer to Section 26 05 00 11 – Electrical General Requirements.

2. Products

2.1 Material

- .1 Conduits, Conduit Fastenings and Conduit Fittings Section 26 05 33 00
- .2 STI fire stopping products where conduit passes through wall or floor.
- .3 Splitters, Junction, Pull Boxes and Cabinets Section 26 05 31 00

3. Execution

3.1 Installation

- .1 Firestop all wall, ceiling and floor penetrations.
- .2 Install raceway system, including overhead distribution system, fish wire, terminal cabinets, outlet boxes, floor boxes, pull boxes, cover plates, conduit, sleeves and caps, raceways, miscellaneous and positioning material to constitute complete system.

END OF SECTION

1. GENERAL

1.1 Related Work

- .1 Conduits, Conduit Fastenings and Conduit Fittings:
- .2 Wires and Cables 0-1000V:

1.2 References

- .1 CAN/ULC-S524, Installation of Fire Alarm Systems.
- .2 ULC-S525, Audible Signal Appliances for Fire Alarm.
- .3 CAN/ULC-S526, Visual Signal Appliances, Fire Alarm.
- .4 CAN/ULC-S527, Control Units, Fire Alarm.
- .5 CAN/ULC-S528, Manual Pull Stations.
- .6 CAN/ULC-S530, Heat Actuated Fire Detectors, Fire Alarm.
- .7 CAN/ULC-S536, Inspection and Testing of Fire Alarm Systems.
- .8 CAN/ULC-S537, Verification of Fire Alarm Systems.
- .9 NBC, National Building Code of Canada.

1.3 System Description

- .1 Integrate new signalling devices, heat detectors and Double interlocked Pre-action sprinkler zone into existing fire alarm system.
 - .2 Electrical contractor to carry all costs of fire alarm manufacturer representative for installation of new cards (if necessary), devices as shown on drawings and fire alarm verification.
 - .3 Electrical contractor to arrange for manufacturer to attend pre-tender walkthrough. Manufacturer to evaluate existing fire alarm panel for devices being installed and submit price for incorporating new Fire Alarm in to existing system. Price for Fire alarm to be shown as separate line item in bid.
 - .4 Sprinkler pre-action system is to be located in Mechanical room SB0H. Final location of equipment in SB0H is by Sprinkler Contractor. Electrical contractor to coordinate with Sprinkler Contractor for final location of Fire Alarm Components on sprinkler system. Install 21mm conduit and FAS wire from Pre-action release panel to Main Fire Alarm panel. Create new Zone in Main Fire Alarm panel called "Range Pre-action". New zone to have dedicated indicator button on Main Fire Alarm panel display.
-

-
- .5 Sequence of Operations for Double interlocked Pre-action system:
 - A. Activation of either manual pull station and low air will fill the sprinkler pipe with water.
 - B. Activation of any two heat detectors and low air will fill the sprinkler pipe with water.
 - .6 Double interlocked Pre-action System including pre-action release panel to be supplied by Mechanical. Electrical contractor to include:
 - .1 Installation and wiring of pre-action release panel.
 - .2 Installation and wiring of all pressure switches, tamper switches, control modules, monitoring modules and end of line devices as shown on drawings.
 - .3 Conduit and wire to Main Fire Alarm panel for interconnect of pre-action release panel and main fire alarm panel.
 - .4 New zone and all programming at Main Fire Alarm panel.

1.4 Requirements of Regulatory Agencies

- .1 System components: listed by ULC and comply with applicable provisions of Alberta Building Code, Local Building Code, and meet requirements of the local authority having jurisdiction.

1.5 Shop Drawings

- .1 Submit shop drawings in accordance with Electrical General Requirements.
- .2 Include:
 - .1 Detail assembly and internal wiring diagrams for control unit
 - .2 Overall system riser wiring diagram identifying control equipment initiating devices, signalling circuits; identifying terminations, terminal numbers, conductors and raceways.
 - .3 Details for devices.
 - .4 Details and performance specifications for control, annunciation and peripherals with item by item cross reference to specification for compliance.
 - .5 Step-by-step operating sequence, cross referenced to logic flow diagram.

1.6 Operation and Maintenance Data

- .1 Provide operation and maintenance data for fire alarm system for incorporation into manual specified in Electrical General Requirements.
 - .2 Include:
 - .1 Descriptors and address numbers of new system devices.
-

- .2 Instructions for all new components of fire alarm system to permit effective operation and maintenance.
- .3 Technical data - illustrated parts lists with parts catalogue numbers.
- .4 Copy of approved shop drawings with corrections completed and marks removed except review stamps.
- .5 List of recommended spare parts for system.

1.7 Maintenance Materials

- .1 Provide maintenance materials in accordance with Division 01 - Maintenance Materials, Special Tool and Spare Parts.

1.8 Maintenance

- .1 Provide one year's free maintenance with two inspections by manufacturer during warranty period. Inspection tests to conform to CAN/ULC-S536. Submit inspection report to Owner or the Owner's Representative.
- .2 Include in tender price temporary program changes during construction period, and final programming prior to occupancy including zone labels, control functions, system operation, device identification and system adjustments.

1.9 Training

- .1 Provide on-site lectures and demonstration by fire alarm equipment manufacturer to train operational personnel in use and maintenance of fire alarm system.

2. **PRODUCT**

2.1 Materials

- .1 Equipment and devices: ULC listed and labeled and supplied by single manufacturer.
- .2 Audible signal devices: to ULC-S525.
- .3 Visual signal devices: to CAN/ULC-S526.
- .4 Manual pull stations: to CAN/ULC-S528.
- .5 Thermal detectors: to CAN/ULC-S530.

2.2 System Operation:

- .1 Actuation of any alarm initiating device to:
 - .1 Cause electronic latch to lock-in alarm state at central control unit and data gathering panel/transponder.
 - .2 Indicate zone of alarm at central control unit and at remote annunciator.

-
- .3 Cause audible signalling devices to sound in alarm tone throughout building.
 - .4 Transmit signal to fire department via central station and or the monitoring agent selected by the owner.
 - .5 Cause air conditioning and ventilation fans to shut down.
 - .2 Acknowledging alarm: indicated at central control unit.
 - .3 Silence signals by "alarm silence" switch at central control unit only after a 60 second period of operation.
 - .4 Subsequent alarm, received after previous alarm has been silenced, to re-activate signals.
 - .5 Actuation of any supervisory device to:
 - .1 Cause electronic latch to lock-in supervisory state at central control unit and data gathering panel/transponder.
 - .2 Indicate respective supervisory zone at central control unit and remote annunciator.
 - .3 Cause audible signal at central control unit to sound.
 - .4 Activate common supervisory sequence.
 - .6 Resetting alarm/ supervisory device not to return system indications/functions back to normal until control unit is reset.
 - .7 Trouble on system to:
 - .1 Indicate circuit in trouble at central control unit.
 - .2 Activate "system trouble" indication, buzzer and common trouble sequence. Acknowledging trouble condition to silence audible indication; visual indication to remain until trouble is cleared and system is back to normal.
 - .8 Troubles on system: suppressed during course of alarm.
 - .9 Trouble condition on any circuit in system not to initiate alarm conditions.

2.3 Control Panel

- .1 General: Comply with ULC-S527, "Control Units for Fire Alarm Systems."
 - .2 The following FACP hardware shall be provided:
 - .1 One Auxiliary electronically resetable fused 2A @24VDC Output, with programmable disconnect operation for 4-wire detector reset.
 - .2 One Auxiliary Relay, SPDT 2A @32VDC, programmable as a trouble relay, either as normally energized or de-energized, or as an auxiliary control.
 - .3 Remote Unit Interface: supervised serial communication channel for control and monitoring of remotely located annunciators and I/O panels.
-

- .4 Modular Network Communications Card.
- .5 Service Port Modem for dial in passcode access to all fire control panel information.

2.4 Power Supplies

- .1 120 V, 60 Hz as primary source of power for system.
- .2 Voltage regulated, current limited distributed system power.
- .3 Primary power failure or power loss (less than 102 V) will activate common trouble sequence.
- .4 Interface with battery charger and battery to provide uninterruptible transfer of power to standby source during primary power failure or loss.
- .5 During normal operating conditions fault in battery charging circuit, short or open in battery leads to activate common trouble sequence and standby power trouble indicator.
- .6 Standby batteries: sealed, maintenance free.
- .7 Continuous supervision of wiring for external initiating and alarm circuits to be maintained during power failure.

2.5 Initiating/Input Circuits

- .1 Receiving circuits for alarm initiating devices such as manual pull stations , heat detectors and water flow switches.
- .2 Actuation of alarm initiating device: cause system to operate as specified in "System Operation".
- .3 Receiving circuits for supervisory, N/O devices. Devices.
- .4 Actuation of supervisory initiating device: cause system to operate as specified in "System Operation".

2.6 Alarm Output Circuits

- .1 Alarm output circuit: connected to signals, wired in class A configuration to central control unit and DGPs/transponders.
 - .1 Signal circuits' operation to follow system programming; capable of sounding alarms and driving visuals.
 - .2 Manual alarm silence, automatic alarm silence and alarm silence inhibit to be provided by system's common control.
-

2.7 Auxiliary Circuits

- .1 Auxiliary contacts for control functions.
- .2 Upon resetting system, auxiliary contacts to return to normal or to operate as pre-programmed.
- .3 Auxiliary circuits: rated at 2 A, 24 V dc or 120 V ac, fuse-protected.

2.8 Wiring

- .1 Twisted copper conductors: rated 600 V.
- .2 To initiating circuits: 18 AWG minimum, and in accordance with manufacturer's requirements.
- .3 To signal circuits: 14 AWG minimum, and in accordance with manufacturer's requirements.
- .4 To control circuits: 14 AWG minimum, and in accordance with manufacturer's requirements.

2.9 Manual Alarm Stations

- .1 Manual alarm stations: pull lever, wall mounted semi-flush type to match existing building, non-coded single pole normally open contact for single stage Bilingual signage. Electronics to communicate station's status to addressable module/transponder over 2 wires and to supply power to station. Station address to be set on station in field.

2.10 Automatic Alarm Initiating Devices

- .1 Addressable thermal fire detectors, rate of rise, self-restoring rate of rise, rate of rise 8.3 °C per minute.
 - .1 Heat detectors are to be installed in baffled ceiling. Electrical contractor to mount heat detector to offset piece of ½" threaded rod so that detector heat shield is not blocked by ceiling baffle. Do not mount heat detector below protection of lower edge of ceiling baffle.
 - .2 Electronics to communicate detector's status to addressable module/transponder.
 - .3 Detector address to be set on detector in field.

2.11 Combination Audible Visual Signal Devices

- .1 Horn Strobes: Designed for surface mounting on walls and or ceilings. Backboxes shall be flush with concealed conduit
-

- .2 Visual Signal Device: 24 V dc, xenon with intensity selection of 15, 30, 75 or 110 candela. . Synchronize all visual alarm units in a temporal pattern
- .3 Horns: 24 V dc, temporal or 60 BPM March Time Pattern.
- .4 Audible and Visual Devices to be wired Class A.

2.12 End-of-Line Devices

- .1 End-of-line devices to control supervisory current in alarm circuits, sized to ensure correct supervisory current for each circuit. Open, short or ground fault in any circuit will alter supervisory current in that circuit, producing audible and visible alarm at main control panel and remotely as indicated.

3. EXECUTION

3.1 Installation

- .1 Install systems in accordance with CAN/ULC-S524.
 - .2 Install pre-action release panel and complete all wiring and programming
 - .3 Install manual alarm stations and connect to alarm circuit wiring.
 - .4 Locate and install detectors and connect to alarm circuit wiring. Connect alarm circuits to main control panel.
 - .5 Install signal horns and visual signal devices and connect to signalling circuits.
 - .6 Install end-of-line devices at end of alarm initiating circuits.
 - .7 Sprinkler system: wire alarm and supervisory switches and connect to control panel.
 - .8 Splices are not permitted.
 - .9 Install isolation modules as shown on drawings to isolate faults in system
 - .10 Provide necessary raceways, cable and wiring to make interconnections to terminal boxes, annunciator equipment as required by equipment manufacturer.
 - .11 Ensure that wiring is free of opens, shorts or grounds, before system testing and handing over.
 - .12 Identify circuits and other related wiring at central control unit, annunciators, and terminal boxes.
-

3.2 Field Quality Control

- .1 Perform verification test in accordance with CAN/ULC-S537. Pretest for verification with system manufacturer and complete all items in "Fire Alarm Pre Verification checksheet" below, then submit Fire Alarm Pre Verification checksheet to Engineer to book time for Verification. Coordinate with RCMP to ensure monitoring agreement is in place with monitoring agency. Fire alarm system must be 100% operational before bringing in Engineer for verification
- .2 Electrical Contractor shall allow as a cash allowance, the sum of \$2000.00 for the electrical engineer's portion of the verification.

FIRE ALARM PRE VERIFICATION CHECKSHEET - COMPLETE AND RETURN TO THE CONSULTANT

		YES	NO	N/A
1.0	GENERAL			
.1	Has the building been cleaned	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
.2	Have the PPE requirements been removed	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
.3	Is the building ready for occupancy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
.4	Has the system been pre-verified	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
.5	Have you tested the horn/strobes	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
.6	Is the panel clear of all Grounds	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
.7	Is the Panel clear of all troubles (excluding overrides i.e. elevator homing, bells, sprinkler tamper switches)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
.8	Will the crew that installed the system be Present for the FAVI	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
.9	Is the Sprinkler System 100% complete filled with water and the valves open	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

		YES	NO	N/A
2.0	INSTALLATION			
.1	Do you have stranded wire at the horn/strobes	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
.2	Are all the devices away from their mounting location, ready for the verification	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
.3	Is the final device mounting crew here	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
.4	Is the breaker red and locked off or ready to be locked off	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
.5	Are the lamaroids /Labeling complete	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
.6	Have you checked the voltages at the EOL's	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
.7	Have you confirmed the settings for all the horn/strobes	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
.8	Do we have access to all devices	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
.9	Do you have an LED for Duct Detectors	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
.10	Is the sprinkler tree ready and has it been pre-tested	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
.11	Has the Pre-AC system been tested	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
.12	Is the interface to Building Automation System completed and tested	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
.13	Is all door hardware installed and tested	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3.0	TECHNICIANS			
.1	Is the system programmer here	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
.2	Do you have a print out (hard copy) of all the points	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
.3	Is the programming 100% complete	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

		YES	NO	N/A
.4	Do we have field communication everywhere (radios/phones)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
.5	Have the descriptors been pre-approved by the owner	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
.6	Do you have the as-builts for the ISO's	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
.7	Do you know the sequence of operation for all the output relays (ancillary devices)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.0	FINAL			
.1	Is the system ready to be handed over to the owner	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
.2	Will the owner be responding to panel troubles	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
.3	Has the bell ring been coordinated with the owner	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
.4	Have the Vesda/s been pre-verified	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
.5	Has the call out been pre-verified	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
.6	Has the owner been advised of the Verification be attending the verification <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> and will he
.7	Do you have a Plan and a Contingency Plan for this verification.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Stantec Consulting Ltd.

END OF SECTION