

SPECIFICATION

**FACILITY BUILDING
NEW CONSTRUCTION
PART 2 – MECHANICAL AND ELECTRICAL**

**ISLAND LAKE MANITOBA
PROJECT NO. 13-168-01-14, IO 1003959**

TENDER

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Part 1 General**1.1 SUBMITTALS**

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop drawings to show:
 - .1 Mounting arrangements.
 - .2 Operating and maintenance clearances.
- .3 Shop drawings and product data accompanied by:
 - .1 Detailed drawings of bases, supports, and anchor bolts.
 - .2 Acoustical sound power data, where applicable.
 - .3 Points of operation on performance curves.
 - .4 Manufacturer to certify current model production.
 - .5 Certification of compliance to applicable codes.
- .4 In addition to transmittal letter referred to in Section 01 33 00 - Submittal Procedures: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.
- .5 Closeout Submittals:
 - .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
 - .2 Operation and maintenance manual approved by, and final copies deposited with, Consultant before final inspection.
 - .3 Operation data to include:
 - .1 Control schematics for systems including environmental controls.
 - .2 Description of systems and their controls.
 - .3 Description of operation of systems at various loads together with reset schedules and seasonal variances.
 - .4 Operation instruction for systems and component.
 - .5 Description of actions to be taken in event of equipment failure.
 - .6 Valves schedule and flow diagram.
 - .7 Colour coding chart.
 - .4 Maintenance data to include:
 - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
 - .2 Data to include schedules of tasks, frequency, tools required and task time.
 - .5 Performance data to include:
 - .1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.
 - .2 Equipment performance verification test results.

- .3 Special performance data as specified.
- .4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .6 Approvals:
 - .1 Submit 2 copies of draft Operation and Maintenance Manual to Consultant for approval. Submission of individual data will not be accepted unless directed by Consultant.
 - .2 Make changes as required and re-submit as directed by Consultant.
- .7 Additional data:
 - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.
- .8 Site records:
 - .1 Consultant will provide 1 set of reproducible mechanical drawings. Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring.
 - .2 Transfer information weekly to reproducibles, revising reproducibles to show work as actually installed.
 - .3 Use different colour waterproof ink for each service.
 - .4 Make available for reference purposes and inspection.
- .9 As-built drawings:
 - .1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings.
 - .2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).
 - .3 Submit to Consultant for approval and make corrections as directed.
 - .4 Perform testing, adjusting and balancing for HVAC using as-built drawings.
 - .5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.
- .10 Submit copies of as-built drawings for inclusion in final TAB report.

1.2 QUALITY ASSURANCE

- .1 Quality Assurance: in accordance with Section 01 45 00 - Quality Control.
- .2 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.3 MAINTENANCE

- .1 Furnish spare parts in accordance with Section 01 78 00 - Closeout Submittals as follows:

- .1 One set of packing for each pump.
 - .2 One casing joint gasket for each size pump.
 - .3 One head gasket set for each heat exchanger.
 - .4 One glass for each gauge glass.
 - .5 One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.
- .2 Provide one set of special tools required to service equipment as recommended by manufacturers and in accordance with Section 01 78 00 - Closeout Submittals.
 - .3 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.

1.4 DELIVERY, STORAGE, AND HANDLING

- .1 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Execution

2.1 PAINTING REPAIRS AND RESTORATION

- .1 Do painting in accordance with Section 09 91 23 - Interior Painting.
- .2 Prime and touch up marred finished paintwork to match original.
- .3 Restore to new condition, finishes which have been damaged.

2.2 CLEANING

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

2.3 FIELD QUALITY CONTROL

- .1 Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report as described in PART 1 - SUBMITTALS.
- .2 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
 - .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.

2.4 DEMONSTRATION

- .1 Consultant will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .3 Use operation and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials.
- .4 Instruction duration time requirements as specified in appropriate sections.
- .5 Consultant will record these demonstrations on video tape for future reference.

2.5 PROTECTION

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

END OF SECTION

Part 1 General**1.1 SUBMITTALS**

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1.3 MAINTENANCE

- .1 Furnish spare parts in accordance with Section 01 78 00 - Closeout Submittals as follows:

- .1 One set of packing for each pump.
- .2 One casing joint gasket for each size pump.
- .3 One glass for each gauge glass.
- .2 Provide one set of special tools required to service equipment as recommended by manufacturers and in accordance with Section 01 78 00 - Closeout Submittals.
- .3 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.

1.4 DELIVERY, STORAGE, AND HANDLING

- .1 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section [01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Execution**2.1 PAINTING REPAIRS AND RESTORATION**

- .1 Do painting in accordance with Section 09 91 23 - Interior Painting.
- .2 Prime and touch up marred finished paintwork to match original.
- .3 Restore to new condition, finishes which have been damaged.

2.2 CLEANING

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

2.3 FIELD QUALITY CONTROL

- .1 Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report as described in PART 1 - SUBMITTALS.
 - .1 [].
- .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.

2.4 DEMONSTRATION

- .1 Consultant will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 Trial usage to apply to following equipment and systems:
 - .1 [].
- .3 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .4 Use operation and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials.
- .5 Instruction duration time requirements as specified in appropriate sections.
- .6 Consultant will record these demonstrations on video tape for future reference.

2.5 PROTECTION

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

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Disinfection of potable water distribution system.
- .2 Testing and reporting results.

1.2 RELATED SECTIONS

- .1 Section 01 20 13 - Price and Payment Procedures.
- .2 Section 01 33 00 - Administrative Requirements.
- .3 Section 01 44 00 - Quality Assurance.
- .4 Section 01 61 00 - Common Product Requirements.
- .5 Section 01 78 10 - Execution Requirements.
- .6 Section 33 11 16 - Site Water Utility Distribution Piping.
- .7 Section 33 21 13 - Public Water Supply Well.
- .8 Section 22 10 00 - Plumbing Piping: Disinfection of building domestic water piping system.

1.3 UNIT PRICE - MEASUREMENT AND PAYMENT

- .1 Section 01 20 13: Unit prices.
- .2 Disinfection: By the linear metre. Includes preparing, disinfecting, testing, and reporting.

1.4 REFERENCES

- .1 AWWA B300 - Standard for Hypochlorites.
- .2 AWWA B301 - Standard for Liquid Chlorine.
- .3 AWWA B302 - Standard for Ammonium Sulfate.
- .4 AWWA B303 - Standard for Sodium Chlorite.
- .5 AWWA C651 - Standards for Disinfecting Water Mains.

1.5 SUBMITTALS FOR INFORMATION

- .1 Test Reports: Indicate results comparative to specified requirements.

□

- .2 Certificate: Certify that cleanliness of water distribution system meets or exceeds specified requirements.

1.6 PROJECT RECORD DOCUMENTS

- .1 Section 01 78 10: Submission procedures.
- .2 Disinfection report:
 - .1 Type and form of disinfectant used.
 - .2 Date and time of disinfectant injection start and time of completion.
 - .3 Test locations.
 - .4 Initial and 24 hour disinfectant residuals (quantity in treated water) in ppm for each outlet tested.
 - .5 Date and time of flushing start and completion.
 - .6 Disinfectant residual after flushing in ppm for each outlet tested.
- .3 Bacteriological report:
 - .1 Date issued, project name, and testing laboratory name, address, and telephone number.
 - .2 Time and date of water sample collection.
 - .3 Name of person collecting samples.
 - .4 Test locations.
 - .5 Initial and 24 hour disinfectant residuals in ppm for each outlet tested.
 - .6 Coliform bacteria test results for each outlet tested.
 - .7 Certification that water conforms, or fails to conform, to bacterial standards of [].

1.7 QUALITY ASSURANCE

- .1 Perform Work in accordance with AWWA C651.
- .2 Water Treatment Firm: Company specializing in disinfecting potable water systems specified in this Section with minimum three years documented experience.
- .3 Testing Firm: Company specializing in testing potable water systems, certified/approved by the Province of Manitoba.
- .4 Submit bacteriologist's signature and authority associated with testing.

1.8 REGULATORY REQUIREMENTS

- .1 Conform to applicable code or regulation for performing the work of this Section.
- .2 Provide certificate of compliance from authority having jurisdiction indicating approval of water system.

Part 2 Products

2.1 DISINFECTION CHEMICALS

- .1 Chemicals: AWWA B300, Hypochlorite, AWWA B301, Liquid Chlorine, AWWA B302, Ammonium Sulfate, and AWWA B303, Sodium Chlorite.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify that piping system and water well has been cleaned, inspected, and pressure tested.
- .2 Perform scheduling and disinfecting activity with start-up, testing, adjusting and balancing, demonstration procedures, including coordination with related systems.

3.2 EXECUTION

- .1 Provide and attach required equipment to perform the work of this Section.
- .2 Inject treatment disinfectant into piping system.
- .3 Maintain disinfectant in system for 24 hours.
- .4 Flush, circulate, and clean until required cleanliness is achieved; use domestic water.
- .5 Replace permanent system devices removed for disinfection.
- .6 Pressure test system to 400 kPa. Repair leaks and re-test.

3.3 FIELD QUALITY CONTROL

- .1 Section 01 44 00: Field inspection and testing.
- .2 Test samples in accordance with AWWA C651.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Pipe, pipe fittings, valves, and connections for piping systems.
 - .1 Sanitary sewer.
 - .2 Domestic water.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Administrative Requirements.
- .2 Section 01 44 00 - Quality Assurance: Requirements for references and standards.
- .3 Section 01 44 00 - Quality Assurance.
- .4 Section 01 61 00 - Common Product Requirements.
- .5 Section 01 78 10 - Execution Requirements.
- .6 Section 08 31 13 - Access Doors And Frames.
- .7 Section 09 91 10 - Painting.
- .8 Section 23 05 48 - Vibration Isolation.
- .9 Section 23 05 53 - Mechanical Identification.
- .10 Section 23 07 19 - Piping Insulation.
- .11 Section 26 05 80 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3 REFERENCES

- .1 AGA Z21.22 - Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems.
- .2 ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
- .3 ASME B16.3 - Malleable Iron Threaded Fittings.
- .4 ASME B16.4 - Grey Iron Threaded Fittings.
- .5 ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- .6 ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- .7 ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV.

- .8 ASME B16.26 - Copper Alloy Bronze Fittings for Flared Copper Tubes.
- .9 ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
- .10 ASME B16.32 - Cast Copper Alloy Solder Joint Fittings for Solvent Drainage Systems.
- .11 ASME B31.1 - Power Piping.
- .12 ASME B31.2 - Fuel Gas Piping.
- .13 ASME B31.9 - Building Services Piping.
- .14 ASME SEC IV - Construction of Heating Boilers.
- .15 ASME SEC IX - Welding and Brazing Qualifications.
- .16 ASTM A47/A47M - Ferritic Malleable Iron Castings.
- .17 ASTM A53/A53M - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- .18 ASTM A74 - Cast Iron Soil Pipe and Fittings.
- .19 ASTM A234/A234M - Piping Fittings of Wrought-Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
- .20 ASTM B32 - Solder Metal.
- .21 ASTM B42 - Seamless Copper Pipe, Standard Sizes.
- .22 ASTM B43 - Seamless Red Brass Pipe, Standard Sizes.
- .23 ASTM B68 - Seamless Copper Tube, Bright Annealed.
- .24 ASTM B75 - Seamless Copper Tube.
- .25 ASTM B88 - Seamless Copper Water Tube.
- .26 ASTM B251 - General Requirements for Wrought Seamless Copper and Copper-Alloy Tube.
- .27 ASTM B280 - Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
- .28 ASTM B302 - Threadless Copper Pipe, Standard Sizes.
- .29 ASTM B306 - Copper Drainage Tube (DWV).
- .30 ASTM C4 - Clay Drain Tile and Perforated Clay Drain Tile.

- .31 ASTM C14/C14M - Concrete Sewer, Storm Drain, and Culvert Pipe.
- .32 ASTM C425 - Compression Joints for Vitrified Clay Pipe and Fittings.
- .33 ASTM C443 - Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
- .34 ASTM C564 - Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
- .35 ASTM C700 - Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.
- .36 ASTM C1053 - Borosilicate Glass Pipe and Fittings for Drain, Waste, and Vent (DWV) Applications.
- .37 ASTM D1785 - Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
- .38 ASTM D2235 - Solvent Cement for Acrylonitrile - Butadiene - Styrene (ABS) Plastic Pipe and Fittings.
- .39 ASTM D2239 - Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.
- .40 ASTM D2241 - Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
- .41 ASTM D2447 - Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter.
- .42 ASTM D2466 - Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
- .43 ASTM D2513 - Thermoplastic Gas Pressure Pipe, Tubing, and Fittings.
- .44 ASTM D2564 - Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
- .45 ASTM D2609 - Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe.
- .46 ASTM D2661 - Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings.
- .47 ASTM D2662 - Polybutylene (PB) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.
- .48 ASTM D2665 - Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
- .49 ASTM D2666 - Polybutylene (PB) Plastic Tubing.
- .50 ASTM D2683 - Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
- .51 ASTM D2729 - Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- .52 ASTM D2751 - Acrylonitrile-Butadiene-Styrene (ABS) Sewer, Pipe, and Fittings.

- .53 ASTM D2846 - Chlorinated Polyvinyl Chloride (CPVC) Pipe, Fittings, Solvent Cements and Adhesives for Potable Hot Water Systems.
- .54 ASTM D2855 - Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.
- .55 ASTM D2996 - Filament-Wound 'Fibreglass' (Glass-Fibre-Reinforced Thermosetting-Resin) Pipe.
- .56 ASTM D2997 - Centrifugally-Cast 'Fibreglass' (Glass-Fibre-Reinforced Thermosetting-Resin) Pipe.
- .57 ASTM D3000 - Polybutylene (PB) Plastic Pipe (SDR-PR) Based on Outside Diameter.
- .58 ASTM D3034 - Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- .59 ASTM D3262 - 'Fibreglass' (Glass-Fibre-Reinforced Thermosetting-Resin) Sewer Pipe.
- .60 ASTM D3309 - Polybutylene (PB) Plastic Hot- and Cold-Water Distribution System.
- .61 ASTM D3517 - 'Fibreglass' (Glass-Fibre-Reinforced Thermosetting-Resin) Pressure Pipe.
- .62 ASTM D3754 - 'Fibreglass' (Glass-Fibre-Reinforced Thermosetting-Resin) Sewer and Industrial Pressure Pipe.
- .63 ASTM D3840 - 'Fibreglass' (Glass-Fibre-Reinforced Thermosetting-Resin) Pipe Fittings for Non-Pressure Applications.
- .64 ASTM E814 - Fire Tests of Through-Penetration Fire Stops.
- .65 ASTM F437 - Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
- .66 ASTM F438 - Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40.
- .67 ASTM F439 - Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
- .68 ASTM F441 - Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
- .69 ASTM F442 - Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe(SDR-PR).
- .70 ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
- .71 ASTM F493 - Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
- .72 ASTM F628 - Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe with a Cellular Core.

- .73 ASTM F679 - Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
- .74 ASTM F708 - Design and Installation of Rigid Pipe Hangers.
- .75 ASTM F1281 - Crosslinked Polyethylene/Aluminum/Crosslinked Polyethylene (PEX-AL-PEX) Pressure Pipe.
- .76 ASTM F1282 - Polyethylene/Aluminum/Polyethylene (PE-AL-PE) Composite Pressure Pipe.
- .77 AWS A5.8 - Filler Metals for Brazing and Braze Welding.
- .78 AWWA C105 - Polyethylene Encasement for Ductile-Iron Piping Systems.
- .79 AWWA C110 - Ductile - Iron and Gray - Iron Fittings, 3 In. - 48 In. (76 mm - 1219 mm), for Water.
- .80 AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- .81 AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast, for Water.
- .82 AWWA C651 - Disinfecting Water Mains.
- .83 AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe (and Fabricated Fittings), 4 inch - 12 inch (100 mm - 300 mm), for Water Distribution.
- .84 AWWA C901 - Polyethylene (PE) Pressure Pipe and Tubing, 1/2 inch - 3 inch (13 mm - 76 mm) for Water Service.
- .85 AWWA C902 - Polybutylene (PB) Pressure Pipe and Tubing, 1/2 inch - 3 inch (13 mm - 76 mm) for Water.
- .86 AWWA C905 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 inch - 48 inch (350 mm - 1200mm).
- .87 AWWA C950 - Fibreglass Pressure Pipe.
- .88 CAN-3 B281 - Aluminum Drain, Waste, and Vent Pipe and Components.
- .89 CISPI 301 - Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications.
- .90 CISPI 310 - Joints with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
- .91 MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
- .92 MSS SP-67 - Butterfly Valves.
- .93 MSS SP69 - Pipe Hangers and Supports - Selection and Application.

- .94 MSS SP-70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
- .95 MSS SP-71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends.
- .96 MSS SP-78 - Cast Iron Plug Valves, Flanged and Threaded Ends.
- .97 MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves.
- .98 MSS SP-85 - Cast Iron Globe & Angle Valves, Flanged and Threaded Ends.
- .99 MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
- .100 MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.
- .101 NCPWB - Procedure Specifications for Pipe Welding.
- .102 UL 1479 - Fire Tests of Through-Penetration Firestops.

1.4 SUBMITTALS FOR REVIEW

- .1 Section 01 33 00: Procedures for submittals.
- .2 Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

- .1 Section 01 78 10: Procedures for submittals.
- .2 Project Record Documents: Record actual locations of valves.

1.6 QUALITY ASSURANCE

- .1 Perform Work to Province of Manitoba standards. Maintain one copy on site.
- .2 Valves: Manufacturer's name and pressure rating marked on valve body.
- .3 Welding Materials and Procedures: Conform to ASME SEC IX and applicable provincial labour regulations.
- .4 Welders Certification: To ASME SEC IX and NCPWB Standard Procedure Specifications.
- .5 Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.

1.7 REGULATORY REQUIREMENTS

- .1 Perform Work to Province of Manitoba plumbing code.

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- .2 Conform to applicable code for installation of backflow prevention devices.

1.8 DELIVERY, STORAGE, AND PROTECTION

- .1 Section 01 61 00: Transport, handle, store, and protect products.
- .2 Accept valves on site in shipping containers with labelling in place. Inspect for damage.
- .3 Provide temporary protective coating on cast iron and steel valves.
- .4 Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- .5 Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.9 ENVIRONMENTAL REQUIREMENTS

- .1 Section 01 61 00: Environmental conditions affecting products on site.
- .2 Do not install underground piping when bedding is wet or frozen.

1.10 EXTRA MATERIALS

- .1 Section 01 78 10: Operation and maintenance data.
- .2 Provide two repacking kits for each size valve.

Part 2 Products**2.1 SANITARY SEWER PIPING, ABOVE GRADE**

- .1 PVC Pipe: ASTM D2729.
 - .1 Fittings: PVC.
 - .2 Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.
- .2 PVC Pipe: ASTM D2665.
 - .1 Fittings: PVC.
 - .2 Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

2.2 WATER PIPING, ABOVE GRADE

- .1 Copper Tubing: ASTM B88M, Type L, hard drawn.
 - .1 Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
 - .2 Joints: ASTM B32, solder, Grade 95TA.

2.3 FLANGES, UNIONS, AND COUPLINGS

- .1 Pipe Size 80 mm and Under:
 - .1 Ferrous pipe: Class 150 malleable iron threaded unions.
 - .2 Copper tube and pipe: Class 150 bronze unions with soldered joints.
- .2 Pipe Size Over 25 mm:
 - .1 Ferrous pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
 - .2 Copper tube and pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.
- .3 Grooved and Shouldered Pipe End Couplings:
 - .1 Housing: Malleable iron clamps to engage and lock, designed to permit some angular deflection, contraction, and expansion; steel bolts, nuts, and washers; galvanized for galvanized pipe.
 - .2 Sealing gasket: "C" shape composition sealing gasket.
- .4 Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.4 PIPE HANGERS AND SUPPORTS

- .1 Plumbing Piping - Drain, Waste, and Vent:
 - .1 Conform to ASME B31.9 ASTM F708 MSS SP58 MSS SP69 MSS SP89.
 - .2 Hangers for Pipe Sizes 15 to 40 mm: Carbon steel, adjustable swivel, split ring.
 - .3 Hangers for Pipe Sizes 50 mm and Over: Carbon steel, adjustable, clevis.
 - .4 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 - .5 Wall Support for Pipe Sizes to 80 mm: Cast iron hook.
 - .6 Wall Support for Pipe Sizes 100 mm and Over: Welded steel bracket and wrought steel clamp.
 - .7 Vertical Support: Steel riser clamp.
 - .8 Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 - .9 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- .2 Plumbing Piping - Water:
 - .1 Conform to ASME B31.9 ASTM F708 MSS SP58 MSS SP69 MSS SP89.
 - .2 Hangers for Pipe Sizes 15 to 40 mm: Malleable iron Carbon steel, adjustable swivel, split ring.
 - .3 Hangers for Cold Pipe Sizes 50 mm and Over: Carbon steel, adjustable, clevis.
 - .4 Hangers for Hot Pipe Sizes 50 to 100 mm: Carbon steel, adjustable, clevis.
 - .5 Hangers for Hot Pipe Sizes 150 mm and Over: Adjustable steel yoke, cast iron pipe roll, double hanger.

- .6 Multiple or Trapeze Hangers: Steel channels with welded supports or spacers and hanger rods.
- .7 Multiple or Trapeze Hangers for Hot Pipe Sizes 150 mm and Over: Steel channels with welded supports or spacers and hanger rods, cast iron roll.
- .8 Wall Support for Pipe Sizes to 80 mm: Cast iron hook.
- .9 Wall Support for Pipe Sizes 100 mm and Over: Welded steel bracket and wrought steel clamp.
- .10 Wall Support for Hot Pipe Sizes 150 mm and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron pipe roll.
- .11 Vertical Support: Steel riser clamp.
- .12 Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- .13 Floor Support for Hot Pipe Sizes to 100 mm: Cast iron adjustable pipe saddle, locknut, nipple, floor flange, and concrete pier or steel support.
- .14 Floor Support for Hot Pipe Sizes 150 mm and Over: Adjustable cast iron pipe roll and stand, steel screws, and concrete pier or steel support.
- .15 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.5**GATE VALVES**

- .1 Up To and Including 80 mm:
 - .1 MSS SP-80, Class 125 , bronze body, bronze trim, rising stem, handwheel, inside screw, solid wedge disc, solder or threaded ends.
- .2 50 mm and Larger:
 - .1 MSS SP-70, Class 125 , iron body, bronze trim, outside screw and yoke, handwheel, solid wedge disc, flanged ends. Provide chain-wheel operators for valves 150 mm and larger mounted over 2400 mm above floor.

2.6**GLOBE VALVES**

- .1 Up To and Including 80 mm:
 - .1 MSS SP-80, Class 125 , bronze body, bronze trim, handwheel, teflon disc, solder or threaded ends.
- .2 50 mm and Larger:
 - .1 MSS SP-85, Class 125 , iron body, bronze trim, handwheel, outside screw and yoke, renewable bronze plug-type disc, renewable seat, flanged ends. Provide chain-wheel operators for valves 150 mm and larger mounted over 2400 mm above floor.

2.7**BALL VALVES**

- .1 Construction, 100 mm and Smaller: MSS SP-110, Class 150, 2760 kPa CWP , bronze, two piece body, chrome plated brass ball, regular port, teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, solder or threaded ends with union.

2.8 PLUG VALVES

- .1 Construction 65 mm and Larger: MSS SP-78, 1200 kPa CWP , cast iron body and plug, pressure lubricated, teflon or Buna N packing, flanged or grooved ends. Provide lever operator with set screw.

2.9 FLOW CONTROLS

- .1 Construction: Class 150 , Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet , blowdown/backflush drain.
- .2 Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 24 kPa.

2.10 SWING CHECK VALVES

- .1 Up To and Including 80 mm:
 - .1 MSS SP-80, Class 125 , bronze body and cap, bronze swing disc with rubber seat, solder or threaded ends.
- .2 50 mm and Larger:
 - .1 MSS SP-71, Class 125 , iron body, bronze swing disc, renewable disc seal and seat, flanged or grooved ends.

2.11 SPRING LOADED CHECK VALVES

- .1 Class 125 , iron body, bronze trim, stainless steel springs, bronze disc, Buna N seals, wafer style ends.

2.12 WATER PRESSURE REDUCING VALVES

- .1 MSS SP-80, bronze body, stainless steel and thermoplastic internal parts, fabric reinforced diaphragm, strainer, threaded double union ends.
- .2 Over 50 mm:
 - .1 MSS SP-85, cast iron body, bronze fitted, elastomeric diaphragm and seat disc, flanged.

2.13 RELIEF VALVES

- .1 Pressure Relief:
 - .1 AGA Z21.22 certified, bronze body, teflon seat, steel stem and springs, automatic, direct pressure actuated.
- .2 Temperature and Pressure Relief:
 - .1 AGA Z21.22 certified, bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, temperature relief maximum 98.9 degrees C, capacity ASME SEC IV certified and labelled.

2.14 STRAINERS

- .1 Size 50 mm and Under:
 - .1 Class 150, threaded bronze body 2070 kPa CWP, Y pattern with 0.8 mm 1/32 inch stainless steel perforated screen.
- .2 Size 40 mm to 100 mm:
 - .1 Class 125, flanged iron body, Y pattern with 1.6 mm stainless steel perforated screen.
- .3 Size 125 mm and Larger:
 - .1 Class 125, flanged iron body, basket pattern with 3.2 mm stainless steel perforated screen.

2.15 FIRE STOP SYSTEMS

- .1 General Purpose Fire Stopping Sealant:
 - .1 Water based, nonslumping, premixed sealant with intumescent properties, rated for 3 hours per ASTM E814 and UL 1479.
- .2 General Purpose Vibration Resistant Fire Stopping Sealant:
 - .1 Silicone based, nonslumping, premixed sealant with intumescent properties, vibration and moisture resistant, rated for 3 hours per ASTM E814 and UL 1479.
- .3 DWV Plastic Pipe Systems Fire Stopping Sealant:
 - .1 Silicone based, premixed sealant with intumescent properties, vibration and moisture resistant, rated for 3 hours per ASTM E814 and UL 1479 with metal collars.

Part 3 Execution

3.1 EXAMINATION

- .1 Section 01100- Coordination and Meetings: Verification of existing conditions before starting work.
- .2 Verify that excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

- .1 Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- .2 Remove scale and dirt, on inside and outside, before assembly.
- .3 Prepare piping connections to equipment with flanges or unions.

3.3 INSTALLATION

- .1 Install to manufacturer's instructions.

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- .2 Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- .3 Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- .4 Install piping to maintain headroom, conserve space, and not interfere with use of space.
- .5 Group piping whenever practical at common elevations.
- .6 Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 23 05 16.
- .7 Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 23 07 19.
- .8 Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08 31 13.
- .9 Establish elevations of buried piping outside the building to ensure not less than 1.0 m of cover.
- .10 Install vent piping penetrating roofed areas to maintain integrity of roof assembly
- .11 Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- .12 Provide support for utility meters to requirements of utility companies.
- .13 Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 09 91 10.
- .14 Excavate to Sections 31 23 18 and 31 23 23 for work of this Section.
- .15 Backfill to Sections 31 23 16 and 31 23 23 for work of this Section.
- .16 Install bell and spigot pipe with bell end upstream.
- .17 Install valves with stems upright or horizontal, not inverted.
- .18 Pipe vents from gas pressure reducing valves to outdoors and terminate in weather proof hood.
- .19 Install water piping to ASME B31.9.
- .20 Sleeve pipes passing through partitions, walls and floors.
- .21 Inserts:
 - .1 Provide inserts for placement in concrete formwork.
 - .2 Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

- .3 Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 100 mm.
 - .4 Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - .5 Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above flush with top of recessed into and grouted flush with slab.
- .22 Pipe Hangers and Supports:
- .1 Install to ASTM B31.9 ASTM F708 and MSS SP89.
 - .2 Support horizontal piping as scheduled.
 - .3 Install hangers to provide minimum 15 mm space between finished covering and adjacent work.
 - .4 Place hangers within 300 mm of each horizontal elbow.
 - .5 Use hangers with 40 mm minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - .6 Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
 - .7 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 - .8 Provide copper plated hangers and supports for copper piping sheet lead packing between hanger or support and piping.
 - .9 Prime coat exposed steel hangers and supports. Refer to Section 09 91 10. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
 - .10 Provide hangers adjacent to motor driven equipment with vibration isolation; refer to Section 23 05 48.
 - .11 Support cast iron drainage piping at every joint.

3.4 APPLICATION

- .1 Use grooved mechanical couplings and fasteners only in accessible locations.
- .2 Install unions downstream of valves and at equipment or apparatus connections.
- .3 Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.
- .4 Install gate ball or butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- .5 Install globe ball or butterfly valves for throttling, bypass, or manual flow control services.
- .6 Provide lug end butterfly valves adjacent to equipment when provided to isolate equipment.
- .7 Provide spring loaded check valves on discharge of water pumps.
- .8 Provide flow controls in water recirculating systems where indicated.

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3.5 ERECTION TOLERANCES

- .1 Section 01 44 00: Tolerances.
- .2 Establish invert elevations, slopes for drainage to 2 one percent minimum. Maintain gradients.
- .3 Slope water piping minimum 0.25 percent and arrange to drain at low points.

3.6 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- .1 Disinfect water distribution system to Section 22 05 81.

3.7 SERVICE CONNECTIONS

- .1 Provide new sanitary sewer services. Before commencing work check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.
- .2 Provide new water service complete with approved double check backflow preventer and water meter with by-pass valves pressure reducing valve,.
 - .1 Provide sleeve in wall for service main and support at wall with reinforced concrete bridge. Caulk enlarged sleeve and make watertight with pliable material. Anchor service main inside to concrete wall.

3.8 SCHEDULES

- .1 Pipe Hanger Schedule:
 - .1 Metal Piping:
 - .1 Pipe size: 15 to 32 mm:
 - .1 Maximum hanger spacing: 2 m.
 - .2 Hanger rod diameter: 9 mm.
 - .2 Pipe size: 40 to 50 mm:
 - .1 Maximum hanger spacing: 3 m.
 - .2 Hanger rod diameter: 9 mm.
 - .3 Pipe size: 65 to 75 mm:
 - .1 Maximum hanger spacing: 3 m.
 - .2 Hanger rod diameter: 13 mm.
 - .4 Pipe size: 100 to 150 mm:
 - .1 Maximum hanger spacing: 3 m.
 - .2 Hanger rod diameter: 15 mm.
 - .5 Pipe size: 200 to 300 mm:
 - .1 Maximum hanger spacing: 4.25 m.
 - .2 Hanger rod diameter: 22 mm.
 - .6 Pipe size: 350 mm and Over:
 - .1 Maximum hanger spacing: 6 m.

- .2 Hanger rod diameter: 25 mm.
- .2 Plastic Piping:
 - .1 All Sizes:
 - .1 Maximum hanger spacing: 1.8 m.
 - .2 Hanger rod diameter: 9 mm.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Roof and floor drains.
- .2 Cleanouts.
- .3 Hose bibs.
- .4 Hydrants.
- .5 Backflow preventers.
- .6 Water hammer arrestors.
- .7 Interceptors.
- .8 Thermostatic mixing valves.
- .9 Catch basins and manholes.
- .10 Lift Station

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Administrative Requirements.
- .2 Section 01 61 00 - Common Product Requirements.
- .3 Section 01 78 10 - Execution Requirements.
- .4 Section 22 10 00 - Plumbing Piping.
- .5 Section 22 42 02 - Plumbing Fixtures.
- .6 Section 22 47 00 - Plumbing Equipment.
- .7 Section 26 05 80 - Equipment Wiring: Electrical characteristics and wiring connections.
- .8 Section 33 05 13 - Manholes And Catch Basins.

1.3 REFERENCES

- .1 ASME A112.21.1 - Floor Drains.
- .2 ASME A112.21.2 - Roof Drains.
- .3 ASME A112.26.1 - Water Hammer Arrestors.

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- .4 ASSE 1011 - Hose Connection Vacuum Breakers.
- .5 ASSE 1012 - Backflow Preventers with Immediate Atmospheric Vent.
- .6 ASSE 1013 - Backflow Preventers, Reduced Pressure Principle.
- .7 ASSE 1019 - Wall Hydrants, Frost Proof Automatic Draining Anti-Backflow Types.
- .8 ASTM C478 - Precast Reinforced Concrete Manhole Sections.
- .9 AWWA C506 - Backflow Prevention Devices - Reduced Pressure Principle and Double Check Valve Types.
- .10 PDI G-101 - Testing and Rating Procedure for Grease Interceptors with Appendix of Sizing and Installation Data.
- .11 PDI WH-201 - Water Hammer Arrestors.

1.4 SUBMITTALS FOR REVIEW

- .1 Section 01 33 00: Procedures for submittals.
- .2 Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.
- .3 Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.

1.5 SUBMITTALS FOR INFORMATION

- .1 Section 01 33 00: Procedures for submittals.
- .2 Manufacturer's Instructions: Indicate Manufacturer's Installation Instructions: Indicate assembly and support requirements.

1.6 SUBMITTALS AT PROJECT CLOSEOUT

- .1 Section 01 78 10: Procedures for submittals.
- .2 Project Record Documents: Record actual locations of equipment, cleanouts, backflow preventers, water hammer arrestors.
- .3 Operation Data: Indicate frequency of treatment required for interceptors.
- .4 Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.7 QUALITY ASSURANCE

- .1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.8 DELIVERY, STORAGE, AND PROTECTION

- .1 Section 01 61 00: Transport, handle, store, and protect products.
- .2 Accept specialties on site in original factory packaging. Inspect for damage.

1.9 EXTRA MATERIALS

- .1 Section 01 78 10.
- .2 Supply two loose keys for outside hose bibs, hose end vacuum breakers for hose bibs, service kits for .

Part 2 Products**2.1 FLOOR DRAINS**

- .1 Floor Drain (FD-1):
 - .1 Manufacturers:
 - .1 Zurn Model ZN-415-R.
 - .2 Substitutions: Refer to Section 01 62 00.
 - .2 ANSI A112.21.1; lacquered galvanized cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable nickel-bronze strainer.
 - .3 Tamper proof gill with holes no larger than 12mm
 - .4 Secure with security screws Series 262 mil-spec S46163A Type 2 Grade 0
 - .5 Mount screws with "Locktite Liquid Thread Locker"
- .2 Floor Drain (FD-2):
 - .1 Smith Series 2005A-P050 Floor Drain, all Duco coated cast iron body, reversible flashing clamp with seepage openings and adjustable 5" (127mm) diameter nickel bronze 1/4" (6.35mm) thick strainer, secured with S.S. screws, 4" (100mm) throat on strainer. In quarry or mosaic tiled areas, provide 'B' - 5" x 5" (127mm x 127mm) square nickel bronze strainer. Provide a trap seal primer line to all floor drains.
 - .2
- .3 Floor Drain (FD-3):
 - .1 Manufacturers:
 - .1 ZURN ZN-211-BE Funnel Floor Drain, Dura-Coated cast iron body with bottom outlet, adjustable "Type BE" polished nickel bronze round strainer with 4" 102 round funnel.
 - .2 Substitutions: Refer to Section 01 62 00.
 - .2 ANSI A112.21.1; lacquered galvanized cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable nickel-bronze strainer with polished bronze funnel or anti-splash rim.

2.2 CLEANOUTS

- .1 Interior Finished Floor Areas (CO):
 - .1 Manufacturers:
 - .1 Zurn Model ZN-1400-HD-BP-NH
 - .2 Substitutions: Refer to Section 01 62 00.
 - .2 Galvanized cast iron body with anchor flange, reversible clamping collar, threaded top assembly, and round gasketed scored cover in service areas and round gasketed depressed cover to accept floor finish in finished floor areas.
- .2 Interior Finished Wall Areas (CO):
 - .1 Manufacturers:
 - .1 Zurn Model ZANB-1460
 - .2 Substitutions: Refer to Section 01 62 00.
 - .2 Line type with lacquered cast iron body and round epoxy coated gasketed cover, and round stainless steel access cover secured with machine screw.
- .3 Interior Unfinished Accessible Areas (CO-5): Caulked or threaded type. Provide bolted stack cleanouts on vertical rainwater leaders.

2.3 HOSE BIBS

- .1 Interior:
 - .1 Manufacturers:
 - .1 Zurn 1341 Wall Faucet
 - .2 Substitutions: Refer to Section 01 62 00.
 - .2 Bronze or brass with integral mounting flange, replaceable hexagonal disc, hose thread spout, with handwheel, vacuum breaker to ANSI/ASSE 1011.

2.4 HYDRANTS

- .1 Wall Hydrant:
 - .1 Manufacturers:
 - .1 Zurn Model Z-1305 Non Freeze Wall Hydrant
 - .2 Substitutions: Refer to Section 01 62 00.
 - .2 ANSI/ASSE 1019; non-freeze, self-draining type with lockable recessed box hose thread spout, handwheel, and integral vacuum breaker 19 dia

2.5 RECESSED VALVE BOX

- .1 Washing Machine:
 - .1 Manufacturers:
 - .1 Oatey Model 38995. 18GA Metal Washing machine outlet box c/w copper sweat valves and water hammer arrestors.
 - .2 Substitutions: Refer to Section 01 62 00.

- .2 Plastic preformed rough-in box with brass valves with single lever handle, socket for 50 mm waste, slip in finishing cover.

2.6 BACKFLOW PREVENTERS

.1 Reduced Pressure Backflow Preventers:

- .1 ANSI/ASSE 1013 AWWA C506; bronze body with bronze internal parts and stainless steel springs; two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve that opens under back pressure in case of diaphragm failure; non-threaded vent outlet; assembled with two gate valves, strainer, and four test cocks.

.2 Double Check Valve Assemblies:

- .1 ANSI/ASSE 1012 AWWA C506; Bronze body with corrosion resistant internal parts and stainless steel springs; two independently operating check valves with intermediate atmospheric vent.

2.7 WATER HAMMER ARRESTORS

- .1 ANSI A112.26.1; stainless steel construction, bellows type sized to PDI WH-201, precharged suitable for operation in temperature range -73 to 149 degrees C 1 to 120 degrees C and maximum 1700 kPa 1000 kPa working pressure.

2.8 SUMPS

- .1 Manufacturer: Westland Plastics Model SP-02OCT. 30"x30" sump pit with a capacity of 75 gallons.
 - .1 Substitutions: Refer to Section 01 62 00.
- .2 Cover: By Manufacturer.

2.9 TRAP PRIMERS

- .1 Manufacturer: P.P.P. Inc. Model PR-500
- .2 All Brass with integral Vacuum Breaker, NPS 1/2" solder ends, 1/2" drip line connection.

2.10 LIFT STATION LS-1

- .1 The duplex ejector system shall be Model 1102 /LE73M as manufactured by Liberty Pumps, Bergen, N.Y. or equal. The system shall be factory pre-assembled with pumps, discharge pipe nipples, and floats pre-mounted in the basin. Volume per pump cycle shall be factory set at 28 U.S. gallons. Floats shall be tethered to a removable standpipe/access cover assembly.
- .2 The basin shall be constructed of heavy duty polyethylene. Dimensions shall be 30" diameter x 36" deep and shall have a total capacity of 110 U.S. gallons. The inlet hub

shall be 4" and preassembled to basin. The basin shall have "torque-stops" to locate and retain the pump in its proper position

- .3 The cover shall be "heavy duty" 1/4" steel plate, enamel-coated on both sides. The cover shall be 34" in diameter, and have 2" discharges and vent flange. The cover shall be fitted with two 16" diameter pump openings, and one 10" diameter inspection cover with integral stand pipe for float tethering. All cover hardware shall be stainless steel.
- .4 Control: A NEMA 1 indoor duplex control panel with four float switches and a high water alarm. High water alarm to be located at front reception counter.
- .5 Pump: Liberty Model LE70-73M2-3 Each submersible pump shall be rated at 3/4 hp 208 volts 3 phase 60 Hz. 1725 RPM. The unit shall produce 140 G.P.M. at 5 feet of total dynamic head. The submersible pump shall be capable of handling residential sewage with 2" solid handling capability. The submersible pump shall have a shut-off head of 28 feet and a maximum flow of 144 GPM @ 5 feet of total dynamic head.

Part 3 Execution

3.1 INSTALLATION

- .1 Install to manufacturer's instructions.
- .2 Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.
- .3 Encase exterior cleanouts in concrete flush with grade.
- .4 Install floor cleanouts at elevation to accommodate finished floor.
- .5 Install approved potable water protection devices on plumbing lines where contamination of domestic water may occur; on boiler feed water lines, janitor rooms, fire sprinkler systems, premise isolation, irrigation systems, flush valves, interior and exterior hose bibs.
- .6 Pipe relief from backflow preventer to nearest drain.
- .7 Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to lavatories sinks washing machine outlets.
- .8 Install air chambers on hot and cold water supply piping to each fixture or group of fixtures (each washroom). Fabricate same size as supply pipe or 20 mm minimum, and minimum 450 mm long.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Water closets.
- .2 Penal combi-units.
- .3 Urinals.
- .4 Lavatories.
- .5 Sinks.
- .6 Service sinks.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Administrative Requirements.
- .2 Section 01 44 00 - Quality Assurance.
- .3 Section 01 61 00 - Common Product Requirements.
- .4 Section 01 78 10 - Execution Requirements.
- .5 Section 07 92 00 - Joint Sealants: Seal fixtures to walls and floors.
- .6 Section 23 05 29 - Supports And Anchors.
- .7 Section 22 10 00 - Plumbing Piping.
- .8 Section 22 42 01 - Plumbing Specialties.
- .9 Section 22 47 00 - Plumbing Equipment.
- .10 Section 26 05 80 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3 REFERENCES

- .1 ASME A112.6.1 - (Floor Affixed) Supports for Off-the-Floor Plumbing Fixtures for Public Use.
- .2 ASME A112.18.1 - Plumbing Fixture Fittings.
- .3 ASME A112.19.1 - Enamelled Cast Iron Plumbing Fixtures.
- .4 ASME A112.19.2 - Vitreous China Plumbing Fixtures.
- .5 ASME A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).

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.6 ASME A112.19.4 - Porcelain Enamelled Formed Steel Plumbing Fixtures.

.7 ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks, and Urinals.

.8 NFPA 70 - National Electrical Code.

1.4 SUBMITTALS FOR REVIEW

.1 Section 01 33 00: Procedures for submittals.

.2 Product Data: Provide catalogue illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

.3 Samples: Submit two lavatory supply fittings fixtures for colour matching sets of colour chips for each standard colour .

1.5 SUBMITTALS FOR INFORMATION

.1 Section 01 33 00: Procedures for submittals.

.2 Manufacturer's Instructions: Indicate installation methods and procedures.

1.6 SUBMITTALS AT PROJECT CLOSEOUT

.1 Section 01 78 10: Procedures for submittals.

.2 Maintenance Data: Include fixture trim exploded view and replacement parts lists.

.3 Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.7 QUALITY ASSURANCE

.1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.8 REGULATORY REQUIREMENTS

.1 Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.9 DELIVERY, STORAGE, AND PROTECTION

.1 Section 01 61 00: Transport, handle, store, and protect products.

.2 Accept fixtures on site in factory packaging. Inspect for damage.

.3 Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.10 WARRANTY

- .1 Section 01 78 10.

1.11 EXTRA MATERIALS

- .1 Section 01 78 10.
- .2 Supply two sets of faucet washers, Flush valve service kits, lavatory supply fittings, shower heads, toilet seats..

Part 2 Products

2.1 TANK TYPE WATER CLOSETS WC-1 AND WC-2

- .1 American Standard Cadet 3 right height elongated 419 mm high #2386.500.020 low consumption toilet, white vitreous china with Everclean antimicrobial surface, floor-mounted, siphon jet flush action, 6l per flush, raised sanitary bar and four point tank stabilization. Lined tank, unbolted tank cover, oversized flush valve with flapper, pilot valve water control (without float) for quiet refill, 12" rough-in, and 54mm fully glazed internal trapway, floor outlet, bolt caps. Centoco #820STSS.001 heavy duty toilet seat, for elongated bowl open front, white solid plastic, with cover, reinforced stainless steel check hinges, metal flat washers stainless steel posts and nuts. McGuire #H1 72BV toilet supply, chrome plated polished brass, ¼ turn ball valve angle stop, 13mm i.d. inlet x 127mm long rigid short horizontal integral copper sweat tube nipple, combination v.p. loose key handle, escutcheon and flexible copper riser. Floor flange (provide same material as connecting pipe drain) with all brass bolts and rubber gasket.

2.2 WATER/LAVATORY COMBO DF-1

- .1 Combination water closet and lavatory for prison cell, floor type waste outlet one piece unit with welded components of 1.8mm 304 stainless steel with recessed paper holder. 1.8mm vertical cabinet enclosure reinforced with 3mm steel plate, angles and wall sleeve completely sound deadened. Exposed surfaces #4 finishes
- .2 Water closet bowl: elongated, blowout type with back inlet and outlet, with integral flushing rim, complete with min. 76mm trap seal, capable of passing a 64mm ball and free of burrs, crevices and projections. Jet located at lowest point of upward leg trap.
- .3 Lavatory top bowl: on piece of construction with perforated fast drain outlet and raised edges around rim and back, integral trap. Lavatory back with keyed depression for push button escutcheon and fastened with lock nut to prevent removal from room side. Hot and cold vandal proof push button valves complete with lavatory spout. The water shall discharge from the spout in a downward direction and NOT upward.
- .4 Self draining soap dish, no paper holders, nuts and mounting angles shall be included with the unit. No exposed fasteners in room allowed, all piping concealed.

- .5 Concealed penal flushometer with remote controlled cast brass adjustable flush diaphragm valve, pressure loss check, vacuum breaker, renewable seat flush connection for 40 mm back spun and universal 25mm i.p./copper sweat inlet wheel handle angle stop

- .1 Acceptable Materials
 - .1 Fixture: Acorn 1440
 - .2 Willoughby 1806 ECW-R/L-MOD-RCMP

2.3 WALL HUNG URINALS

- .1 Urinal:
 - .1 Manufacturer: American Standard Model 6590.525 Ultra High Efficiency Urinal System.
 - .2 Other acceptable manufacturers offering equivalent products.
 - .1 Substitutions: Refer to Section 01 62 00.
 - .3 ASME A112.19.2; vitreous china, wall hung washout urinal with shields, integral trap, removable stainless steel strainer, 25 mm, top spud, steel supporting hanger.
- .2 Exposed Flush Valve:
 - .1 Manufacturer: American Standard Selectronic Flush Valve.
 - .2 Other acceptable manufacturers offering equivalent products.
 - .1 Substitutions: Refer to Section 01 62 00.

2.4 LAVATORIES LAV-1

- .1 Vitreous China Wall Hung Basin: LAV-1, LAV-2
 - .1 Manufacturer: American Standard Aqualyn 0476028
 - .2 Substitutions: Refer to Section 01 62 00.
 - .2 Vitreous china, CSA B651 listed ,self-rimming, with front overflow, soap depressions, gasket, swivel clamps, semi-oval or rectangular bowl, supply openings on 100mm centres. Sizes: 475 x 400 mm outside, 400 x 250mm nominal inside.
- .2 Trim
 - .1 Moen M Dura 8228 chrome-plated cast brass 8"(400mm) widespread faucet. Handles shall be 4" wrist-blade with hot and cold d indicators and affixed by vandal-resistant screws.
- .3 Accessories:
 - .1 Chrome plated 1.3 mm brass P-trap with clean-out plug and arm with escutcheon.
 - .2 Offset waste with perforated open strainer plug and strainer.
 - .3 Screwdriver stops.
 - .4 Rigid supplies.

2.5 SINKS

- .1 **DOUBLE COMPARTMENT BOWL: S-1**

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- .1 Manufacturer: Kindred LBD7508P-1/3
- .2 Substitutions: Refer to Section 01 62 00.
- .2 ASME A112.19.3; Double bowl sink with faucet ledge 18 GA SS. Self rimming. Exposed surfaces are satin finished. Spillway between bowls. Underside is fully sound dampened and undercoated. Complete with factory installed rim seal, installation kit and 3 ½" waste assembly. O.D. 56X84X20 cm outside dimensions. Faucet drilled for 3 hole 1 ½" diameter on 4" centers, 8" widespread.
- .3 Trim:
 - .1 Manufacturer: DELTA 100LF-HDF
 - .2 Substitutions: Refer to Section 01 62 00.
- .4 ASME A112.18.1; chrome plated brass supply with long swing spout, vandal proof water economy aerator with maximum 0.14 L/s flow, single lever handle.
- .5 Accessories: 1.3 mm brass P-trap with clean-out plug and arm with escutcheon, wheel handle stop, flexible supplies.
- .2 SINGLE COMPARTMENT BOWL: S-2**
 - .1 Kindred Commercial LBS1306 S.S. sink, three hole with 4" centers, 8" wide spread , 15-7/16" x 15-1/6" x 6" (392mm x 384mm x 152mm) deep, counter mounted, back ledge, grade 18-8 type 302 stainless steel, single compartment, satin finished rim and bowl, self-rimming, with 1 1/2" (38mm) tail piece, sound deadening and mounting kit, 3-112" (89mm) crumb cup strainer with 1-112" (38mm) tail piece.
 - .2 Substitutions: Refer to Section 01 62 00.
- .2 Trim:
 - .1 Moen model #8248 two handle faucet with 4" blades, brass construction with chrome plating, gooseneck swing spout, 2.2 GPM vandal proof aerator, and ceramic cartridge. Substitutions: Refer to Section 01 62 00.
- .3 Accessories: 1.3 mm brass P-trap with clean-out plug and arm with escutcheon, wheel handle stop, flexible supplies.
- .3 SINGLE COMPARTMENT BOWL: S-3**
 - .1 Manufacturer: Kindred LBS4608P-1/3
 - .2 Substitutions: Refer to Section 01 62 00.
 - .2 ASME A112.19.3; Single bowl sink with faucet ledge 18 GA SS. Self rimming. Exposed surfaces are satin finished. Spillway between bowls. Underside is fully sound dampened and undercoated. Complete with factory installed rim seal, installation kit and 3 ½" waste assembly. O.D. 36X41X20 cm outside dimensions. Faucet drilled for 3 hole 1 ½" diameter on 4" centers, 8" widespread.
 - .3 Trim:
 - .1 Manufacturer: DELTA 100LF-HDF
 - .2 Substitutions: Refer to Section 01 62 00.
 - .4 ASME A112.18.1; chrome plated brass supply with long swing spout, vandal proof water economy aerator with maximum 0.14 L/s flow, single lever handle.
 - .5 Accessories: 1.3 mm brass P-trap with clean-out plug and arm with escutcheon, wheel handle stop, flexible supplies.

.4 SINGLE COMPARTMENT BOWL: S-4

- .1 Manufacturer: Kindred LBS7808P-1/3
- .2 Substitutions: Refer to Section 01 62 00.
- .2 ASME A112.19.3; Single bowl sink with faucet ledge 18 GA SS. Self rimming. Exposed surfaces are satin finished. Spillway between bowls. Underside is fully sound dampened and undercoated. Complete with factory installed rim seal, installation kit and 3 1/2" waste assembly. O.D. 43X71X20 cm outside dimensions. Faucet drilled for 3 hole 1 1/2" diameter on 4" centers, 8" widespread.
- .3 Trim:
 - .1 Manufacturer: DELTA 100LF-HDF
 - .2 Substitutions: Refer to Section 01 62 00.
- .4 ASME A112.18.1; chrome plated brass supply with long swing spout, vandal proof water economy aerator with maximum 0.14 L/s flow, single lever handle.
- .5 Accessories: 1.3 mm brass P-trap with clean-out plug and arm with escutcheon, wheel handle stop, flexible supplies.

2.6 SERVICE SINKS MS-1

- .1 Bowl:
 - .1 Manufacturer: Crane: Fiat Model TSB-100
 - .1 Substitutions: Refer to Section 01 62 00.
- .2 Trim:
 - .1 Manufacturer: Fiat 830-AA
 - .2 Other acceptable manufacturers offering equivalent products.
 - .1 Substitutions: Refer to Section 01 62 00.
 - .3 ASME A112.18.1 exposed wall type supply with lever handles, spout wall brace, vacuum breaker, hose end spout, strainers, eccentric adjustable inlets, integral screwdriver stops with covering caps and adjustable threaded wall flanges.
- .3 Accessories:
 - .1 1.5 m of 13 mm diameter plain end reinforced plastic rubber hose.
 - .2 Hose clamp hanger.
 - .3 Mop hanger.
 - .4 Aluminum Bumper Guard
 - .5 Wall Guards

2.7 EMERGENCY EYE AND FACE WASH EW-1

- .1 Manufacturer:
 - .1 Manufacturer: Haws Model 7360BT wall mount eyewash unit
 - .1 Substitutions: Refer to Section 01 62 00.

- .2 ANSI Z358.1; wall-mounted, self-cleaning, non-clogging eye and face wash with quick opening, full-flow valves, stainless steel eye and face wash receptor, twin eye wash heads and face spray ring, stainless steel dust cover, copper alloy PVC control valve and fittings.
- .3 Thermostatic Mixing valve:
 - .1 Haws #9201EW Emergency Supply Fixture For Eyewash/ Face wash, thermostatic temperature control valve, all brass and stainless steel design, with liquid-filled thermal motor, inlet check valve, safety shut-off should cold water supply fail, hot water failure will allow cold water flow through both the fixed and variable by-pass, outlet temperature gauge, 1/2" (13mm) NPT inlets and outlets. Tempered water factory set at 85°F (29°C) (Mixing Valve provides up to 7 GPM (26.6 LPM) at 30psi (246kPa) drop through valve), temperature range 70°F (21°C) to 90°F (32°C) with set point at 85°F (29°C).
 - .2 Cold water bypass, positive shut off on cold water failure, capacity of 38 litres per minute(10 gpm), dial thermometers reading 0 degree C to 50 degree C and union angle check stops on inlets
 - .3 Certified by CSA to meet ANSI Z358.1 Standard for emergency eyewash and shower equipment.
 - .4 Dust Cover

2.8 SHOWER SH-1

- .1 Fait Model: A6036.05LF100 1-Piece Acrylic Shower High gloss acrylic with fiberglass reinforcement Fold-up wheelchair seat Integrally molded soap dish and shelves 1-3/4" (44mm) Threshold (1) - 30" (76mm) x 1-1/2" (38mm) horizontal stainless steel grab bar (side wall) (1) - 48" (1219mm) x 1-1/2" (38mm) horizontal stainless steel grab bar (back wall) (1) - 1" (25mm) stainless steel curtain rod. Safety-textured floor pattern.
- .2 Trim: Delta Model T17TH335 TempAssure® 17T Thermostatic cartridge • Thermostatic wax element maintains the outlet temperature to +/- 3.6 F • Polished chrome plated finish • Non-removeable red/blue temperature markings • Separate ROUGH-IN – R10700-UNWS required • ADA Compliant diverter handle • ADA Compliant lever volume control, field adjustable to limit rotation into hot water zone; temperature adjustment dial • In-wall diverter valve (R10700-UNWS ROUGH-IN) • Standard 24" Stainless Steel Bar with ADA Slide Handshower with Push Button Pause • Handshower Flow Rate MAX: 2.5 GPM @ 80 PSI (9.5 L/min @ 552 kPa) • Handshower Flow Rate MIN: 2.4 GPM @ 45 PSI (9.1 L/min @ 310 kPa) • Backflow protection provided by two integral check valves in handshower • Handle#: 5 - Metal Lever Volume Control Handle w/Temperature Adjustment • #3 Shower - Touch Clean™ Showerhead, Arm and Flange • #3 Shower Flow Rate MAX: 2.0 GPM @ 80 PSI (7.6 L/min @ 552 kPa) • #3 Shower Flow Rate MIN: 1.8 GPM @ 45 PSI (6.8 L/min @ 310 kPa)

2.9 SHOWER SH-2

- .1 Acorn Model 17413-1750, recessed rear-mount penal shower head complete with following features: triple chrome plated brass construction, vandal resistant, tapered body, non-removable spray head complete with 0.16 lps flow rate. Nominal 30 degree angle spray complete with adjustable spray pattern. Stainless steel back plate. Provide rear access.

- .2 Trim: Acudor Acorn Model 1741-03-M shower assembly complete with shower head. Remote mount pressure balancing temperature control box.
 - .1 Recessed rear mount penal metering valve complete with following features: stainless steel non-hold open push button and back plate. Single temperature metering valve complete with strainer, check stop, 0.16 L/s flow control and adjustable 15 second to 120 second time range. Pressure balanced mixing valve complete with temperature gauge, adjustable temperature limit stop set at 40 degrees Celsius and check stops. 75 mm dial 0-93 degrees Celsius thermometer. Ball type isolation valves. Steel shower control panel complete with key access hinged door, enamel finish to match wall, and identification in 25 mm letters on front. Shower valve to be accessible from adjacent Room.
- .3 Thermostatic Mixing Valve: Symmons 7-102A, complete with wall mounting bracket

2.10 HOSE REEL

- .1 Guardian Model 3621 swing out hose reel
- .2 Thermostatic Mixing Valve: Symmons 7-200A, complete with wall mounting bracket

Part 3 Execution

3.1 EXAMINATION AND PREPARATION

- .1 Section 01 70 00: Verification of existing conditions before starting work.
- .2 Verify that walls and floor finishes are prepared and ready for installation of fixtures.
- .3 Verify that electric power is available and of the correct characteristics.
- .4 Confirm that millwork is constructed with adequate provision for the installation of counter top lavatories and sinks.

3.2 PREPARATION

- .1 Rough-in fixture piping connections to minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.3 INSTALLATION

- .1 Install each fixture with trap, easily removable for servicing and cleaning.
- .2 Provide chrome plated rigid or flexible supplies to fixtures with loose key screwdriver stops, reducers, and escutcheons.
- .3 Install components level and plumb.
- .4 Install and secure fixtures in place with wall supports wall carriers and bolts.

- .5 Seal fixtures to wall and floor surfaces with sealant as specified in Section 07 92 00, colour to match fixture.
- .6 Solidly attach water closets to floor with lag screws. Lead flashing is not intended hold fixture in place.

3.4 INTERFACE WITH OTHER PRODUCTS

- .1 Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

3.5 ADJUSTING

- .1 Section 01 78 10 - Execution Requirements: Adjusting installed work.
- .2 Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.6 CLEANING

- .1 Section 01 78 10 - Execution Requirements: Cleaning installed work.
- .2 Clean plumbing fixtures and equipment.

3.7 PROTECTION OF FINISHED WORK

- .1 Section 01 78 10 - Execution Requirements: Protecting installed work.
- .2 Do not permit use of fixtures.

3.8 SCHEDULES

- .1 Fixture Heights: Install fixtures to heights above finished floor as indicated.
 - .1 Water Closet:
 - .1 Standard: 380 mm mm to top of bowl rim.
 - .2 Accessible: 455 mm mm to top of seat.
 - .2 Water Closet Flush Valves:
 - .1 Standard: 280 mm mm min. above bowl rim.
 - .2 Recessed: 255 mm mm min. above bowl rim.
 - .3 Urinal:
 - .1 Standard: 560 mm mm to top of bowl rim.
 - .2 Accessible: 430 mm mm to top of bowl rim.
 - .4 Lavatory:
 - .1 Standard: 785 mm mm to top of basin rim.
 - .2 Accessible: 865 mm mm to top of basin rim.
 - .5 Drinking Fountain:
 - .1 Child: 760 mm mm to top of basin rim.

- .2 Standard Adult: 1015 mm mm to top of basin rim.
- .3 Accessible: 915 mm mm to top of spout.
- .6 Shower Heads:
 - .1 Adult Male: 1765 mm mm to bottom of head.
 - .2 Adult Female: 1640 mm mm to bottom of head.
 - .3 Child: 1490 mm mm to bottom of head.
- .7 Emergency Eye And Face Wash:
 - .1 Standard: 965 mm mm to receptor rim.
- .8 Emergency Shower:
 - .1 Standard: 2130 mm mm to bottom of head.

.2 Fixture Rough-In

Water Closet: (Flush Valve)	25 mm	100 mm	50 mm	
Water Closet: (Tank Type)	15 mm	100 mm	50 mm	
Bidet:	15 mm	15 mm	40 mm	32 mm
Urinal: (Flush Valve)	20 mm	50 mm	40 mm	
Urinal: (Tank Type)	15 mm	50 mm	40 mm	
Lavatory:	15 mm	15 mm	40 mm	32 mm
Sink:	15 mm	15 mm	40 mm	32 mm
Service Sink:	15 mm	15 mm	50 mm	40 mm
Service Sink:	15 mm	15 mm	80 mm	40 mm
Drinking Fountain:	15 mm	32 mm	32 mm	
Bathtub:	15 mm	15 mm	40 mm	32 mm
Shower:	15 mm	15 mm	40 mm	32 mm

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Water Heaters.
- .2 Pumps.
 - .1 Hot water circulators.
 - .2 Sump Pumps.
 - .3 Sewage Ejectors.
- .3 Water pressure booster system.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Administrative Requirements.
- .2 Section 01 61 00 - Common Product Requirements.
- .3 Section 01 78 10 - Execution Requirements.
- .4 Section 23 05 48 - Vibration Isolation.
- .5 Section 26 05 80 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3 REFERENCES

- .1 ASHRAE 90A - Energy Conservation in New Building Design.
- .2 ASME Section 8D - Boilers and Pressure Vessel Codes - Rules for Construction of Pressure Vessels.
- .3 UL 1453 - Electric Booster and Commercial Storage Tank Water Heaters.
- .4 UL 174 - Household Electric Storage Tank Water Heaters.
- .5 CAN/CSA C22.2 No.110, Construction and Test of Electric Storage Tank Water Heaters.
- .6 CAN/CSA-C191, Performance of Electric Storage Tank Water Heaters for Household Service.
- .1 CAN/CSA-C309, Performance Requirements for Glass-Lined Storage Tanks for Household Hot Water Service.

1.4 SUBMITTALS FOR REVIEW

- .1 Section 01 33 00: Procedures for submittals.
- .2 Product Data:

□

- .1 Provide dimension drawings of water heaters indicating components and connections to other equipment and piping.
 - .2 Indicate pump type, capacity, power requirements.
 - .3 Provide certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.
 - .4 Provide electrical characteristics and connection requirements.
- .3 Shop Drawings:
- .1 Indicate heat exchanger dimensions, size of tapplings, and performance data.
 - .2 Indicate dimensions of tanks, tank lining methods, anchors, attachments, lifting points, tapplings, and drains.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

- .1 Section 01 78 10: Procedures for submittals.
- .2 Project Record Documents: Record actual locations of components.
- .3 Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.
- .4 Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.6 QUALITY ASSURANCE

- .1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- .2 Provide pumps with manufacturer's name, model number, and rating/capacity identified.
- .3 Ensure products and installation of specified products are to recommendations and requirements of the following organizations:
 - .1 Canadian Standards Association (CSA).
 - .2 National Sanitation Foundation (NSF).
 - .3 American Society of Mechanical Engineers (ASME).
 - .4 National Board of Boiler and Pressure Vessel Inspectors (NBBPVI).
 - .5 National Electrical Manufacturers' Association (NEMA).
 - .6 Underwriters Laboratories of Canada (ULC).
- .4 Ensure pumps operate at specified system fluid temperatures without vapour binding and cavitation, are non-overloading in parallel or individual operation, operate within 25 percent of midpoint of published maximum efficiency curve.

1.7 DELIVERY, STORAGE, AND PROTECTION

- .1 Section 01 61 00: Transport, handle, store, and protect products.

- .2 Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.8 WARRANTY

- .1 Section 01 78 10.
- .2 Provide five year manufacturer warranty for domestic water heaters, in-line circulator, submersible sump pumps, sewage ejectors.

Part 2 Products**2.1 COMMERCIAL ELECTRIC WATER HEATERS**

- .1 Manufacturer: One (1) of Giant 102A330.
- .2 Other acceptable manufacturers offering equivalent products.
 - .1 Rheem-Ruud.
 - .2 Substitutions: [Refer to Section 01 62 00.]
- .3 Type: Factory-assembled and wired, electric, vertical storage.
- .4 Performance:
 - .1 Storage capacity: 80 gal.
 - .2 Heating element size: 30 kW.
 - .3 Minimum recovery rate: 460 Lph 56 degrees C temperature rise.
 - .4 Maximum working pressure: 865 kPa
- .5 Electrical Characteristics:
 - .1 208 volts, three phase, 60 Hz.
- .6 Tank: Welded steel ASME labelled pressure vessel, glass lined; thermally insulated with minimum 50 mm glass fibre encased in corrosion-resistant steel jacket; baked-on enamel finish.
- .7 Controls: Automatic immersion water thermostat; externally adjustable temperature range from 16 to 82 degrees C, flanged or screw-in nichrome elements, high temperature limit thermostat.
- .8 Controls: Ventilated control cabinet, factory-wired with solid state progressive sequencing step controller, fuses, magnetic contactors, control transformer, pilot lights indicating main power and heating steps, control circuit toggle switch, electronic low-water (probe-type) cut-off, high temperature limit thermostat, flush-mounted temperature and pressure gauges.
- .9 Heating Elements: Flange-mounted immersion elements; individual elements sheathed with Incoloy corrosion-resistant metal alloy, rated less than 480 W/sq cm.

2.2 EXPANSION TANKS

- .1 Manufacturer: Amtrol ST-8.
- .2 Other acceptable manufacturers offering equivalent products.
 - .1 Watts.
 - .2 Substitutions: [Refer to Section 01 62 00.]
- .3 Type: Therm-X-Trol replacable bladder ASME tank..
- .4 Performance:
 - .1 Max working pressure: 150 psig
 - .2 Total Volume: 3.2 Gal.
 - .3 Maximum acceptance: 1.9 Gal.

2.3 HOT WATER RECIRCULATING PUMPS

- .1 Manufacturer: Armstrong Astro 2 Series 225SS.
- .2 Other acceptable manufacturers offering equivalent products.
 - .1 Taco.
 - .2 Substitutions: [Refer to Section 01 62 00.]
- .3 Type: Factory-assembled and wired, 2-bolt flange connection, with 24h timer.
- .4 Performance:
 - .1 10 GPM at 4' head.
 - .2 Max. water temperature 230F (110C).
 - .3 Max. working pressure 150 psi (1034 kPa).
- .5 Electrical Characteristics:
 - .1 115 volts/60 Hz/1 phase, 0.6A, 83W. 1.5 m power cord.
- .6 Controls: 12 hour analog clock with mechanical toggles for each 15min interval.

2.4 SUBMERSIBLE SUMP PUMPS

- .1 Manufacturer: Liberty Model FL283.
 - .1 Substitutions: [Refer to Section 01 62 00.]
- .2 Type: Completely submersible, vertical, centrifugal.
- .3 Casing: Cast iron pump body and oil filled motor chamber.
- .4 Impeller: Cast iron; semi-open non-clog, stainless steel shaft.
- .5 Bearings: Ball bearings.

- .6 Accessories: Oil resistant 25 foot cord and plug with three-prong connector for connection to electric wiring system including grounding connector.
- .7 Servicing: Slide-away coupling consisting of discharge elbow secure to sump floor, movable bracket, guide pipe system, lifting chain and chain hooks.
- .8 Controls: Motor control panel containing across-the-line electric motor starters with ambient compensated quick trip overloads in each phase with manual trip button and reset button, circuit breaker, control transformer, electro mechanical alternator, hand-off-automatic selector switches, pilot lights, high water alarm pilot light, reset button and alarm horn. Provide mercury switch liquid level controls, steel shell switch encased in polyurethane foam with cast iron weight for pump on (each pump), pump off (common), and alarm.
- .9 Performance:
 - .1 Flow: 40 gpm , 21 feet lift.
 - .2 Motor: 1/2 hp , 115 volt, single phase, 60 Hz.

2.5 SUBMERSIBLE SEWAGE EJECTORS

- .1 Manufacturer: Liberty Model FL202A2.
 - .1 Substitutions: [Refer to Section 01 62 00.]
- .2 Type: Completely submersible, vertical, centrifugal.
- .3 Casing: Cast iron pump body and oil filled motor chamber.
- .4 Impeller: Cast iron; semi-open non-clog, stainless steel shaft.
- .5 Bearings: Ball bearings.
- .6 Accessories: Oil resistant 25 foot cord and plug with three-prong connector for connection to electric wiring system including grounding connector.
- .7 Servicing: Slide-away coupling consisting of discharge elbow secure to sump floor, movable bracket, guide pipe system, lifting chain and chain hooks.
- .8 Level Controls: pump shall be controlled by a wide angle mechanical float sealed in a PVC housing. The float shall have a series plug for manual by-pass operation.
- .9 Controls: Motor control panel containing across-the-line electric motor starters with ambient compensated quick trip overloads in each phase with manual trip button and reset button, circuit breaker, control transformer, electro mechanical alternator, hand-off-automatic selector switches, pilot lights, high water alarm pilot light, reset button and alarm horn. Provide mercury switch liquid level controls, steel shell switch encased in polyurethane foam with cast iron weight for pump on (each pump), pump off (common), and alarm.
- .10 Performance:

- .1 Flow 60 gpm, at 90 feet lift.
- .2 Motor: 2 hp, 208V-230V volt, single phase, 60 Hz.

Part 3 Execution

3.1 INSTALLATION

- .1 Install water heaters to manufacturer's instructions.
- .2 Coordinate with plumbing piping and related electrical work to achieve operating system.
- .3 Domestic Hot Water Storage Tanks:
 - .1 Provide steel pipe support, independent of building structural framing members.
 - .2 Clean and flush after installation. Seal until pipe connections are made.
- .4 Pumps:
 - .1 Ensure shaft length allows sump pumps to be located minimum 600 mm below lowest invert into sump pit and minimum 150 mm clearance from bottom of sump pit.
 - .2 Provide air cock and drain connection on horizontal pump casings.
 - .3 Provide line sized isolating valve and strainer on suction and line sized soft seated check valve and balancing valve on discharge.
 - .4 Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. Provide supports under elbows on pump suction and discharge line sizes 100 mm and over.
 - .5 Ensure pumps operate at specified system fluid temperatures without vapour binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
 - .6 Align and verify alignment of base mounted pumps prior to start-up.

END OF SECTION

Part 1 General

1.1 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop drawings; submit drawings stamped and signed by professional engineer registered or licensed in Province of Manitoba, Canada.
- .3 Shop drawings to show:
 - .1 Mounting arrangements.
 - .2 Operating and maintenance clearances.
- .4 Shop drawings and product data accompanied by:
 - .1 Detailed drawings of bases, supports, and anchor bolts.
 - .2 Acoustical sound power data, where applicable.
 - .3 Points of operation on performance curves.
 - .4 Manufacturer to certify current model production.
 - .5 Certification of compliance to applicable codes.
- .5 In addition to transmittal letter referred to in Section 01 33 00 - Submittal Procedures: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.
- .6 Closeout Submittals:
 - .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
 - .2 Operation and maintenance manual approved by, and final copies deposited with, Consultant before final inspection.
 - .3 Operation data to include:
 - .1 Control schematics for systems including environmental controls.
 - .2 Description of systems and their controls.
 - .3 Description of operation of systems at various loads together with reset schedules and seasonal variances.
 - .4 Operation instruction for systems and component.
 - .5 Description of actions to be taken in event of equipment failure.
 - .6 Valves schedule and flow diagram.
 - .7 Colour coding chart.
 - .4 Maintenance data to include:
 - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
 - .2 Data to include schedules of tasks, frequency, tools required and task time.
 - .5 Performance data to include:

- .1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.
- .2 Equipment performance verification test results.
- .3 Special performance data as specified.
- .4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .6 Approvals:
 - .1 Submit 2 copies of draft Operation and Maintenance Manual to Consultant for approval. Submission of individual data will not be accepted unless directed by Consultant.
 - .2 Make changes as required and re-submit as directed by Consultant.
- .7 Additional data:
 - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.
- .8 Site records:
 - .1 Consultant will provide 1 set of reproducible mechanical drawings. Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring.
 - .2 Transfer information weekly to reproducibles, revising reproducibles to show work as actually installed.
 - .3 Use different colour waterproof ink for each service.
 - .4 Make available for reference purposes and inspection.
- .9 As-built drawings:
 - .1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings.
 - .2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).
 - .3 Submit to Consultant for approval and make corrections as directed.
 - .4 Perform testing, adjusting and balancing for HVAC using as-built drawings.
 - .5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.
- .10 Submit copies of as-built drawings for inclusion in final TAB report.

1.2 QUALITY ASSURANCE

- .1 Quality Assurance: in accordance with Section 01 45 00 - Quality Control.
- .2 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.3 MAINTENANCE

- .1 Furnish spare parts in accordance with Section 01 78 00 - Closeout Submittals as follows:
 - .1 One set of packing for each pump.
 - .2 One casing joint gasket for each size pump.
 - .3 One head gasket set for each heat exchanger.
 - .4 One glass for each gauge glass.
 - .5 One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.
- .2 Provide one set of special tools required to service equipment as recommended by manufacturers and in accordance with Section 01 78 00 - Closeout Submittals.
- .3 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.

1.4 DELIVERY, STORAGE, AND HANDLING

- .1 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Execution

2.1 PAINTING REPAIRS AND RESTORATION

- .1 Do painting in accordance with Section 09 91 23 - Interior Painting.
- .2 Prime and touch up marred finished paintwork to match original.
- .3 Restore to new condition, finishes which have been damaged.

2.2 CLEANING

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

2.3 FIELD QUALITY CONTROL

- .1 Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report as described in PART 1 - SUBMITTALS.
 - .1 [].
- .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.

2.4 DEMONSTRATION

- .1 Consultant will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 Trial usage to apply to following equipment and systems:
 - .1 Fan coils and air conditioning units.
 - .2 In-floor hydronic system.
 - .3 Exhaust fans.
 - .4 Hot water tank and recirculation pump.
 - .5 LAN room AC unit.
 - .6 Forced flow heaters.
- .3 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .4 Use operation and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials.
- .5 Instruction duration time requirements as specified in appropriate sections.
- .6 Consultant will record these demonstrations on video tape for future reference.

2.5 PROTECTION

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

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Testing, adjustment, and balancing of air systems.
- .2 Testing, adjustment, and balancing of hydronic systems.
- .3 Measurement of final operating condition of HVAC systems.
- .4 Sound measurement of equipment operating conditions.
- .5 Vibration measurement of equipment operating conditions.

1.2 RELATED SECTIONS

- .1 Section 01 20 13 - Price and Payment Procedures.
- .2 Section 01 33 00 - Administrative Requirements.
- .3 Section 01 44 00 - Quality Assurance:
 - .1 Testing laboratory services.
 - .2 Employment of testing agency and payment for services.
 - .3 Inspection and testing allowances.
- .4 Section 01 61 00 - Common Product Requirements.
- .5 Section 01 78 10 - Execution Requirements:
 - .1 Starting of Systems.
 - .2 Testing, Adjusting, and Balancing of Systems.

1.3 ALLOWANCES

- .1 Cash Allowance: Section 01 20 13 for the Cash Allowance Sum applicable to this section.
- .2 Allowance includes testing, adjusting, and balancing of mechanical systems.
- .3 Work is included in this section and is part of the Contract Sum/Price.

1.4 REFERENCES

- .1 AABC - National Standards for Total System Balance.
- .2 ADC - Test Code for Grilles, Registers, and Diffusers.
- .3 ASHRAE 111 - Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-conditioning, and Refrigeration Systems.

.4 NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

.5 SMACNA - HVAC Systems Testing, Adjusting, and Balancing.

1.5 SUBMITTALS

.1 Section 01 33 00: Procedures for submittals.

.2 Submit name of adjusting and balancing agency for approval within 30 days after award of Contract.

.3 Section 01 44 00: Procedures for submitting Field Reports.

.4 Field Reports: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

.5 Prior to commencing work, submit report forms or outlines indicating adjusting, balancing, and equipment data required.

.6 Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Consultant and for inclusion in operating and maintenance manuals.

.7 Provide reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

.8 Include detailed procedures, agenda, sample report forms and copy of AABC National Project Performance Guaranty prior to commencing system balance.

.9 Test Reports: Indicate data on AABC National Standards for Total System Balance forms. Submit data in S.I. Metric units.

1.6 PROJECT RECORD DOCUMENTS

.1 Section 01 78 10: Submittals for project closeout.

.2 Record actual locations of flow measuring stations and balancing valves and rough setting.

1.7 QUALITY ASSURANCE

.1 Perform total system balance to AABC National Standards for Field Measurement and Instrumentation, Total System Balance.

.2 Maintain one copy of each document on site.

1.8 QUALIFICATIONS

- .1 Agency: Company specializing in the testing, adjusting, and balancing of systems specified in this Section with minimum three years documented experience certified by AABC/CAABC.
- .2 Perform Work under supervision of CAABC Certified Test and Balance Engineer.

1.9 PRE-BALANCING CONFERENCE

- .1 Convene one week prior to commencing work of this section, to Section 01 33 00.

1.10 SEQUENCING

- .1 Sequence work to Section 01 10 13.
- .2 Sequence work to commence after completion of systems and schedule completion of work before Substantial Completion of Project.

1.11 SCHEDULING

- .1 Schedule work to Section 01 33 00.
- .2 Schedule and provide assistance in final adjustment and test of life safety and smoke control system with Fire Authority.

Part 2 Products

- .1 Not used

Part 3 Execution

3.1 AGENCIES

- .1 Air Movement Services, Winnipeg.
- .2 Airdronics, Winnipeg.
- .3 Other AABC/CAABC certified balancing companies.

3.2 EXAMINATION

- .1 Verify that systems are complete and operable before commencing work. Ensure the following conditions:
 - .1 Systems are started and operating in a safe and normal condition.
 - .2 Temperature control systems are installed complete and operable.
 - .3 Proper thermal overload protection is in place for electrical equipment.

- .4 Final filters are clean and in place. If required, install temporary media in addition to final filters.
- .5 Duct systems are clean of debris.
- .6 Fans are rotating correctly.
- .7 Fire and volume dampers are in place and open.
- .8 Air coil fins are cleaned and combed.
- .9 Access doors are closed and duct end caps are in place.
- .10 Air outlets are installed and connected.
- .11 Duct system leakage is minimized.
- .12 Hydronic systems are flushed, filled, and vented.
- .13 Pumps are rotating correctly.
- .14 Proper strainer baskets are clean and in place.
- .15 Service and balance valves are open.
- .2 Submit field reports. Report defects and deficiencies noted during performance of services which prevent system balance.
- .3 Beginning of work means acceptance of existing conditions.

3.3 PREPARATION

- .1 Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Consultant to facilitate spot checks during testing.
- .2 Provide additional balancing devices as required.

3.4 INSTALLATION TOLERANCES

- .1 Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.
- .2 Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.
- .3 Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.5 ADJUSTING

- .1 Ensure recorded data represents actual measured or observed conditions.
- .2 Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- .3 After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

- .4 Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- .5 At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.
- .6 Check and adjust systems approximately six months after final acceptance and submit report.

3.6 AIR SYSTEM PROCEDURE

- .1 Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities [at site altitude].
- .2 Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- .3 Measure air quantities at air inlets and outlets.
- .4 Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- .5 Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
- .6 Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
- .7 Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- .8 Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
- .9 Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- .10 Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- .11 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.]
- .12 Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 12.5 Pa positive static pressure near the building entries.
- .13 Check multi-zone units for motorized damper leakage. Adjust air quantities with mixing dampers set first for cooling, then heating, then modulating.

- .14 For variable air volume system powered units set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.
- .15 On fan powered VAV boxes, adjust air flow switches for proper operation.

3.7 WATER SYSTEM PROCEDURE

- .1 Adjust water systems to provide required or design quantities.
- .2 Use calibrated [Venturi tubes, orifices, or other metered] fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
- .3 Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- .4 Effect system balance with automatic control valves fully open to heat transfer elements.
- .5 Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
- .6 Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.8 SCHEDULES

- .1 Equipment requiring testing, adjusting and balancing:
 - .1 Plumbing Pumps
 - .2 HVAC Pumps
 - .3 Forced Air Furnaces
 - .4 Heat recovery ventilators
 - .5 Air Cooled Refrigerant Condensers
 - .6 Computer Room Air Conditioning Units
 - .7 Electric duct heater Coils
 - .8 Fans
 - .9 Air Filters
 - .10 Air Inlets and Outlets
- .2 Report Forms
 - .1 Title Page:
 - .1 Name of Testing, Adjusting, and Balancing Agency
 - .2 Address of Testing, Adjusting, and Balancing Agency

- .3 Telephone number of Testing, Adjusting, and Balancing Agency
- .4 Project name
- .5 Project location
- .6 Project Architect
- .7 Project Engineer
- .8 Project Contractor
- .9 Project altitude
- .10 Report date
- .2 Summary Comments:
 - .1 Design versus final performance
 - .2 Notable characteristics of system
 - .3 Description of systems operation sequence
 - .4 Summary of outdoor and exhaust flows to indicate amount of building pressurization
 - .5 Nomenclature used throughout report
 - .6 Test conditions
- .3 Instrument List:
 - .1 Instrument
 - .2 Manufacturer
 - .3 Model number
 - .4 Serial number
 - .5 Range
 - .6 Calibration date
- .4 Electric Motors:
 - .1 Manufacturer
 - .2 Model/Frame
 - .3 HP/BHP
 - .4 Phase, voltage, amperage; nameplate, actual, no load
 - .5 RPM
 - .6 Service factor
 - .7 Starter size, rating, heater elements
 - .8 Sheave Make/Size/Bore
- .5 V-Belt Drive:
 - .1 Identification/location
 - .2 Required driven RPM
 - .3 Driven sheave, diameter and RPM
 - .4 Belt, size and quantity
 - .5 Motor sheave diameter and RPM
 - .6 Centre to centre distance, maximum, minimum, and actual
- .6 Pump Data:

- .1 Identification/number
- .2 Manufacturer
- .3 Size/model
- .4 Impeller
- .5 Service
- .6 Design flow rate, pressure drop, BHP
- .7 Actual flow rate, pressure drop, BHP
- .8 Discharge pressure
- .9 Suction pressure
- .10 Total operating head pressure
- .11 Shut off, discharge and suction pressures
- .12 Shut off, total head pressure
- .7 Air Cooled Condenser:
 - .1 Identification/number
 - .2 Location
 - .3 Manufacturer
 - .4 Model number
 - .5 Serial number
 - .6 Entering DB air temperature, design and actual
 - .7 Leaving DB air temperature, design and actual
 - .8 Number of compressors
- .8 Cooling Coil Data:
 - .1 Identification/number
 - .2 Location
 - .3 Service
 - .4 Manufacturer
 - .5 Air flow, design and actual
 - .6 Entering air DB temperature, design and actual
 - .7 Entering air WB temperature, design and actual
 - .8 Leaving air DB temperature, design and actual
 - .9 Leaving air WB temperature, design and actual
 - .10 Water flow, design and actual
 - .11 Water pressure drop, design and actual
 - .12 Entering water temperature, design and actual
 - .13 Leaving water temperature, design and actual
 - .14 Saturated suction temperature, design and actual
 - .15 Air pressure drop, design and actual
- .9 Heating Coil Data:
 - .1 Identification/number
 - .2 Location

- .3 Service
- .4 Manufacturer
- .5 Air flow, design and actual
- .6 Water flow, design and actual
- .7 Water pressure drop, design and actual
- .8 Entering water temperature, design and actual
- .9 Leaving water temperature, design and actual
- .10 Entering air temperature, design and actual
- .11 Leaving air temperature, design and actual
- .12 Air pressure drop, design and actual
- .10 Electric Duct Heater:
 - .1 Manufacturer
 - .2 Identification/number
 - .3 Location
 - .4 Model number
 - .5 Design kW
 - .6 Number of stages
 - .7 Phase, voltage, amperage
 - .8 Test voltage (each phase)
 - .9 Test amperage (each phase)
 - .10 Air flow, specified and actual
 - .11 Temperature rise, specified and actual
- .11 Air Moving Equipment
 - .1 Location
 - .2 Manufacturer
 - .3 Model number
 - .4 Serial number
 - .5 Arrangement/Class/Discharge
 - .6 Air flow, specified and actual
 - .7 Return air flow, specified and actual
 - .8 Outside air flow, specified and actual
 - .9 Total static pressure (total external), specified and actual
 - .10 Inlet pressure
 - .11 Discharge pressure
 - .12 Sheave Make/Size/Bore
 - .13 Number of Belts/Make/Size
 - .14 Fan RPM
- .12 Return Air/Outside Air Data:
 - .1 Identification/location
 - .2 Design air flow

- .3 Actual air flow
- .4 Design return air flow
- .5 Actual return air flow
- .6 Design outside air flow
- .7 Actual outside air flow
- .8 Return air temperature
- .9 Outside air temperature
- .10 Required mixed air temperature
- .11 Actual mixed air temperature
- .12 Design outside/return air ratio
- .13 Actual outside/return air ratio
- .13 Exhaust Fan Data:
 - .1 Location
 - .2 Manufacturer
 - .3 Model number
 - .4 Serial number
 - .5 Air flow, specified and actual
 - .6 Total static pressure (total external), specified and actual
 - .7 Inlet pressure
 - .8 Discharge pressure
 - .9 Sheave Make/Size/Bore
 - .10 Number of Belts/Make/Size
 - .11 Fan RPM
- .14 Duct Traverse:
 - .1 System zone/branch
 - .2 Duct size
 - .3 Area
 - .4 Design velocity
 - .5 Design air flow
 - .6 Test velocity
 - .7 Test air flow
 - .8 Duct static pressure
 - .9 Air temperature
 - .10 Air correction factor
- .15 Duct Leak Test:
 - .1 Description of ductwork under test
 - .2 Duct design operating pressure
 - .3 Duct design test static pressure
 - .4 Duct capacity, air flow
 - .5 Maximum allowable leakage duct capacity times leak factor

- .6 Test apparatus
 - .1 Blower
 - .2 Orifice, tube size
 - .3 Orifice size
 - .4 Calibrated
- .7 Test static pressure
- .8 Test orifice differential pressure
- .9 Leakage
- .16 Air Monitoring Station Data:
 - .1 Identification/location
 - .2 System
 - .3 Size
 - .4 Area
 - .5 Design velocity
 - .6 Design air flow
 - .7 Test velocity
 - .8 Test air flow
- .17 Flow Measuring Station:
 - .1 Identification/number
 - .2 Location
 - .3 Size
 - .4 Manufacturer
 - .5 Model number
 - .6 Serial number
 - .7 Design Flow rate
 - .8 Design pressure drop
 - .9 Actual/final pressure drop
 - .10 Actual/final flow rate
 - .11 Station calibrated setting
- .18 Air Distribution Test Sheet:
 - .1 Air terminal number
 - .2 Room number/location
 - .3 Terminal type
 - .4 Terminal size
 - .5 Area factor
 - .6 Design velocity
 - .7 Design air flow
 - .8 Test (final) velocity
 - .9 Test (final) air flow
 - .10 Percent of design air flow

- .19 Sound Level Report:
 - .1 Location
 - .2 Octave bands - equipment off
 - .3 Octave bands - equipment on
- .20 Vibration Test:
 - .1 Location of points:
 - .1 Fan bearing, drive end
 - .2 Fan bearing, opposite end
 - .3 Motor bearing, centre (if applicable)
 - .4 Motor bearing, drive end
 - .5 Motor bearing, opposite end
 - .6 Casing (bottom or top)
 - .7 Casing (side)
 - .8 Duct after flexible connection (discharge)
 - .9 Duct after flexible connection (suction)
 - .2 Test readings:
 - .1 Horizontal, velocity and displacement
 - .2 Vertical, velocity and displacement
 - .3 Axial, velocity and displacement
 - .3 Normally acceptable readings, velocity and acceleration
 - .4 Unusual conditions at time of test
 - .5 Vibration source (if non-complying)

END OF SECTION

Part 1 General**1.1 SECTION INCLUDES**

- .1 Duct work insulation.
- .2 Duct Liner.
- .3 Insulation jackets.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Administrative Requirements.
- .2 Section 01 44 00 - Quality Assurance.
- .3 Section 01 61 00 - Common Product Requirements.
- .4 Section 09 91 10 - Painting: Painting insulation jackets.
- .5 Section 23 05 53 - Mechanical Identification.
- .6 Section 23 31 00 - Duct Work: Glass fibre duct work.
- .7 Section 23 31 00 - Duct Work: Duct liner.

1.3 REFERENCES

- .1 Section 01 44 00: Requirements for references and standards.
- .2 ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
- .3 ASTM C518 - Steady-State Thermal Transmission Properties by Means of the Heat Flow Metre Apparatus.
- .4 ASTM C553 - Standard Specification for Mineral Fibre Blanket Thermal Insulation for Commercial and Industrial Applications.
- .5 ASTM C612 - Standard Specification for Mineral Fibre Block and Board Thermal Insulation.
- .6 ASTM C921 - Properties of Jacketing Materials for Thermal Insulation.
- .7 ASTM C1071 - Fibrous Glass Duct Lining Insulation(Thermal Sound Absorbing Material).
- .8 ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- .9 ASTM E96 - Water Vapour Transmission of Materials.

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- .10 ASTM E162 - Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source.
- .11 ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- .12 NAIMA National Insulation Standards.
- .13 NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.
- .14 SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
- .15 UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS FOR REVIEW

- .1 Section 01 33 00: Procedures for submittals.
- .2 Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.5 SUBMITTALS FOR INFORMATION

- .1 Section 01 33 00: Procedures for submittals.
- .2 Manufacturer's Instructions: Indicate installation procedures which ensure acceptable workmanship and installation standards will be achieved.

1.6 QUALITY ASSURANCE

- .1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- .2 Applicator Qualifications: Company specializing in performing the work of this section with minimum three years documented experience.

1.7 REGULATORY REQUIREMENTS

- .1 Materials: Flame spread/smoke developed rating of 25/50 to [ASTM E84] [NFPA 255] [UL 723].

1.8 DELIVERY, STORAGE, AND PROTECTION

- .1 Section 01 61 00: Transport, handle, store, and protect products.
- .2 Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.
- .3 Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.9 ENVIRONMENTAL REQUIREMENTS

- .1 Section 01 61 00: Environmental conditions affecting products on site.
- .2 Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- .3 Maintain temperature during and after installation for minimum period of 24 hours.

Part 2 Products**2.1 INSULATION**

- .1 Mineral fibre: as specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 deg C mean temperature when tested in accordance with ASTM C 335
- .3 TIAC Code C-1; Rigid mineral fibre board to ASTM C 612, with or without factory applied vapour retarder jacket to CBSB 51-GP-52Ma
- .4 TIAC Code C-2: Mineral fibre blanket to ASTM C 553 faced with or without factory applied vapour retarder jacket to CGSB 51-GP-52Ma
 - .1 Mineral Fibre to ASTM c 553
 - .2 Jacket: to CGSB 51-gp-52MA
 - .3 Maximum "k" Factor to ASTM C 553

2.2 JACKETS

- .1 Canvas:
 - .1 220 gm/m2 cotton. Plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921

2.3 ACCESSORIES

- .1 Vapour retarder lap adhesive
 - .1 Water based, fire retardant type, compatible with insulation
- .2 Indoor Vapour Retarder Finish
 - .1 Vinyl emulsion type acrylic, compatible with insulation
- .3 Insulating Cement: hydraulic setting on mineral wool, to ASTM C 449
- .4 ULC Listed Canvas Jacket
- .5 Tape self-adhesive, aluminum reifinroced 75mm wide
- .6 Contact adhesive: quick setting

- .7 Canvas adhesive: washable
- .8 Tie wire: 1.5mm stainless steel
- .9 Banding: 12mm wide, 0.5mm thick stainless steel
- .10 Facing: 25mm galvanized steel hexagonal wire mesh stitched on one face of insulation
- .11 Fasteners: 4mm dia pins with 35mm dia clips, length to suit insulation thickness.

Part 3 Execution

3.1 EXAMINATION

- .1 Section 01 70 00 - Examination and Preparation: Verification of existing conditions before starting work.
- .2 Verify that duct work has been tested before applying insulation materials.
- .3 Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

- .1 Section 01 44 00 - Quality Assurance: Manufacturer's instructions.
- .2 Install to NAIMA National Insulation Standards.
- .3 Insulated duct work conveying air below ambient temperature:
 - .1 Provide insulation with vapour barrier jackets.
 - .2 Finish with tape and vapour barrier jacket.
 - .3 Continue insulation through walls, sleeves, hangers, and other duct penetrations.
 - .4 Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
- .4 Insulated duct work conveying air above ambient temperature:
 - .1 Provide with or without standard vapour barrier jacket.
 - .2 Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
- .5 Duct Work Exposed in Mechanical Equipment Rooms or Finished Spaces below 3 metres above finished floor: Finish with canvas jacket sized for finish painting or aluminum jacket.
- .6 Exterior Applications: Provide insulation with vapour barrier jacket. Cover with caulked aluminum jacket with seams located on bottom side of horizontal duct section.
- .7 External Duct Insulation Application:

- .1 Secure insulation with vapour barrier with wires and seal jacket joints with vapour barrier adhesive or tape to match jacket.
 - .2 Secure insulation without vapour barrier with staples, tape, or wires.
 - .3 Install without sag on underside of duct work. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift duct work off trapeze hangers and insert spacers.
 - .4 Seal vapour barrier penetrations by mechanical fasteners with vapour barrier adhesive.
 - .5 Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
- .8 Duct and Plenum Liner Application:
- .1 Adhere insulation with adhesive for 90 percent coverage.
 - .2 Secure insulation with mechanical liner fasteners. Refer to SMACNA Standards for spacing.
 - .3 Seal and smooth joints. Seal and coat transverse joints.
 - .4 Seal liner surface penetrations with adhesive.
 - .5 Duct dimensions indicated are net inside dimensions required for air flow. Increase duct size to allow for insulation thickness.

3.3**SCHEDULES**

Ducts	Insulation
Exhaust Ducts Within 3 m of Exterior Openings	2" foil-faced insulation
Outside Air Intake Ducts and Plenum	2" foil-faced insulation
Supply and Return Ducts and Plenums in Basement	1" foil-faced insulation or to match existing
Supply and Return Ducts and Plenums in Crawlspace	2" foil-faced insulation or to match existing
Supply and Return Ducts and Plenums in Attic space	2" foil-faced insulation
Supply and Return Ducts in Ceiling Space above General offices	Acoustic insulation
Vertical supply and return shafts supplying General offices	Acoustic insulation

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Piping insulation.
- .2 Jackets and accessories.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Administrative Requirements.
- .2 Section 01 61 00 - Common Product Requirements.
- .3 Section 09 91 10 - Painting: Painting insulation jacket.
- .4 Section 22 10 00 - Plumbing Piping: Placement of hangers and hanger inserts.
- .5 Section 23 05 53 - Mechanical Identification. Section 23 21 00 - Hydronic Piping: Placement of hangers and hanger inserts.
- .7 Section 23 22 00 - Steam And Steam Condensate Piping: Placement of hangers and hanger inserts.
- .8 Section 23 23 00 - Refrigerant Piping And Specialties: Placement of inserts.

1.3 REFERENCES

- .1 ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
- .2 ASTM C177 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
- .3 ASTM C195 - Mineral Fibre Thermal Insulating Cement.
- .4 ASTM C335 - Steady-State Heat Transfer Properties of Horizontal Pipe Insulation.
- .5 ASTM C449/C449M - Mineral Fibre Hydraulic-setting Thermal Insulating and Finishing Cement.
- .6 ASTM C518 - Steady-State Thermal Transmission Properties by Means of the Heat Flow Metre Apparatus.
- .7 ASTM C533 - Calcium Silicate Block and Pipe Thermal Insulation.
- .8 ASTM C534 - Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
- .9 ASTM C547 - Mineral Fibre Pipe Insulation.

- .10 ASTM C552 - Cellular Glass Thermal Insulation.
- .11 ASTM C578 - Rigid, Cellular Polystyrene Thermal Insulation.
- .12 ASTM C585 - Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
- .13 ASTM C591 - Unfaced Preformed Cellular Polyisocyanurate Thermal Insulation.
- .14 ASTM C610 - Moulded Expanded Perlite Block and Pipe Thermal Insulation.
- .15 ASTM C921 - Properties of Jacketing Materials for Thermal Insulation.
- .16 ASTM D1056 - Flexible Cellular Materials - Sponge or Expanded Rubber.
- .17 ASTM D1667 - Flexible Cellular Materials - Vinyl Chloride Polymers and Copolymers (Closed Cell Foam).
- .18 ASTM D2842 - Water Absorption of Rigid Cellular Plastics.
- .19 ASTM E84 - Surface Burning Characteristics of Building Materials.
- .20 ASTM E96 - Water Vapour Transmission of Materials.
- .21 NFPA 255 - Surface Burning Characteristics of Building Materials.
- .22 UL 723 - Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS

- .1 Section 01 33 00: Procedures for submittals.
- .2 Product Data: Provide product description, list of materials and thickness for each service, and locations.
- .3 Samples: Submit two samples of any representative size illustrating each insulation type.
- .4 Manufacturer's Installation Instructions: Indicate procedures which ensure acceptable workmanship and installation standards will be achieved.

1.5 QUALITY ASSURANCE

- .1 Materials: Flame spread/smoke developed rating of 25/50 25/100 / or less to ASTM E84. NFPA 255. UL 723.

1.6 QUALIFICATIONS

- .1 Applicator: Company specializing in performing the work of this section with minimum three years experience.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Section 01 61 00: Transport, handle, store, and protect products.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.
- .3 Store insulation in original wrapping and protect from weather and construction traffic.
- .4 Protect insulation against dirt, water, chemical, and mechanical damage.

1.8 ENVIRONMENTAL REQUIREMENTS

- .1 Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- .2 Maintain temperature during and after installation for minimum period of 24 hours.

Part 2 Products

2.1 INSULATION

- .1 Mineral fiber specified includes glass fibre, rock wool, slag wool.
- .2 Thermal Conductivity ('k' factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C 335
- .3 TIAC Code A-1: Rigid moulded mineral fibre without factory applied vapour retarder jacket
- .4 TIAC Code A-3: Rigid moulded mineral fibre with factory applied vapour retarder jacket
- .5 TIAC Code C-2: mineral fiber blanket faced with or without factory applied vapour retarder jacket
- .6 Acceptable materials: Fiberglass canada, manson, knauf, plasti-fab, manville

2.2 INSULATION SECUREMENT

- .1 Vapour retarder lap adhesive
 - .1 Water based, fire retardant type, compatible with insulation
- .2 Indoor Vapour Retarder Finish
 - .1 Vinyl emulsion type acrylic, compatible with insulation
- .3 Insulating Cement: hydraulic setting on mineral wool, to ASTM C 449
- .4 ULC Listed Canvas Jacket
- .5 Tape self-adhesive, aluminum reifinroced 75mm wide

- .6 Contact adhesive: quick setting
- .7 Canvas adhesive: washable
- .8 Tie wire: 1.5mm stainless steel
- .9 Banding: 12mm wide, 0.5mm thick stainless steel

2.3 JACKETS

- .1 Canvas
 - .1 220 gm/m² cotton. Plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921
- .2 Use Armaflex insulation for liquid and gas lines to condenser.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify that piping has been tested before applying insulation materials.
- .2 Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

- .1 Install materials to manufacturer's instructions.
- .2 On exposed piping, locate insulation and cover seams in least visible locations.
- .3 Insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature:
 - .1 Provide vapour barrier jackets, factory applied or field applied.
 - .2 Insulate fittings, joints, and valves with moulded insulation of like material and thickness as adjacent pipe.
 - .3 Finish with glass cloth and vapour barrier adhesive.
 - .4 PVC fitting covers may be used.
 - .5 Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.
 - .6 Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
- .4 For insulated pipes conveying fluids above ambient temperature:
 - .1 Provide standard jackets, with or without vapour barrier, factory applied or field applied.
 - .2 Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe.

- .3 Finish with glass cloth and adhesive.
- .4 PVC fitting covers may be used.
- .5 For hot piping conveying fluids 60 degrees C or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
- .6 For hot piping conveying fluids over 60 degrees C, insulate flanges and unions at equipment.
- .5 Inserts and Shields:
 - .1 Application: Piping 40 mm diameter or larger.
 - .2 Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
 - .3 Insert Location: Between support shield and piping and under the finish jacket.
 - .4 Insert Configuration: Minimum 150 mm long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 - .5 Insert Material: hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- .6 Finish insulation at supports, protrusions, and interruptions.
- .7 For pipe exposed in mechanical equipment rooms or in finished spaces below 3 metres above finished floor, finish with canvas jacket sized for finish painting.
- .8 For exterior applications, provide vapour barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapour barrier cement. Cover with aluminum stainless steel jacket with seams located on bottom side of horizontal piping.
- .9 For buried piping, provide factory fabricated assembly with inner all-purpose service jacket with self sealing lap, and asphalt impregnated open mesh glass fabric, with one mil (0.025 mm) thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with a polyester film.
- .10 For heat traced piping, insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

3.3 TOLERANCE

- .1 Substituted insulation materials: Thermal resistance within 10 percent at normal conditions, as materials indicated.

	PIPING SYSTEMS	PIPE SIZE mm	INSULATION THICKNESS mm
Plumbing Systems			
	Domestic Hot Water Supply	All	25mm
	Domestic Hot Water Recirc	All	25mm
	Domestic Cold Water Supply	All	25mm
	Vent Lines	All	25mm

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	PIPING SYSTEMS	PIPE SIZE mm	INSULATION THICKNESS mm
Cooling Systems			
	Refrigerant Suction	All	25mm
	Refrigerant Hot Gas	All	25mm
Other Systems			
	Humidifier Supply Piping	All	25mm
	Humidifier Steam piping	All	As per manufacturer

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Metal duct work.
- .2 Casing and plenums.
- .3 Duct cleaning.

1.2 RELATED SECTIONS

- .1 Section 01 10 00 - Summary of Work: Owner provided kitchen range hoods.
- .2 Section 01 33 00 - Administrative Requirements.
- .3 Section 01 61 00 - Common Product Requirements.
- .4 Section 01 78 10 - Execution Requirements.
- .5 Section 03 30 00 - Cast-in-place Concrete.
- .6 Section 09 91 10 - Painting: Weld priming, weather resistant, paint or coating.
- .7 Section 11 40 00 - Food Service Equipment: Supply of kitchen range hoods for placement by this Section.
- .8 Section 23 05 29 - Supports And Anchors: Sleeves.
- .9 Section 23 07 13 - Duct Insulation: External insulation and duct liner.
- .10 Section 23 33 00 - Duct Work Accessories.
- .11 Section 23 36 00 - Air Terminal Units.
- .12 Section 23 37 00 - Air Outlets And Inlets.
- .13 Section 23 05 93 - Testing, Adjusting, And Balancing.

1.3 REFERENCES

- .1 ASTM A36/A36M - Carbon Structural Steel.
- .2 ASTM A90/A90M - Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
- .3 ASTM A167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

- .4 ASTM A480/A480M - General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
- .5 ASTM A568/A568M - General Requirements for Steel Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled.
- .6 ASTM A653/A653M - Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- .7 ASTM A1008/A1008M - Steel, Sheet, Cold-Rolled Carbon, Structural, High-Strength Low-Alloy and High Strength Low-Alloy with Improved Formability.
- .8 ASTM A1011/A1011M - Standard Specification for Steel, Sheet, and Strip Hot-Rolled, Carbon, Structural, High-Strength, Low-Alloy with Improved Formability.
- .9 ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
- .10 ASTM C14/C14M - Concrete Sewer, Storm Drain, and Culvert Pipe.
- .11 ASTM C443 - Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
- .12 AWS D9.1 - Sheet Metal Welding Code.
- .13 NBS PS 15 - Voluntary Product Standard for Custom Contact-Moulded Reinforced-Polyester Chemical Resistant Process Equipment.
- .14 NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
- .15 NFPA 90B - Installation of Warm Air Heating and Air-Conditioning Systems.
- .16 NFPA 91 - Exhaust Systems for Air Conveying of Vapours, Gases, Mists, and Noncombustible Particulate Solids.
- .17 NFPA 96 - Ventilation Control and Fire Protection of Commercial Cooking Operations.
- .18 SMACNA - HVAC Air Duct Leakage Test Manual.
- .19 SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
- .20 SMACNA - Fibrous Glass Duct Construction Standards.
- .21 UL 181 - Factory-Made Air Ducts and Connectors.

1.4 PERFORMANCE REQUIREMENTS

- .1 No variation of duct configuration or sizes permitted except by written permission. Size round ducts installed in place of rectangular ducts to ASHRAE table of equivalent rectangular and round ducts.

1.5 SUBMITTALS

- .1 Section 01 33 00: Procedures for submittals.
- .2 Shop Drawings: Indicate duct fittings, particulars such as gauges, sizes, welds, and configuration prior to start of work for 1000 kPa pressure class and higher glass fibre duct systems.
- .3 Product Data: Provide data for duct materials duct liner duct connectors .

1.6 PROJECT RECORD DOCUMENTS

- .1 Section 01 78 10: Submittals for project closeout.
- .2 Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.7 QUALITY ASSURANCE

- .1 Perform Work to SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
- .2 Maintain one copy of document on site.

1.8 QUALIFICATIONS

- .1 Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- .2 Installer: Company specializing in performing the work of this section with minimum 3 years documented experience.

1.9 REGULATORY REQUIREMENTS

- .1 Construct duct work to NFPA 90B standards.

1.10 ENVIRONMENTAL REQUIREMENTS

- .1 Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
- .2 Maintain temperatures during and after installation of duct sealants.

Part 2 Products

2.1 MATERIALS

- .1 Galvanized Steel Ducts: ASTM A653 galvanized steel sheet, lock-forming quality, having G90 zinc coating of to ASTM A90.
- .2 Fasteners: Rivets, bolts, or sheet metal screws.

- .3 Sealant:
 - .1 Manufacturers:
 - .1 Duro Dyne S-2.
 - .2 Foster
 - .3 Substitutions: Refer to Section 01 62 00. Not permitted.
 - .2 Non-hardening, water resistant, fire resistive, compatible with mating materials; liquid used alone or with tape, or heavy mastic.
- .4 Hanger Rod: ASTM A36; steel , galvanized; threaded both ends, threaded one end, or continuously threaded.

2.2 DUCT WORK FABRICATION

- .1 Fabricate and support to SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.
- .2 Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centreline. Where not possible and where rectangular elbows are used, provide air foil turning vanes. Where acoustical lining is indicated, provide turning vanes of perforated metal with glass fibre insulation.
- .3 Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- .4 Provide standard 45 degree lateral wye takeoffs unless otherwise indicated where 90 degree conical tee connections may be used.

2.3 MANUFACTURED DUCT WORK AND FITTINGS

- .1 Manufacture to SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.

2.4 CASINGS

- .1 Fabricate casings to SMACNA HVAC Duct Construction Standards - Metal and Flexible and construct for operating pressures indicated.
- .2 Mount floor mounted casings on 100 mm high concrete curbs. At floor, rivet panels on 200 mm centres to angles. Where floors are acoustically insulated, provide liner of 1.20 mm galvanized expanded metal mesh supported at 300 mm centres, turned up 300 mm at sides with sheet metal shields.
- .3 Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles. Install hinged access doors where indicated or required for access to equipment for cleaning and inspection. Provide clear wire glass observation ports, minimum 150 X 150 mm size.

- .4 Fabricate acoustic casings with reinforcing turned inward. Provide 1.50 mm back facing and 0.80 mm perforated front facing with 2.4 mm diameter holes on 4 mm centres. Construct panels 75 mm thick packed with 72 kg/cu m minimum glass fibre media, on inverted channels of 1.50 mm.

Part 3 Execution

3.1 INSTALLATION

- .1 Install to manufacturer's instructions.
- .2 Install and seal ducts to SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- .3 Duct Sizes are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- .4 Provide openings in duct work where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated duct work, install insulation material inside a metal ring.
- .5 Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- .6 Use crimp joints with or without bead for joining round duct sizes 200 mm and smaller with crimp in direction of air flow.
- .7 Use double nuts and lock washers on threaded rod supports.
- .8 Connect diffusers or light troffer boots to low pressure ducts directly or with 1.5 m maximum length of flexible duct held in place with strap or clamp.
- .9 Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.
- .10 Set plenum doors 150 to 300 mm above floor. Arrange door swings so that fan static pressure holds door in closed position.
- .11 During construction provide temporary closures of metal or taped polyethylene on open duct work to prevent construction dust from entering duct work system.

3.2 CLEANING

- .1 Clean work to 01 78 10.
- .2 Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment which may be harmed by excessive dirt with temporary filters, or bypass during cleaning.

- .3 Clean duct systems with high power vacuum machines. Protect equipment which may be harmed by excessive dirt with filters, or bypass during cleaning. Provide adequate access into duct work for cleaning purposes.

3.3 SCHEDULES

3.4 DUCT WORK MATERIAL SCHEDULE

	AIR SYSTEM	MATERIAL
	Low Pressure Supply (Heating Systems)	Steel
	Low Pressure Supply (System with Cooling Coils)	Steel
	Return and Relief	Steel,
	General Exhaust	Steel
	Outside Air Intake	Steel
	Evaporative Condenser Intake and Exhaust	Steel

3.5 DUCT WORK PRESSURE CLASS SCHEDULE

	AIR SYSTEM	PRESSURE CLASS
	Supply (Heating Systems)	125 Pa 250 Pa
	Supply (System with Cooling Coils)	125 Pa 250 Pa 500 Pa
	Return and Relief	125 Pa 250 Pa
	General Exhaust	125 Pa 250 Pa
	Outside Air Intake	125 Pa 250 Pa 500 Pa
	Evaporative Condenser	125 Pa
	Intake and Exhaust	250 Pa 500 Pa

END OF SECTION

Part 1 General**1.1 SECTION INCLUDES**

- .1 Air turning devices/extractors.
- .2 Backdraft dampers.
- .3 Combination fire and smoke dampers.
- .4 Duct access doors.
- .5 Duct test holes.
- .6 Fire dampers.
- .7 Flexible duct connections.
- .8 Volume control dampers.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Administrative Requirements.
- .2 Section 01 61 00 - Common Product Requirements.
- .3 Section 01 78 10 - Execution Requirements.
- .4 Section 23 05 48 - Vibration Isolation.
- .5 Section 23 31 00 - Duct Work.
- .6 Section 23 36 00 - Air Terminal Units: Pressure regulating damper assemblies.
- .7 Section 26 05 80 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3 REFERENCES

- .1 NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
- .2 NFPA 92A - Smoke-Control Systems.
- .3 SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
- .4 UL 33 - Heat Responsive Links for Fire-Protection Service.
- .5 UL 555 - Fire Dampers.
- .6 UL 555S - Smoke Dampers.

1.4 SUBMITTALS

- .1 Section 01 33 00: Procedures for submittals.
- .2 Shop Drawings: Indicate for shop fabricated assemblies including [volume control dampers] [duct access doors] [and] [duct test holes].
- .3 Product Data: Provide for shop fabricated assemblies including [volume control dampers] [duct access doors] [duct test holes] [and] [hardware used]. Include electrical characteristics and connection requirements.
- .4 Manufacturer's Installation Instructions: Indicate for [fire dampers] [and] [combination fire and smoke dampers].

1.5 PROJECT RECORD DOCUMENTS

- .1 Section 01 78 10: Submittals for project closeout.
- .2 Record actual locations of access doors and test holes.

1.6 QUALIFICATIONS

- .1 Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.7 REGULATORY REQUIREMENTS

- .1 Products Requiring Electrical Connection: Listed and classified by CSA as suitable for the purpose specified and indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

- .1 Section 01 61 00: Transport, handle, store, and protect products.
- .2 Protect dampers from damage to operating linkages and blades.

1.9 EXTRA MATERIALS

- .1 Section 01 78 10: Submittals for project closeout.
- .2 Provide two of each size and type of fusible link.

Part 2 Products

2.1 BACKDRAFT DAMPERS.

- .1 Manufacturers:
 - .1 Naylor
 - .2 Substitutions: Refer to Section 01 62 00.

- .2 Gravity Backdraft Dampers, Size 450 x 450 mm or Smaller, Provided with Air Moving Equipment: Air moving equipment manufacturers standard construction.
- .3 Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: 1.5 mm thick galvanized steel, or extruded aluminum, with centre pivoted blades of maximum 150 mm width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

2.2 COMBINATION FIRE AND SMOKE DAMPERS

- .1 Manufacturers:
 - .1 Accudoor.
 - .2 Substitutions: Refer to Section 01 62 00.
- .2 Fabricate to NFPA 90A, UL 555, UL 555S, and as indicated.
- .3 Provide factory sleeve and collar for each damper.
- .4 Multiple Blade Dampers: Fabricate with 1.5 mm galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, stainless steel jamb seals, 3.2 x 12.7 mm plated steel concealed linkage, stainless steel closure spring, blade stops, and lock, and 12.7 mm actuator shaft.
- .5 Operators: UL listed and labelled spring return pneumatic type suitable for operation on 0-140 kPa instrument air. electric type suitable for 120 volts, single phase, 60 Hz. Provide end switches to indicate damper position. Locate damper operator on interior exterior of duct and link to damper operating shaft.
- .6 Normally Closed Smoke Responsive Fire Dampers: Curtain type, opening by gravity upon actuation of electro thermal link, flexible stainless steel blade edge seals to provide constant sealing pressure.
- .7 Normally Open Smoke Responsive Fire Dampers: Curtain type, closing upon actuation of electro thermal link, flexible stainless steel blade edge seals to provide constant sealing pressure, stainless steel springs with locking devices to ensure positive closure for units mounted horizontally.
- .8 Electro Thermal Link: Fusible link melting at 74 degrees C; 120 volts, single phase, 60 Hz; UL listed and labeled.

2.3 DUCT ACCESS DOORS

- .1 Manufacturers:
 - .1 Naylor
 - .2 Substitutions: Refer to Section 01 62 00.
- .2 Fabricate to SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

- .3 Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated duct work, install minimum 25 mm thick insulation with sheet metal cover.

- .1 Less Than 300 mm Square: Secure with sash locks.
- .2 Up to 450 mm Square: Provide two hinges and two sash locks.
- .3 Up to 600 x 1200 mm: Three hinges and two compression latches with outside and inside handles.
- .4 Larger Sizes: Provide an additional hinge.

- .4 Access doors with sheet metal screw fasteners are not acceptable.

2.4 DUCT TEST HOLES

- .1 Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

2.5 FIRE DAMPERS

- .1 Manufacturers:
 - .1 Naylor Model Type A or B
 - .2 Substitutions: Refer to Section 01 62 00.
- .2 Fabricate to NFPA 90A and UL 555, and as indicated.
- .3 Ceiling Dampers: Galvanized steel, 0.76 mm frame and 1.5 mm flap, two layers 3.2 mm ceramic fibre on top side, and one layer on bottom side for round flaps, with locking clip.
- .4 Horizontal Dampers: Galvanized steel, 0.76 mm frame, stainless steel closure spring, and lightweight, heat retardant non-asbestos fabric blanket.
- .5 Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations closure under air flow conditions. Configure with blades out of air stream except for 250 Pa pressure class ducts up to 300 mm in height.
- .6 Multiple Blade Dampers: 1.5 mm galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 3.2 x 12.7 mm plated steel concealed linkage, stainless steel closure spring, blade stops, and lock.
- .7 Fusible Links: UL 33, separate at 71 degrees C with adjustable link straps for combination fire/balancing dampers.

2.6 FLEXIBLE DUCT CONNECTIONS

- .1 Manufacturers:
 - .1 Flexmaster
 - .2 Substitutions: Refer to Section 01 62 00.

- .2 Fabricate to SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.
- .3 Connector: Fabric crimped into metal edging strip.
 - .1 Fabric: UL listed fire-retardant neoprene coated woven glass fibre fabric to NFPA 90A, minimum density 1.0 kg/sq m.
 - .2 Net Fabric Width: Approximately 50 75 150 mm wide.
 - .3 Metal: 75 mm wide, 0.6 mm thick galvanized steel .
- .4 Leaded Vinyl Sheet: Minimum 14 mm thick, 4.2 kg/sq m, 10 dB attenuation in 10 to 10,000 Hz range.

Part 3 Execution**3.1 PREPARATION**

- .1 Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION

- .1 Install accessories to manufacturer's instructions, NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible. Refer to Section 23 31 00 for duct construction and pressure class.
- .2 Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- .3 Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and elsewhere as indicated. Provide minimum 200 x 200 mm size for hand access, 450 x 450 mm size for shoulder access, and as indicated. Provide 100 x 100 mm for balancing dampers only. Review locations prior to fabrication.
- .4 Provide duct test holes where indicated and required for testing and balancing purposes.
- .5 Provide fire dampers , combination fire and smoke dampers and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components , and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
- .6 Install smoke dampers and combination smoke and fire dampers to NFPA 92A.
- .7 Demonstrate re-setting of fire dampers to Owner's representative.
- .8 Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment , and supported by vibration isolators. Refer to Section 23 05 48. For fans developing static pressures of 1250 Pa and over, cover connections with leaded vinyl sheet, held in place with metal straps.

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DUCT WORK ACCESSORIES

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- .9 Use splitter dampers only where indicated.
- .10 Provide balancing dampers on high velocity systems where indicated. Refer to Section 23 36 00.
- .11 Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Inline centrifugal fans.
- .2 Fan Accessories.

1.2 RELATED WORK

- .1 Section 01 33 00 - Administrative Requirements.
- .2 Section 01 61 00 - Common Product Requirements.
- .3 Section 01 78 10 - Execution Requirements.
- .4 Section 23 05 13 - Motors.
- .5 Section 23 05 48 - Vibration Isolation.
- .6 Section 23 07 13 - Duct Insulation.
- .7 Section 23 31 00 - Duct Work.
- .8 Section 23 33 00 - Duct Work Accessories: Backdraft dampers.
- .9 Section 23 73 23 - Air Handling Units.
- .10 Section 26 05 80 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3 REFERENCES

- .1 AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- .2 AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
- .3 AMCA 99 - Standards Handbook.
- .4 AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
- .5 AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
- .6 AMCA 301 - Method of Calculating Fan Sound Ratings from Laboratory Test Data.
- .7 SMACNA - HVAC Duct Construction Standards - Metal and Flexible.

1.4 SUBMITTALS

- .1 Section 01 33 00: Procedures for submittals.

- .2 Shop Drawings: Indicate assembly of centrifugal fans and accessories including fan curves with specified operating point clearly plotted, sound power levels for both fan inlet and outlet at rated capacity, and electrical characteristics and connection requirements.
- .3 Product Data: Provide data on centrifugal fans and accessories including fan curves with specified operating point clearly plotted, sound power levels for both fan inlet and outlet at rated capacity, and electrical characteristics and connection requirements.
- .4 Manufacturer's Installation Instructions.

1.5 OPERATION AND MAINTENANCE DATA

- .1 Section 01 78 10: Submittals for project closeout.
- .2 Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Section 01 61 00: Transport, handle, store, and protect products.
- .2 .Protect motors, shafts, and bearings from weather and construction dust.

1.7 ENVIRONMENTAL REQUIREMENTS

- .1 Do not operate fans for any purpose until ductwork is clean, filters in place, bearings lubricated, and fan has been test run under observation.

1.8 EXTRA MATERIALS

- .1 Section 01 78 10: Submittals for project closeout.

Part 2 Products

2.1 MANUFACTURERS

- .1 Greenheck [See Schedule] .
- .2 Substitutions: [Refer to Section 01 61 00.]

2.2 GENERAL

- .1 Performance Ratings: Conform to AMCA 210 [and bear the AMCA Certified Rating Seal.]
- .2 Sound Ratings: AMCA 301, tested to AMCA 300 ,and bear AMCA Certified Sound Rating Seal.
- .3 Fabrication: Conform to AMCA 99.
- .4 Performance Base: Sea level conditions.

- .5 Static and Dynamic Balance: Eliminate vibration or noise transmission to occupied areas.
- .6 Performance: See Schedule

2.3 WHEEL AND INLET

- .1 Backward Inclined: Steel or aluminum construction with smooth curved inlet flange, heavy back plate, backwardly curved blades welded or riveted to flange and back plate; cast iron [or cast steel] hub riveted to back plate and keyed to shaft with set screws.
- .2 Forward Curved: Galvanized steel construction with inlet flange, back plate, shallow blades with inlet and tip curved forward in direction of airflow, mechanically secured to flange and back plate; steel hub swaged to back plate and keyed to shaft with set screw.
- .3 Airfoil Wheel: Steel construction with smooth curved inlet flange, heavy back plate die formed hollow airfoil shaped blades continuously welded at tip flange, and back plate; cast iron or cast steel hub riveted to back plate and keyed to shaft with set screws.
- .4 Radial: Steel construction with inlet flange, heavy reinforced back plate, plate blades with reinforcing gussets and wearing strips welded or riveted to back plate and flange; cast iron or cast steel hub riveted to back plate and keyed to shaft with set screws.

2.4 HOUSING

- .1 Heavy gauge steel, spot welded [for AMCA 99 Class I and II fans, and continuously welded for Class III], adequately braced, designed to minimize turbulence with spun inlet bell and shaped cut-off.
- .2 Factory finish before assembly with enamel or prime coat. For fans handling air downstream of humidifiers, [provide two additional coats of paint.] [fabricate of galvanized steel.] [Prime coating on aluminum parts is not required.]
- .3 Provide bolted construction with horizontal flanged split housing [, where indicated].
- .4 Fabricate plug fans without volute housing, with steel cabinet, lined. Refer to Section 23 07 13.

2.5 BEARINGS AND DRIVES

- .1 Bearings: AFBMA 9, [L-10 life at 50,000 hours] [L-50 life at 100,000 hours] heavy duty pillow block type, self-aligning, grease-lubricated ball bearings, or AFBMA 11 [L-10 life at 120,000 hours] [L-50 life at 400,000 hours] pillow block type, self-aligning, grease-lubricated roller bearings.
- .2 Shafts: Hot rolled steel, ground and polished, with key- way, protectively coated with lubricating oil, and shaft guard.

2.6 ELECTRICAL CHARACTERISTICS AND COMPONENTS

- .1 Electrical Characteristics: See Schedule.

- .2 Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to code.

2.7 ACCESSORIES

- .1 Fixed Inlet Vanes: Steel construction with fixed cantilevered inlet guide vanes welded to inlet bell.
- .2 Adjustable Inlet Vanes: Steel construction with blades [supported at both ends] [cantilevered] with two permanently lubricated bearings, variable mechanism [out of air stream] terminating in single control lever with control shaft for double width fans [and locking quadrant].
- .3 Discharge Dampers: [Parallel] [Opposed] blade heavy duty steel damper assembly with blades constructed of two plates formed around and welded to shaft, channel frame, sealed ball bearings, with blades linked out of air stream to single control lever.
- .4 Inlet/Outlet Screens: Galvanized steel welded grid.
- .5 Access Doors: Shaped to conform to scroll, with quick opening latches and gaskets.
- .6 Scroll Drain: <13 mm><<1/2 inch>> steel pipe coupling welded to low point of fan scroll.

Part 3 Execution

3.1 INSTALLATION

- .1 Install to manufacturer's instructions.
- .2 Install fans as indicated with resilient mountings and flexible electrical leads. Refer to Section 23 05 48.
- .3 Install flexible connections specified in Section 23 33 00 between fan inlet and discharge ductwork. Ensure metal bands of connectors are parallel with minimum 25 mm flex between ductwork and fan while running.
- .4 Install fan restraining snubbers as required. Refer to Section 23 05 48. Adjust snubbers to prevent tension in flexible connectors when fan is operating.
- .5 Provide sheaves required for final air balance.
- .6 Provide safety screen where inlet or outlet is exposed.
- .7 Pipe scroll drains to nearest floor drain.
- .8 Provide backdraft dampers on discharge of exhaust fans and as indicated. [Refer to Section 23 33 00.]

3.2 CENTRIFUGAL FAN SCHEDULE

Drawing Code	EF-1	EF-2	EF-3,10	EF-4,5,6,8
Location	Cells (Main exhaust fan)	Cells Rm 125 (pris.effects)	Cells Rm 126,136 (janitor, guard WR)	Cells Rm 127,128,129,138 (Cells, brth'lyzer rm)
Manufacturer	Greenheck	Greenheck	Greenheck	Greenheck
Model	SQ-100VG	SQ-75G	SQ-75G	SQ-75VG
Fan Type	Centrifugal	Centrifugal	Centrifugal	Centrifugal
Arrangement	Inline	Inline	Inline	Inline
Control	Low or high. Switch outside room	Continuous	Continuous	Low or high. Switch outside room
Air Flow Capacity (L/s)	425/250	38	24	48/24
Static Pressure (Pa)	125 Pa	65 Pa	65 Pa	65 Pa
Drive (belt/direct)	Direct	Direct	Direct	Direct
Electrical	115V/1ph/60 Hz	115V/1ph/60 Hz	115V/1ph/60Hz	115V/1ph/60Hz
Motor HP	¼ HP	1/50 HP	1/50 HP	1/6 HP
Accessories	Two-speed, Speed control, backdraft damper	Speed control, backdraft damper	Speed control, backdraft damper	Two speed, Speed control, backdraft damper

Drawing Code	EF-9,11	EF-7	EF-12,13,15	EF-14
Location	Cells Rm 128,134 (Shower,int'view)	Cells Rm 130 (Hold'g cell)	Rm 124 (Secure bay), crawlspace, garage	Crawlspace
Manufacturer	Greenheck	Greenheck	Greenheck	Greenheck
Model	SQ-75G	SQ-75VG	SQ-95G	BSQ-120-4
Fan Type	Centrifugal	Centrifugal	Centrifugal	Centrifugal
Arrangement	Inline	Inline	Inline	Inline
Control	On or off. Switch outside room.	Low or high. Switch outside room	CO monitor or humidity sensor	Humidity sensor
Air Flow Capacity (L/s)	48	61/30	190	550
Static Pressure (Pa)	65 Pa	125Pa	125Pa	125Pa
Drive (belt/direct)	Direct	Direct	Direct	Belt
Electrical	115V/1ph/60Hz	115V/1ph/60 Hz	115V/1ph/60Hz	115V/1ph/60Hz
Motor HP	1/50 HP	1/6 HP	1/15 HP	¼ HP
Accessories	Speed control, backdraft damper	Two speed, Speed control,	Speed control, backdraft damper	Speed control, backdraft damper

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EXHAUST FANS

Drawing Code	EF-9,11	EF-7	EF-12,13,15	EF-14
		backdraft damper		

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Carbon monoxide detectors.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Administrative Requirements.
- .2 Section 01 61 00 - Common Product Requirements.
- .3 Section 01 78 10 - Execution Requirements.
- .4 Section 26 05 80 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3 REFERENCES

- .1 ACGIH - Industrial Ventilation, A Manual of Recommended Practice.

1.4 SUBMITTALS

- .1 Section 01 33 00: Procedures for submittals.
- .2 Shop Drawings: Indicate dimensions, sizes, weights and point loadings, and locations and sizes of field connections.
- .3 Product Data: Provide manufacturers literature and data sheets indicating rated capacities, dimensions, weights and point loadings, accessories, electrical characteristics and connection requirements, wiring diagrams, and location and sizes of field connections.
- .4 Manufacturer's Installation Instructions: Indicate assembly and installation instructions.

1.5 OPERATION AND MAINTENANCE DATA

- .1 Section 01 78 10: Submittals for project closeout.
- .2 Operation and Maintenance Data: Include instructions for sensor maintenance and calibration intervals.

1.6 QUALIFICATIONS

- .1 Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years experience.

1.7 REGULATORY REQUIREMENTS

- .1 Products Requiring Electrical Connection: Listed and classified by CSA as suitable for the purpose specified and indicated.

Part 2 Products**2.1 SENSORS**

- .1 Manufacturers:
 - .1 Honeywell Model E3Point Dual Gas Monitor for NO2 and CO.
 - .2 Other acceptable manufacturers offering equivalent products.
 - .1 Armstrong.
 - .3 Substitutions: [Refer to Section 01 62 00.]
- .2 Detection Circuit
 - .1 Independently adjustable low and high alarm levels
 - .2 SPDT relays (high, low), c/w programmable time delay circuitry
 - .3 Programmable span adjustment.
 - .4 Audible alarm (on/off programmable).
- .3 Carbon monoxide (co) and nitrogen dioxide (no2) sensors shall be long life electrochemical type with 2-3 year minimum life expectancy.
 - .1 Range of CO sensor 0-250ppm
 - .2 NO2 sensor shall be 0-10ppm.
- .4 Signal output to control system of 4-20ma, linear, or RS 485 digital.

Part 3 Execution**3.1 INSTALLATION**

- .1 Install equipment to manufacturers instructions.
- .2 Install at 60" AFF.
- .3 Set alarm levels as follows:
 - .1 Upon sensing of 25 ppm of carbon monoxide, internal SPDT relay shall activate intake damper control. Upon sensing of 75 ppm of carbon monoxide corresponding alarm level indicating light shall energize and internal SPDT relay shall activate. Internal sionalert shall sound where specified
 - .2 Upon sensing of 0.7 ppm of nitrogen dioxide internal SPDT relay shall activate intake damper control. Upon sensing of 2.0 ppm of nitrogen dioxide corresponding alarm level indicating light shall energize and internal SPDT relay shall activate. Internal sionalert shall sound where specified.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Diffusers.
- .2 Light troffer diffusers.
- .3 Registers/grilles.
- .4 Door grilles.
- .5 Louvres.
- .6 Louvred penthouses.
- .7 Roof hoods.
- .8 Goosenecks.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Administrative Requirements.
- .2 Section 01 44 00 - Quality Assurance.
- .3 Section 01 61 00 - Common Product Requirements.
- .4 Section 01 78 10 - Execution Requirements.
- .5 Section 09 91 10 - Painting: Painting of duct work visible behind outlets and inlets.

1.3 REFERENCES

- .1 ADC 1062 - Air Distribution and Control Device Test Code.
- .2 AMCA 500 - Method of Testing Louvres for Ratings.
- .3 AMCA 5000 - Method of Testing Dampers for Ratings.
- .4 ARI 650 - Air Outlets and Inlets.
- .5 ASHRAE 70 - Method of Testing for Rating the Performance of Outlets and Inlets.
- .6 SMACNA - HVAC Duct Construction Standard - Metal and Flexible.
- .7 NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

1.4 SUBMITTALS

- .1 Section 01 33 00: Procedures for submittals.
- .2 Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.
- .3 Samples: Submit two of each required air outlet and inlet type.

1.5 PROJECT RECORD DOCUMENTS

- .1 Section 01 78 10: Submittals for project closeout.
- .2 Record actual locations of air outlets and inlets.

1.6 QUALITY ASSURANCE

- .1 Test and rate air outlet and inlet performance to ADC Equipment Test Code 1062 and ASHRAE 70.
- .2 Test and rate louvre performance to AMCA 500.

1.7 QUALIFICATIONS

- .1 Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

Part 2 Products

- .1 EH Price.
- .2 Substitutions: Refer to Section 01 62 00.
 - .1 Type: As shown on Diffuser Schedule.
 - .2 Frame: As per location in plan
 - .3 Fabrication: As per Schedule.
 - .4 Accessories: As per Schedule.

2.2 GOOSENECKS

- .1 Fabricate to SMACNA HVAC Duct Construction Standards - Metal and Flexible, of minimum 1.20 mm galvanized steel.
- .2 Mount on minimum 300 mm high curb base where size exceeds 230 x 230 mm. .

Part 3 Execution**3.1 INSTALLATION**

- .1 Install to manufacturer's instructions.

□

- .2 Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.
- .3 Install diffusers to duct work with air tight connection.
- .4 Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.
- .5 Paint ductwork visible behind air outlets and inlets matte black. Refer to Section 09 91 10.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Boiler
- .2 Boiler Controls
- .3 Indoor/Outdoor Reset Controller
- .4 Water Connections
- .5 Electrical Hook-up
- .6 Expansion tank.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Administrative Requirements.
- .2 Section 01 44 00 - Quality Assurance.
- .3 Section 01 61 00 - Common Product Requirements.
- .4 Section 01 78 10 - Execution Requirements.
- .5 Section 03 30 00 - Cast-in-place Concrete.
- .6 Section 23 05 20 - Hydronic Specialties.
- .7 Section 23 22 26 - Steam And Steam Condensate Specialties.
- .8 Section [25 50 01 - Analog Control Equipment:] [25 50 02 - Digital Control Equipment:]
Installation and wiring of indoor-outdoor controller.
- .9 Section 26 05 80 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3 REFERENCES

- .1 ASME SEC 4 - Boiler and Pressure Vessel Codes - Rules for Construction of Heating Boilers.
- .2 ASME SEC 8D - Boiler and Pressure Vessel Codes - Rules for Construction of Pressure Vessels.
- .3 NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- .4 UL 834 - Heating, Water Supply, and Power Boilers - Electric.
- .5 UL - Electrical Appliance and Utilization Equipment Directory.

□

1.4 SUBMITTALS FOR REVIEW

- .1 Section 01 33 00: Procedures for submittals.
- .2 Shop Drawings: Indicate assembly, weights, heater configuration, and electrical characteristics and connection requirements.
- .3 Product Data: Provide literature indicating general assembly components, controls, safety controls, wiring diagrams with electrical characteristics and connection requirements, and service connections.
- .4 Section 01 33 00: Submittals for information.
- .5 Submit manufacturer's installation instructions: Indicate rigging, installation, and start-up procedures.
- .6 Manufacturer's field Reports: Indicate conditions observed after start-up, including control settings.
- .7 Section 01 78 10: Submittals for project closeout.
- .8 Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, cleaning procedures, replacement parts list, and maintenance and repair data.

1.5 QUALITY ASSURANCE

- .1 Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.6 REGULATORY REQUIREMENTS

- .1 Conform to ASME SEC 4 and SEC 8D for boiler construction.
- .2 Units: UL labeled.
- .3 Conform to applicable code for internal wiring of factory wired equipment.
- .4 Products Requiring Electrical Connection: Listed and classified by CSA as suitable for the purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND PROTECTION

- .1 Section 01 61 00: Transport, handle, store, and protect products.
- .2 Protect units before, during, and after installation from damage to casing by leaving factory shipping packaging in place until immediately prior to final acceptance.

1.8 WARRANTY

- .1 Section 01 78 10: Submittals for project closeout.

- .2 Provide five year warranty to include coverage for boiler package.

Part 2 Products

2.1 MANUFACTURERS

- .1 Superhot Model Ministar 24MSE with PS option.
- .2 Substitutions: [Refer to Section 01 62 00.]

2.2 MANUFACTURED UNITS

- .1 Description: Electric hot water boiler completely packaged, factory assembled, ready for operation except for connections of piping and electrical connections.

2.3 FABRICATION

- .1 Assembly: Welded steel or Cast iron shell; heater support nipples or flanges; inspection handhole; necessary fittings to accept gauges, safety and operating controls; threaded or flanged inlet and outlet connections; inlet diffuser; and lifting lugs, conforming to ASME SEC 4 and SEC 8D requirements, and tested for maximum working pressure of 620 kPa.
- .2 Heating Elements: Threaded or flanged, incoloy sheathed, with maximum density of 116 kW/sq metre, suitable for operation at 110 kPa. Attach each element to tube sheet by mechanical assembly permitting single elements to be replaced without replacing entire tube bundle.
- .3 Enclose in galvanized steel jacket with factory applied baked enamel, insulated with 50 mm thick fibreglass insulation.

2.4 TRIM

- .1 ASME rated pressure relief valve set at 310 kPa.
- .2 Assemble with pressure gauge, thermometer in brass separable well, automatic air vent, and drain valve.
- .3 Low water cut-off with manual reset and inlet flow switch to automatically prevent operation when water falls below safe level or on low flow through boiler.
- .4 Operating temperature controller with outdoor reset with remote bulb in brass separable well to control heating elements to maintain supply water temperature.
- .5 Electronic operating temperature controller with full cover for wall mounting, ambient temperature range -34 to 66 degrees C, adjustable reset ratio of outside air temperature change to discharge control point change 1:2 to 100:1, integral set point adjustment 27 to 110 degrees C, electronic primary and outdoor sensors, for on-off switching of pilot duty relays.

- .6 High limit temperature controller with automatic reset to prevent boiler water temperature from exceeding safe system temperature.

2.5 CONTROLS

- .1 Provide pre-wired, factory assembled electric controls enclosed in NEMA 250, Type 1 cabinet, factory mounted integral with unit.
- .2 Controls:
 - .1 Unfused disconnect switch with door interlock.
 - .2 Splitter arrangement and fused magnetic contactors for each element.
 - .3 Fused control circuit transformer with control circuit on/off switch.
 - .4 Proportioning step controller.
 - .5 Remote bulb operating thermostat complete with brass separable well.
 - .6 Remote bulb high limit thermostat complete with brass separable well.
 - .7 Pilot lights for each step of control.
 - .8 Terminals for connection of:
 - .1 Peak load control system.
 - .2 Pump motor starter auxiliary contact.
 - .3 Flow switch.
 - .4 Remote mounted three wire temperature controller.

2.6 PERFORMANCE

- .1 Performance rating to HI - Testing and Rating Standard for Cast Iron and Steel Heating Boilers.
- .2 Rating:
 - .1 Heating capacity: 9 kW.
 - .2 Number of Heating Stages: 3.
- .3 Electrical Characteristics:
 - .1 208 volts, three phase, 60 Hz.
 - .2 Refer to Section 26 05 80.

2.7 DIAPHRAGM TYPE EXPANSION TANK

- .1 Manufacturers: Super Hot
- .2 Provided by boiler manufacturer as option.

Part 3 Execution

3.1 INSTALLATION

- .1 Install to manufacturer's instructions.

□

- .2 Install boiler on concrete housekeeping base, sized minimum 100 mm larger than boiler base. Refer to Section 03 30 00.
- .3 Provide piping connections and accessories as indicated; refer to Section 23 05 20.
- .4 Provide piping connections and accessories as indicated; refer to Section 23 22 26.
- .5 Pipe relief valves to nearest floor drain.
- .6 Install circulator and diaphragm expansion tank on boiler.
- .7 Provide for connection to electrical service. Refer to Section 26 05 80.

3.2 MANUFACTURER'S FIELD SERVICES

- .1 Prepare and start systems to Section 01 44 00.
- .2 Instruct operating personnel.

3.3 SCHEDULES

	B-1, 2
Location	
Manufacturer	Allied Products
Model	Super Hot 9MSE
Input	9kW
Working Pressure	90psi
Water Flow Rate	6.2GPM (23)
Entering Water Temperature	72F
Leaving Water Temperature	82F
Electrical	208V-3phase-60Hz
Controls	Microcontroller w/outdoor reset
Options	PS automatic air vent, expansion tank, 1 ¼" circulator, air purger, fill valve

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Fan Coils.
- .2 Refrigerant cooling coils.
- .3 Air cooled condensing units.
- .4 Controls.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Administrative Requirements.
- .2 Section 01 61 00 - Common Product Requirements.
- .3 Section 01 78 10 - Execution Requirements.
- .4 Section 23 07 13 - Duct Insulation: Duct Liner.
- .5 Section 26 05 80 - Equipment Wiring: Electrical characteristics and wiring connections [and installation and wiring of thermostats and other controls components].

1.3 REFERENCES

- .1 ARI 210/240 - Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
- .2 ARI 270 - Sound Rating of Outdoor Unitary Equipment.
- .3 ARI 520 - Positive Displacement Condensing Units.
- .4 ASHRAE 14 - Methods of Testing for Rating Positive Displacement Condensing Units.
- .5 ASHRAE 15 - Safety Standard for Refrigeration Systems.
- .6 ASHRAE 90A - Energy Conservation in New Building Design.
- .7 ASHRAE 103 - Method of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers.
- .8 NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
- .9 NFPA 90B - Installation of Warm Air Heating and Air-Conditioning Systems.
- .10 UL 207 - Refrigerant-Containing Components and Accessories, Non-electrical.
- .11 UL 303 - Refrigeration and Air-Conditioning Condensing and Compressor Units.

1.4 SUBMITTALS FOR REVIEW

- .1 Section 01 33 00: Procedures for submittals.
- .2 Product Data: Provide rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.
- .3 Shop Drawings: Indicate assembly, required clearances, and location and size of field connections.

1.5 SUBMITTALS FOR INFORMATION

- .1 Section 01 33 00: Procedures for submittals.
- .2 Design Data: Indicate refrigerant pipe sizing.
- .3 Manufacturer's Instructions: Indicate rigging, assembly, and installation instructions.

1.6 SUBMITTALS AT PROJECT CLOSEOUT

- .1 Section 01 78 10: Submittals for project closeout.
- .2 Project Record Documents: Record actual locations of components and connections.
- .3 Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.
- .4 Warranty: Submit manufacturers warranty and ensure forms have been filled out in Owners name and registered with manufacturer.

1.7 QUALITY ASSURANCE

- .1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- .2 Installer Qualifications: Company specializing in performing the work of this section approved by manufacturer.

1.8 REGULATORY REQUIREMENTS

- .1 Products Requiring Electrical Connection: Listed and classified by CSA as suitable for the purpose specified and indicated.

1.9 WARRANTY

- .1 Section 01 78 10: Submittals for project closeout.
- .2 Provide [five] year manufacturers warranty for [condensing units] [compressors].

1.10 EXTRA MATERIALS

- .1 Section 01 78 10: Submittals for project closeout.

- .2 Provide [two] of filters for each furnace.

Part 2 Products**2.1 ELECTRIC FAN COILS**

- .1 Manufacturer: Carrier Model FB4C (See Schedule).
 - .1 Other acceptable manufacturers offering equivalent products.
 - .2 Substitutions: [Refer to Section 01 62 00.]
- .2 Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, heating element, controls, air filter, and accessories; wired for single power connection with control transformer.
 - .1 Air Flow Configuration: [Upflow].
 - .2 Heating: Electric.
 - .3 Electric Refrigeration: Refrigerant cooling coil and outdoor package containing compressor, condenser coil and condenser fan.
- .3 Cabinet: Steel with baked enamel finish, easily removed and secured access doors, glass fibre insulation and reflective liner.
- .4 Supply Fan: Centrifugal type rubber mounted with direct drive motor.
- .5 Motor: Refer to Section 23 05 13; 1750 rpm [single speed] [two-speed] [multi-speed].
- .6 Electric Heater: Helix wound bare nichrome wire heating elements arranged in incremental states of 5 kW each, with porcelain insulators.
- .7 Electric Heater Operating Controls:
 - .1 Low voltage adjustable room thermostat energized heater stages in sequence with pre-determined delay between heating stages.
 - .2 High limit temperature control de-energizes heating elements, automatic resets.
 - .3 Supply fan starts before electric elements are energized and continues operating after thermostat is satisfied until bonnet temperature reaches minimum setting. Include manual switch for continuous fan operation.
 - .4 Outdoor thermostat locks out some heating elements until outdoor temperature drops.
- .8 Air Filters: 25 mm glass fibre, disposable type arranged for easy replacement.
- .9 Performance:
 - .1 Refer to Furnace Schedule.

2.2 CONDENSING UNITS

- .1 Manufacturer: Carrier Model 24ABB3.
 - .1 Other acceptable manufacturers offering equivalent products.

- .1 Carrier Model 24ABB3.
- .2 Substitutions: [Refer to Section 01 62 00.]
- .2 Construction and Ratings: To ARI 210/240 [, and UL 207 and UL 303]. Testing: ASHRAE 14.
- .3 Compressor: [ARI 520;] hermetic, [two speed 1800 and] 3600 rpm, resiliently mounted integral with condenser, with positive lubrication, crankcase heater, high pressure control, motor overload protection, service valves and drier. Provide time delay control to prevent short cycling [and rapid speed changes].
- .4 Refrigeration Accessories: Filter Drier, high pressure switch (manual reset), low pressure switch (automatic reset), service valves and gauge ports, thermometer well (in liquid line). [Provide thermostatic expansion valves.] [Provide refrigerant lines, factory cleaned, dried, pressurized and sealed, with insulated suction line.] [Provide reversing valves on heat pump units.]
- .5 Air Cooled Condenser: [ARI 520;] aluminum fin and copper tube coil, with direct drive axial propeller fan resiliently mounted, galvanized fan guard.
 - .1 Rated cooling output: 60000 Btuh.
- .6 Electrical Characteristics:
 - .1 208 volts, single phase, 60 Hz.
 - .2 Disconnect Switch: Factory mount disconnect switch on equipment to Section 26 05 80.
- .7 Refrigeration Operating Controls
 - .1 Room Thermostat: Cycles condensing unit and supply fan to maintain room temperature setting.

2.3**THERMOSTATS**

- .1 Manufacturer: Carrier Model 32CSCPACHP-FC.
 - .1 Other acceptable manufacturers offering equivalent products.
 - .2 Substitutions: [Refer to Section 01 62 00.]
- .2 Adjustable Room Thermostat: Low voltage, to control electric heater stages in sequence with delay between stages, compressor and condenser fan and supply fan to maintain temperature setting. Include system selector switch (heat-off-cool) and fan control switch (auto-on).
- .3 Electric solid state microcomputer based room thermostat with remote sensor:
 - .1 Automatic switching from heating to cooling.
 - .2 Preferential rate control to minimize overshoot and deviation from setpoint.
 - .3 Set-up for four separate temperatures per day.
 - .4 Instant override of setpoint for continuous or timed period from one hour to 31 days.
 - .5 Short cycle protection.

- .6 Programming based on weekdays, Saturday and Sunday OR every day of the week.
- .7 Selection features including degree F or degree C display, 12 or 24 hour clock, keyboard disable, remote sensor, fan on-auto.
- .8 Battery replacement without program loss.
- .9 Thermostat display:
 - .1 Time of day.
 - .2 Actual room temperature.
 - .3 Programmed temperature.
 - .4 Programmed time.
 - .5 Duration of timed override.
 - .6 Day of week.
 - .7 System mode indication: heating, cooling, auto, off, fan auto, fan on.

Part 3 Execution**3.1 EXAMINATION**

- .1 Section 01 10 13: Verification of existing conditions before starting work.
- .2 Verify that floors are ready for installation of units and openings are as indicated on shop drawings. Verify that supports for air cooled condensers are completed.
- .3 Verify that proper power supply is available for furnace and condenser package.

3.2 INSTALLATION

- .1 Install to [NFPA 90A] [and] [NFPA 90B].
- .2 Install refrigeration systems to ASHRAE 15.
- .3 Pipe drain from cooling coils to nearest floor drain.
- .4 Mount air cooled condenser-compressor package as shown on drawings.

3.3 DEMONSTRATION AND INSTRUCTIONS

- .1 Section 01 78 10: Demonstrating installed work.
- .2 Supply initial charge of refrigerant and oil for each refrigeration system. Replace losses of oil or refrigerant prior to end of correction period.
- .3 Charge system with refrigerant and test entire system for leaks after completion of installation. Repair leaks, put system into operation, and test equipment performance.
- .4 Shut-down system if initial start-up and testing takes place in winter and machines are to remain inoperative. Repeat start-up and testing operation at beginning of first cooling season.

- .5 Provide cooling season start-up, and winter season shut-down for first year of operation.
- .6 Inspect and test for refrigerant leaks during first year of operation.

3.4 SCHEDULES

.1 Fan coils

Drawing Code	FC-1	FC-2	FC-3
Location	Offices	Members area	Cells
Manufacturer	Carrier	Carrier	Carrier
Furnace Model	FB4CN060L00	FB4CNP060L00	FB4CNP030000
Heating Type	electric	electric	electric
Heating Output	27 kW	27 kW	20 kW
	208/3 phase/60Hz	208/3 phase/60Hz	208/3 phase/60Hz
Airflow Capacity (L/s)	300	1900	1900
External Static Pressure	0.5	0.5	0.5
Cooling Coil Model	5 TON	5 TON	2.5 TON
Cooling Output (tons)	5	3.5	4
Accessories	Filter kit	Filter kit	Filter kit

.2 CONDENSING UNITS

Drawing Code	CU-1	CU-2	CU-3
Location	Cells	Members area	Offices
Manufacturer	Carrier	Carrier	Carrier
Model Number	24ABB360A003	24ABB348A003	24ABB330A003
Cooling			
Capacity	5 tons	4 tons	2.5 tons
Accessories	TC-PAC01 (Programmable AC control)		
Electrical characteristics	208V/1 phase/60Hz	208V/1 phase/60Hz	208V/1 phase/60Hz

END OF SECTION

Part 1 General**1.1 SECTION INCLUDES**

- .1 Air Conditioning Units.
- .2 Controls.

1.2 RELATED SECTIONS

- .1 Section 01 10 13 - Summary of Work.
- .2 Section 01 33 00 - Administrative Requirements.
- .3 Section 01 44 00 - Quality Assurance.
- .4 Section 01 61 00 - Common Product Requirements.
- .5 Section 01 78 10 - Execution Requirements.
- .6 Section [25 50 01 - Analog Control Equipment:] [25 50 02 - Digital Control Equipment:]
Placement of wall mounted thermostat.
- .7 Section 26 05 80 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3 SUBMITTALS FOR REVIEW

- .1 Section 01 33 00 - Administrative Requirements: Procedures for submittals.
- .2 Product Data: Provide manufacturers literature and data indicating [water,] drain, and electrical characteristics and connection requirements.

1.4 SUBMITTALS FOR INFORMATION

- .1 Section 01 33 00: Submittals for information.
- .2 Submit manufacturer's installation instructions. Indicate procedures required for rigging and making service connections.
- .3 Manufacturer's Field Reports: Indicate conditions at initial start-up including date, and initial set points.

1.5 SUBMITTALS FOR CLOSEOUT

- .1 Section 01 78 10: Submittals for project closeout.
- .2 Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data.

1.6 QUALITY ASSURANCE

- .1 Manufacturer's Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years experience.

1.7 REGULATORY REQUIREMENTS

- .1 Products Requiring Electrical Connection: Listed and classified by CSA as suitable for the purpose specified and indicated.

1.8 WARRANTY

- .1 Section 01 78 10: Submittals for project closeout.
- .2 Provide a 2 year parts warranty and 7 year compressor warranty.

Part 2 Products**2.1 MANUFACTURERS**

- .1 Mitsubishi Model PLA-A12HA and PUY-A12NHA3
- .2 Substitutions: [Refer to Section 01 62 00.]

2.2 AIR CONDITIONING UNITS

- .1 Description: Self contained air cooled, factory assembled, pre-wired and pre-piped unit, consisting of ceiling mounted cassette, remote control, and air-cooled remote condensing unit with ultra-low ambient cooling option (to -40C).
- .2 Assembly: For horizontal ceiling mounting .
- .3 Remote Air Cooled Condenser: Integral copper tube aluminum fin coil sized for rated capacity.

2.3 CONTROL SYSTEM

- .1 Controls: Microprocessor wall mounted with start/stop switch, adjustable temperature setpoint.

2.4 PERFORMANCE

- .1 Cooling:
 - .1 Capacity: 6000-12000 Btu/hr.
 - .2 Air flow: 184 - 250 L/sec.

2.5 ELECTRICAL CHARACTERISTICS AND COMPONENTS

- .1 Electrical Characteristics:

- .1 208-230 volts, single phase, 60 Hz.
 - .2 15 amperes maximum fuse size.
 - .3 Refer to Section 26 05 80.
- .2 Disconnect Switch: Factory mount disconnect switch in control panel.

Part 3 Execution**3.1 EXAMINATION**

- .1 Verification of existing conditions prior to beginning work.
- .2 Verify that ceiling system is ready to receive work and opening dimensions are as indicated on shop drawings.
- .3 Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION

- .1 Install to manufacturer's instructions.
- .2 Coordinate installation of air conditioning unit with computer room ceiling installer.
- .3 Provide adequate drainage connections for condensate.

3.3 MANUFACTURER'S FIELD SERVICES

- .1 Prepare and start systems to Section 01 44 00.
- .2 Set initial temperature and humidity set points. Instruct operating personnel.

END OF SECTION

Part 1 General**1.1 SECTION INCLUDES**

- .1 Hydronic radiant floor heating system.
- .2 Hydronic radiant floor materials.
- .3 Hydronic in-line circulators.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Administrative Requirements.
- .2 Section 01 61 00 - Common Product Requirements.
- .3 Section 01 78 10 - Execution Requirements.

1.3 REFERENCES

- .1 ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials
- .2 ASTM E119 Standard Test Methods for Fire Tests of Building Construction and Materials
- .3 ASTM E814 Standard Test Method for Fire Tests of Through-Penetration Fire Stops
- .4 ASTM F876 Standard Specification for Crosslinked Polyethylene (PEX) Tubing
- .5 ASTM F877 Standard Specification for Crosslinked Polyethylene (PEX) Plastic Hot- and Cold-Water Distribution Systems
- .6 ASTM F1960 Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-linked Polyethylene (PEX) Tubing
- .7 ANSI/UL 263 Standard for Safety for Fire Tests of Building Construction and Materials
- .8 CAN/CSA B137.5 Cross-Linked Polyethylene (PEX) Tubing Systems for Pressure Applications
- .9 DIN 4726 Pipelines of Plastic Materials Used in Warm Water Floor Heating Systems; General Requirements
- .10 Technical Report TR-3 Policies and Procedures for Developing Recommended Hydrostatic Design Stresses for Thermoplastic Pipe Materials
- .11 Technical Report TR-4 Recommended Hydrostatic Strengths and Design Stresses for Thermoplastic Piping and Fitting Compounds

1.4 SYSTEM DESCRIPTION

- .1 Design Requirements
 - .1 Standard Grade hydrostatic pressure ratings from Plastics Pipe Institute in accordance with TR-3 as listed in TR-4. The following three standard grade ratings are required.
 - .2 200 degrees F (93 degrees C) at 80 psi (551 kPa)
 - .3 180 degrees F (82 degrees C) at 100 psi (689 kPa)
 - .4 73.4 degrees F (23 degrees C) at 160 psi (1102 kPa)
- .2 Performance Requirements: Provide hydronic radiant floor heating system that is manufactured, fabricated and installed to comply with regulatory agencies and authorities with jurisdiction, and maintain performance criteria stated by the PEX tubing manufacturer without defects, damage or failure.
 - .1 Show compliance with ASTM F877.
 - .2 Show compliance with DIN 4726 regarding oxygen diffusion concerns where applicable.
 - .3 Show compliance with ASTM E119 and ANSI/UL 263 through certification listings with Underwriters Laboratories, Inc. (UL).
 - .1 UL Design No. K913 — 2 hour concrete floor/ceiling assemblies

1.5 SUBMITTALS

- .1 Section 01 33 00: Procedures for submittals.
- .2 Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description, model and dimensions.
- .3 Shop Drawings
 - .1 Provide installation drawings indicating tubing layout, manifold locations, zoning requirements and manifold schedules with details required for installation of the system.
 - .2 Provide mechanical schematic indicating heat source, mechanical piping and accessories from heat source to manifolds, circulators, water tempering and zone controls. Indicate supply water temperatures and flow rates to manifolds.
- .4 Quality Assurance and Control Submittals: Submit the following.
 - .1 Test Reports: Upon request, submit test reports from recognized testing laboratories.
 - .2 Documentation: Submit the following.
 - .1 Manufacturer's certificate indicating products comply with specified requirements
 - .2 Manufacturer's detailed room-by-room heat-loss analysis for the structure
 - .3 Documentation indicating the installer is trained to install the manufacturer's products
- .5 Closeout Submittals: Submit the following.

- .1 Warranty documents specified herein
- .2 Operation and maintenance data
- .3 Manufacturer's field reports specified herein
- .4 Final as-built tubing layout drawing

1.6 PROJECT RECORD DOCUMENTS

- .1 Section 01 78 10: Submittals for project closeout.
- .2 Record actual locations of flow controls, flow meters, manifolds.
- .3 Provide copies of any detailed layout drawings and photos of installed product before coverings are installed.

1.7 OPERATION AND MAINTENANCE DATA

- .1 Section 01 78 10: Submittals for project closeout.
- .2 Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.8 QUALIFICATIONS

- .1 Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.9 DELIVERY, STORAGE, AND HANDLING

- .1 Section 01 61 00: Transport, handle, store, and protect products.
- .2 Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- .3 Provide temporary protective coating on cast iron and steel valves.
- .4 Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- .5 Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.
- .6 Storage and Protection: Store materials protected from exposure to harmful environmental conditions and at temperature and humidity conditions recommended by the manufacturer.
 - .1 Store PEX tubing in cartons or under cover to avoid dirt or foreign material from entering the tubing.
 - .2 Do not expose PEX tubing to direct sunlight for more than 30 days. If construction delays are encountered, cover the tubing that is exposed to direct sunlight.

1.10 MAINTENANCE SERVICE

- .1 Provide service and maintenance of glycol system for one year from date of substantial completion.
- .2 Seasonal (every 3 months) visit to make glycol fluid concentration analysis on site with refractive index measurement instrument. Detail findings with maintenance personnel in writing of corrective actions needed including analysis and amounts of glycol or water added.

1.11 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 covers the repair or replacement of any tubing or fittings proven defective.
 - .2 Warranty may transfer to subsequent owners.
 - .3 Warranty Period for PEX Tubing: 25-year, non-prorated warranty against failure due to defect in material or workmanship, beginning with date of substantial completion.
 - .4 Warranty Period for Manifolds and Fittings: 5-year, non-prorated warranty against failure due to defect in material or workmanship, beginning with date of substantial completion.
 - .5 Warranty Period for Controls and Electrical Components: 2-year, non-prorated warranty against failure due to defect in material or workmanship, beginning with date of substantial completion.

1.12 1.08 SYSTEM STARTUP

- .1 Do not start the system for a minimum of 25 days or as specified by mortar, concrete, and/or covering manufacturer as applicable.
- .2 Verify all electrical components are installed as per provincial and National Electrical Code prior to start-up.

1.13 1.09 OWNER'S INSTRUCTIONS

- .1 Instruct Owner's personnel about operation and maintenance of installed system. Provide manufacturer's installation, operation and maintenance instructions for installed components within the system.

1.14 EXTRA MATERIALS

- .1 Section 01 78 10: Submittals for project closeout.

- .2 Provide one extra 40 litre drum of propylene glycol.

Part 2 Products**2.1 HYDRONIC RADIANT FLOOR HEATING SYSTEM**

- .1 Manufacturers:
 - .1 Manufacturer: Uponor, Inc.
 - .2 Other acceptable manufacturers offering equivalent products.
 - .1 Watts Radiant, Inc.
 - .2 Rehau
 - .3 Substitutions: [Refer to Section 01 62 00.]
- .2 Provide a complete, operating, engineered and commissioned in-floor glycol-water heating system to provide building skin load. Refer to section 23 52 13 Electric Boilers for boiler information. Include tubing layout and design, manifolds, glycol tanks, controls, two-temperature thermostats, and everything required for a working system.
- .3 Zone the areas as specified in the mechanical drawings, with allowances for other systems (plumbing, electrical etc.) as required. Co-ordinate with other trades, and document locations of tubing before covering.

2.2 HYDRONIC RADIANT FLOOR HEATING SYSTEM MATERIALS

- .1 Tubing
 - .1 Material: Crosslinked polyethylene (PEX).
 - .2 Material Standard: Manufactured in accordance with ASTM F876 and ASTM F877 and tested for compliance by an independent third-party agency.
 - .3 Pressure Ratings: Standard Grade hydrostatic design and pressure ratings as issued by the Plastics Pipe Institute (PPI), a division of the Society of the Plastics Industry (SPI).
 - .4 Show compliance with ASTM E119 and ANSI/UL 263 through certification listings through UL.
 - .5 UL Design No. K913 — 2 hour concrete floor/ceiling assemblies
 - .6 Minimum Bend Radius (Cold Bending): No less than six times the outside diameter. Use the PEX tubing manufacturer's bend supports if radius is less than stated.
 - .7 Provide an oxygen diffusion barrier tubing that shall not exceed an oxygen diffusion rate of 0.1 g/cubic meter per day at 40 degrees C water temperature in accordance with German DIN 4726.
 - .8 An oxygen diffusion barrier tubing is not required if one of the following design strategies is used.
 - .1 Isolate the ferrous materials in the boiler and other components within the primary side of the mechanical system with a heat exchanger.
 - .1 Use non-ferrous components within the secondary system side (e.g., pumps, expansion tanks, etc.).

- .2 Use non-ferrous components within the entire fluid pathway.
- .2 Manifolds (residential and light commercial, valved brass or stainless steel).
 - .1 For system compatibility, use 1¼-inch brass (stainless steel) manifolds offered by the respective PEX tubing manufacturer.
 - .2 Use manifold mounting brackets offered by the respective PEX tubing manufacturer.
 - .3 Manifolds must provide individual flow control for each loop of the manifold through valve actuators available from the manifold supplier.
 - .4 Manifolds must feature manual flow balancing capability within the manifold body for balancing unequal loop lengths across the manifold.
 - .5 Manifolds support 5/16 inch to 5/8 inch PEX tubing.
 - .6 Each manifold location should have the ability to vent air manually from the system.
- .3 Manifolds (commercial, valved copper)
 - .1 For system compatibility, use 2-inch valved copper manifolds manufactured from Type L copper material, offered by the respective PEX tubing manufacturer.
 - .2 Install valved copper manifolds primarily for wall-hung or boxed applications.
 - .3 Use manifolds with an isolation valve or a combination isolation and balancing valve on each outlet.
 - .4 Use manifolds that support 5/8 inch or ¾ inch PEX tubing.
 - .5 Ensure manifold end cap offers tapping for 1/8 inch FNPT and 1/2 inch FNPT for vent and drain.
 - .6 Install supply and return piping to the manifold in a reverse-return configuration to ensure self-balancing.
 - .7 If the supply and return piping is in direct-return configuration, install and balance flow setters on the return leg of each manifold to the mains.
- .4 Fittings
 - .1 For system compatibility, use fittings offered by the PEX tubing manufacturer.
 - .2 The fitting assembly must comply with ASTM F877 and CAN/CSA B137.5 requirements.
- .5 Supply-and-return Piping to the Manifolds (above ground piping)
 - .1 Properly size supply and return distribution piping for the given volume and velocities required at system design.
 - .2 Use suitable distribution piping material (i.e., metric dimensioned PEX with oxygen barrier, type M copper or black iron piping) for all supply fluid temperatures in systems with ferrous components.
 - .3 Use suitable distribution piping material for systems free of or isolated from ferrous components.

- .4 Follow manufacturer's instructions with respect to avoiding exposure of tubing to direct sunlight or install near overhead fluorescent lighting. If PEX tubing is exposed, install suitable pipe insulation around the exposed tubing.
- .5 Use fittings compatible with piping material. Fittings must transition from distribution piping to system manifolds.
- .6 Supply and Return Piping to the Manifolds (below ground piping)
 - .1 Properly size supply and return distribution piping for the given volume and velocities required at system design.
 - .2 Use suitable distribution piping material (i.e., metric dimensioned PEX with oxygen barrier, type M copper or black iron piping) for all supply fluid temperatures in systems with ferrous components.
 - .3 Use suitable distribution piping material for systems free of or isolated from ferrous components.
 - .4 If copper or black iron piping is embedded in concrete or soil, insulate or protect with sleeves.
 - .5 Use fittings compatible with piping material. Fittings must transition from distribution piping to system manifolds.
- .7 Room Temperature Controls
 - .1 Install a dual temp air/floor thermostat (heat only) with digital display in each zone as required.
- .8 Supply Water Temperature Control
 - .1 Design the control strategy and install the components to meet or exceed the system performance requirements as stated in the system design.
 - .2 Use the PEX tubing manufacturer's supply water temperature controls and sensors.
 - .3 Use outdoor temperature reset to adjust heat levels.

2.3 ACCESSORIES

- .1 Use accessories associated with the installation of the radiant floor heating system as recommended by or available from the PEX tubing manufacturer.

2.4 IN-LINE CIRCULATORS

- .1 Manufacturers:
 - .1 Grundfos UP Series
 - .2 Other acceptable manufacturers offering equivalent products.
 - .1 Bell & Gossett NRF series.
 - .2 Astro 20-30

- .3 Substitutions: [Refer to Section 01 62 00.]
- .2 Type: Horizontal shaft, single stage, direct connected, with resiliently mounted motor for in-line mounting, oil lubricated, for 1000 kPa maximum working pressure.
- .3 Casing: Cast iron, with flanged pump connections.
- .4 Impeller: PES composite keyed to shaft.
- .5 Ceramic shaft and radial bearings
- .6 Carbon thrust bearing
- .7 Stainless steel rotor can and bearing plate
- .11 Impeller in corrosion-resistant material
- .1 Flow Capacity etc: See schedule
- .19 Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to code.

Part 3 Execution**3.1 INSTALLATION**

- .1 Install to manufacturer's instructions.
- .2 Clean and flush glycol system before adding glycol solution. Refer to Section 23 25 00.
- .3 Feed glycol solution to system through make-up line with pressure regulator, venting system high points.
- .4 Pre-cast Plank Construction with a Cap Pour
 - .1 Fasten the tubing to flat wire mesh or reinforcing bar, or snap into PEX rails in accordance with the PEX tubing manufacturer's installation recommendations.
 - .2 Use closer tubing on-center distances along exterior walls. Increase tubing on-center distances as the installation moves away from the exterior wall.
 - .1 Do not exceed 12 inches (305mm) on center for residential use applications.
 - .2 Do not exceed 9 inches (229mm) on center for tile or linoleum covered floors.
 - .3 Do not install tubing within 6 inches (152mm) of all walls.
 - .4 Refer to the submitted radiant floor design layout.
 - .3 If the design requires under-slab insulation, the structural engineer determines the vertical compressive strength of the high-density extruded board insulation. The radiant floor design determines the required insulation resistance value (R-value).
 - .4 Use edge insulation when the heated panel directly contacts an exterior wall or panel.

- .5 Install tubing at a consistent depth below the surface elevation as determined by the project engineer. Ensure sufficient clearance to avoid control joint cuts.
 - .6 Depending on the manufacturer's and structural engineer's recommendation, fibrous expansion joints may tolerate penetration.
 - .7 For tubing that exits the slab in a 90-degree bend, use metal or PVC bend supports.
- .5 Glycol and Water Solution
- .1 PEX tubing manufacturer recommends premixed glycol and water solutions.
 - .1 PEX tubing manufacturer allows site-mixed solutions if mixed to the proper concentration before entering the system.
 - .2 Mix the glycol and water solution to proper concentration levels to protect the system freezing during operation shutdown.
 - .3 System circulators must operate continuously for a minimum of 30 days after the system is filled to ensure the glycol and water does not separate in a static system.
 - .2 Do not use ethylene glycol due to toxicity issues. The PEX tubing manufacturer recommends the use of inhibited propylene glycol for hydronic radiant floor heating systems. Refer to the boiler manufacturer's recommendations.
- .6 Through-penetration Firestop
- .1 Ensure compatibility of one- and two-hour rated through-penetration assemblies in accordance with ASTM E814.
 - .2 Refer to the PEX tubing manufacturer for manufacturers that list PEX tubing with their firestop systems.
- .7 In-line circulators
- .1 Install to manufacturer's instructions.
 - .2 Provide access space around pumps for service. Provide no less than minimum as recommended by manufacturer.
 - .3 Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. For close coupled or base mounted pumps, provide supports under elbows on pump suction and discharge line sizes 102 mm. [Refer to Section 23 05 48.]
 - .4 Provide line sized shut-off valve and strainer, pump suction fitting on pump suction, and line sized soft seat check valve and balancing valve, combination pump discharge valve on pump discharge.
 - .5 Provide air cock and drain connection on horizontal pump casings.
 - .6 Provide drains for bases and seals, piped to and discharging into floor drains.
 - .7 Check, align, and certify alignment of base mounted pumps prior to start-up.
 - .8 Install [close coupled and] base mounted pumps on concrete housekeeping base, with anchor bolts, set and level, and grout in place. Refer to Section 03 30 00.
 - .9 Lubricate pumps before start-up.

		CP-1-10
	Manufacturer	Grundfos
	Model	UPS 15-55SFC
	Seal Type	3-speed
	Flow Capacity	0-25GPM
	Head Pressure	0-18 feet
	Motor Size	2 pole single phase, 1/25 HP

.1

3.3 FIELD QUALITY CONTROL

.1 Site Tests

- .1 To ensure system integrity, pressure test the system before covering tubing in concrete or when other trades are working in the vicinity of the tubing.
- .2 Test all electrical controls in accordance with respective installation manuals.

3.4 ADJUSTING

.1 Balancing Across the Manifold

- .1 Balance all loops across each manifold for equal flow resistance based on actual loop lengths and total manifold flow.
- .2 Balancing is unnecessary when all loop lengths across the manifold are within 3 percent of each other in length. Install the supply and return piping to the manifold in a reverse-return configuration to ensure self-balancing.
- .2 Balancing between manifolds is accomplished with a flow control device installed on the return piping leg from each manifold when direct return piping is used for the supply and return mains.

3.5 DEMONSTRATION

- .1 Demonstrate operation of hydronic radiant floor heating system to Owner's personnel.
- .2 Advise the owner's representative about the type and concentration of glycol and water solution if used in the hydronic radiant floor heating system.
 - .1 The Owner monitors the solution effectiveness through an established maintenance program as outlined by the glycol manufacturer.

3.6 PROTECTION

- .1 Protect installed work from damage caused by subsequent construction activity on the site.

END OF SECTION

Part 1 General**1.1 SECTION INCLUDES**

- .1 Sequence of operation:
 - .1 Cabinet Heaters.
 - .2 LAN Room Air Conditioning.
 - .3 Fan coil units.
 - .4 Exhaust fans – general
 - .5 Crawlspace exhaust
 - .6 Secure Bay and Garage Exhaust
 - .7 Heat recovery ventilators
 - .8 Electric Heating Coils
 - .9 Heating water zone control.
 - .10 Unit heaters.
 - .11 Sump pumps
 - .12 Sewage ejector pump.
 - .13 Hot water recirculation pump.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Administrative Requirements.
- .2 Section 01 44 00 - Quality Assurance.
- .3 Section 01 61 00 - Common Product Requirements.
- .4 Section 01 78 10 - Execution Requirements.
- .5 Section 25 30 00 - Instruments And Control Elements.
- .6 Section 25 50 01 - Analog Control Equipment.
- .7 Section 25 50 02 - Digital Control Equipment.
- .8 Section 26 05 80 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3 SYSTEM DESCRIPTION

- .1 This section defines the manner and method by which controls function.
- .2 Requirements for each type of control system operation are specified.
- .3 Equipment, devices, and system components required for control systems are specified in other Sections.

1.4 SUBMITTALS FOR REVIEW

- .1 Section 01 33 00: Procedures for submittals.
- .2 Shop Drawings: Indicate mechanical system controlled and control system components.
 - .1 Label with settings, adjustable range of control and limits. Include written description of control sequence.
 - .2 Include flow diagrams for each control system, graphically depicting control logic.
 - .3 Include draft copies of graphic displays indicating mechanical system components, control system components, and controlled function status and value.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

- .1 Section 01 78 10: Submittals for project closeout.
- .2 Project Record Documents: Record actual locations of components and set points of controls, including changes to sequences made after submission of shop drawings.

Part 2 Products**2.1 Not Used**

- .1 Not Used

Part 3 Execution**3.1 CABINET HEATERS**

- .1 Single temperature thermostat mounted in cabinet return air set 20 degrees C maintains constant space temperature by cycling unit fan motor and electric heating elements. Integral thermostat continues fan operation until element temperature falls below 38 degrees C.

3.2 LAN ROOM AIR CONDITIONING

- .1 On room temperatures above 24 degrees C, ductless air conditioning unit shall cycle on and off to maintain room temperature. Year round operation.

3.3 FAN COIL UNITS

- .1 These units provide tempered air to three different zones in the building. FC-1 provides air to the offices and administrative area. FC-2 provides air to the central members' area and services rooms. FC-3 provides air to the cells area. Fresh air from HRV's (for FC-1 and 2) is introduced to the fan coils via the return air duct. Fresh air for FC-3 comes from a direct fresh air intake. The fan coils provide tempered air during heating season, and will provide building cooling during cooling season. The fan coils shall be switchable between heating and cooling mode at the room thermostat, both manually and

automatically. The fan coils are sized to be able to provide building heat if the hydronic system fails.

- .2 FC-3 will operate in 100% outside air mode or partial recirculation mode. There are 3 types of exhaust fans in the cell area: those operating continuously, those with an ON/OFF switch, and those with a LOW/HIGH switch. When any exhaust fans in the cell area that have ON/OFF or LOW/HIGH controls, are set to ON or HIGH, FC-3 will operate in 100% OA mode and the damper in the return air duct will remain closed in this mode. When all cell exhaust fans with switches are set to OFF or LOW, FC-3 will operate in partial recirculation mode and the return air damper will open.
- .3 During heating season, a supply air thermostat set at 21 degrees C (adjustable) maintains constant supply air temperature by staging electric heater coils.
- .4 During cooling season, area thermostats maintain constant room temperature by cycling DX cooling coils.
- .5 These units will be shut down upon fire alarm.

3.4 EXHAUST FANS - GENERAL

- .1 Exhaust fan: EF-1
 - .1 Fan shall be two speed motor, with automatic hi/low switching.
 - .2 Fan shall run continuously during occupied mode in high speed speed to maintain cell negative pressure relative to guard areas. When all cell exhaust fans and the cell shower exhaust fan are manually turned down, EF-1 shall switch automatically to low speed.
- .2 Cells and Breathalyzer room exhaust fans: EF-4,5,6,7,8
 - .1 Fans shall be two speed motors, with manual hi/low switching.
 - .2 Fans shall run continuously during occupied mode in low speed to maintain cell negative pressure relative to guard areas.
- .3 Exhaust fans: EF-2,3,10 (Jamitor's room, prisoner effects, guard washroom)
 - .1 Fans shall be one speed motors. Fans shall run continuously.
- .4 Exhaust fans: EF-9, 11 (shower, interview room)
 - .1 Fan shall be one speed motor, interlocked with the shower room light switch. Fan to run continuously when shower room light is on.
- .5 Washroom/Changeroom/Workout room/Shower exhausts;
 - .1 Exhaust shall be by heat recovery ventilator exhaust. This exhaust shall run continuously to maintain negative pressure relative to common areas.

3.5 CRAWLSPACE EXHAUST FANS: EF-13, 14

- .1 Outside temperature sensor and dew point sensor monitors outdoor temperature and dewpoint and the crawlspace mounted humidistat monitors crawlspace humidity. When outdoor temperature is greater than 5C AND the relative humidity in the crawlspace is

□

higher than 90%, AND the dew point of the exterior air is less than the crawlspace temperature, the crawlspace ventilation system is activated. The motorised damper for the outdoor air intake is opened and when fully open an end switch sends a signal to the exhaust fan to start operation. Exhaust fan operation will cease and the air intake will close when the humidity in the crawlspace is reduced to 50%.

3.6 SECURE BAY AND GARAGE EXHAUST, EF-12, 15

- .1 When the remote CO/NO_x Sensor reaches the first alarm set point (25PPM for CO and 0.7PPM for NO_x) the exhaust fan is to start and the motorized damper open. The fan is to run until the sensor reads 0ppm, at which point it will stop and the motorized damper will close.
- .2 If the CO/NO_x level does not drop, but rises so the sensor reaches the second alarm set point (75 PPM for CO and 2PPM for NO_x), the alarm located in the garage will sound. The exhaust will continue to run. The motorized damper will remain open.

3.7 HEAT RECOVERY VENTILATORS

- .1 Heat recovery ventilators are used to provide fresh air to the members' area and administrative area. HRV-1 provides 300cfm to FC-1 (for admin area) and HRV-2 provides 900cfm to FC-2 (members' area and service rooms).
- .2 The heat recovery ventilators will run continuously to provide fresh air and exhaust. These units will be shut down on fire alarm.
- .3 These units will have an electric in-duct coil located in the outdoor air intake for defrost, to ensure 100% ventilation at all times. This electric coil will be cycled on off to maintain -5 degrees C air temperature, and will have a failsafe air switch (sail switch) to keep the coil from heating should the air system fail. This control shall be by standalone SCR control based on air temperature sensing.

3.8 ELECTRIC HEATING COILS

- .1 Electric in duct coil on heat recovery ventilator fresh air intake shall cycle on/off as enabled from a duct air temperature sensor to maintain outdoor air temperature above zero Celsius for defrost of heat exchanger, and to maintain ventilation during heat recovery ventilator operation.
- .2 Electric in-duct coil on heat recovery ventilator fresh air supply duct (or on FC-3 intake air duct) shall cycle on/off as enabled from a duct air temperature sensor to maintain air temperature to fan coil at 21C as a supplement to the fan coil heat. When the fan coil is switched from heating mode to cooling mode, this supplemental duct heater shall be de-energized.
- .3 All electric coils shall have air flow and hi limit safety controls.
- .4 In-duct reheat coils shall be enabled by second stage signal from room thermostat. Duct mounted temperature sensor will cycle SCR/stages to maintain 30°C discharge temperature.

3.9 HYDRONIC HEATING

- .1 Boiler Loop Control
 - .1 When outdoor temperature is 10C (adjustable) or lower, enable boilers. Control heating water supply temperature at 31 degrees C.
 - .2 Alternate use of boilers – every Wed at 12 noon and every Sunday at midnight. If one boiler fails, then switch to the other boiler and generate an alarm.
 - .3 Boiler loop to run continuously when boiler in operation.
- .2 Primary Loop control
 - .1 Loop pump operates continuously.
 - .2 Flow control valve will open and close to maintain primary loop temperature at 31 degrees C.
 - .3 Flow switch in heating pump discharge provides on/off indication.
 - .4 On outside temperatures above 10 degrees C, de-energize loop pumps and suppress alarm.
- .3 Zone Loop control
 - .1 Loop pump to operate continuously.
 - .2 On call for heat from zone thermostat, control valve will open and allow water from primary loop to circulate through zone loop. When call for heat is satisfied, control valve will close.
 - .3 Flow switch in heating water circuit on no flow conditions indicates alarm.
 - .4 On outside temperatures above 10 degrees C, de-energize loop pumps and suppress alarm.

3.10 UNIT HEATERS – SECURE/GARAGE BAY

- .1 Single temperature electric room thermostat maintains constant space temperature of 20 degrees C by cycling electric heaters and unit fan motor.

3.11 SUMP PUMPS

- .1 Pit shall have hi level alarm, and shall have a trouble light indicator for hi level located at front reception desk or other room as noted by owner. Hi level alarm shall indicate when sump pits are at 75% capacity.
- .2 Sump pumps shall operate automatically when sump levels rise above sump float trigger.

3.12 SEWAGE EJECTOR PUMPS

- .1 Tank shall have hi level alarm, and shall have a trouble light indicator for hi level located at front reception desk or other room as noted by owner. Hi level alarm shall indicate when tank at 75% capacity.
- .2 Sewage pumps shall operate automatically when sewage tank levels rise above pump float trigger.

3.13 LIFT PUMPS

- .1 Tank shall have hi level alarm, and shall have a trouble light indicator for hi level located at front reception desk or other room as noted by owner. Hi level alarm shall indicate when tanks at 75% capacity.
- .2 Lift pumps shall operate automatically when sewage tank levels rise above pump float trigger.

3.14 DOMESTIC HOT WATER RECIRCULATION PUMP

- .1 Pump shall run continuously on, toggled on/off by switch. 24h timer with 15min intervals available to reduce pump operation while meeting hot water needs.

3.15 DOMESTIC HOT WATER ELECTRIC TANK

- .1 Hot water tanks shall maintain 60 degrees C in water storage by cycling on/off electric immersion heaters as enabled from immersion aqua stat, all as a package from manufacturer.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Definitions:
 - .1 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE SP1122.
- .2 Reference Standards:
 - .1 CSA Group
 - .1 CSA C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.
 - .2 CAN/CSA-C22.3 No.1, Overhead Systems.
 - .3 CAN3-C235, Preferred Voltage Levels for AC Systems, 0 to 50,000 V.
 - .2 Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)
 - .1 IEEE SP1122-[2000], The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.
 - .3 Manitoba Electrical Code.
 - .4 National Building Code.
 - .5 Manitoba Building Code.
 - .6 ULC S524 Installation of Fire Alarm Systems

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 11 00 Summary of Work.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for all equipment and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Submit for review single line electrical diagrams in glazed frames and locate
 - .1 In main electrical room.
- .4 Submit for review fire alarm riser diagram, plan and zoning of building in glazed frame and locate
 - .1 In main electrical room.
- .5 Shop drawings:
 - .1 The term "Shop Drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by Contractor to illustrate details of a portion of Work.

- .2 Provide shop drawings for equipment and systems. Where so indicated, submit drawings stamped and signed by professional engineer registered or licensed in Manitoba, Canada.
- .3 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connection, explanatory notes and other information necessary for completion of Work.
- .4 Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure co-ordinated installation.
- .5 Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.
- .6 Indicate on drawings clearances for operation, maintenance, and replacement of operating equipment devices.
- .7 Make changes in shop drawings as Engineer may require.
- .8 Contractor's responsibility for errors and omissions in submission is not relieved by Engineer's review of submittals.
- .9 Contractor's responsibility for deviations in submission from requirements of Contract Documents is not relieved by Engineer's review.
- .10 Keep one reviewed copy of each submission on Site.
- .11 Detail all shop drawings using the metric system.
- .12 Transmittal form or shop drawing stamp to be signed by Contractor's authorized representative certifying approval of submission, verification of field measurements and compliance with Contract Documents.
- .13 Submit electronic or three (3) hard copies of product data sheets or brochures for requirements requested in specification Sections and as Engineer may reasonably request where shop drawings will not be prepared due to standardized manufacture of product.
- .14 During review, Engineer will mark drawings to indicate review status:
- .15 "REVIEWED" - Make and distribute additional copies as required for execution of the Work.
- .16 "REVIEWED AS NOTED" - Review Engineer's notations. Incorporate into work, or advise where incorporation of review notations is not suitable. Make and distribute additional copies as required for execution of the Work.
- .17 "REVISE & RESUBMIT" - Make the necessary revisions and resubmit revised drawings for review. Show the drawing number of the first such revised drawing and show the latest revision number applicable to the drawing by adding a suffix to the drawing number as - "REV. 1", "REV. 2", etc.
- .18 "NOT REVIEWED" - This notation indicates that Engineer has not reviewed the drawing. It may also be used in combination with the notation to revise and resubmit the drawing where Engineer lacks sufficient information to complete the review and requires resubmission of the drawing for review after revision.
- .19 Drawings will be marked "REVIEWED" together with the notation "REVISE & RESUBMIT" when Engineer requires resubmission of a revised drawing showing corrections made as a result of Engineer's notations on the shop drawings. This procedure will not relieve Contractor of responsibility for errors

- or omissions in the shop drawings or of responsibility for meeting all requirements of Contract.
- .20 Use only those shop drawings on the work that bear the "REVIEWED" notation.
 - .21 Do not revise shop drawings marked "REVIEWED" unless resubmitted to Engineer for further review.
 - .22 Review by Engineer is for the sole purpose of ascertaining conformance with the general design concept. This review does not mean that Engineer approves the detail design inherent in the shop drawings, responsibility for which remains with Contractor, and such review does not relieve Contractor of responsibility for errors or omissions in the shop drawings or of responsibility for meeting all requirements of Contract Documents. Contractor is responsible for dimensions to be confirmed and correlated at the job-site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for coordination of the work of all sub-trades.
 - .23 If changes are required, notify Departmental Representative of these changes before they are made.
 - .24 Provide shop drawings for all major equipment including without limitation:
 - .1 CSTE and metering.
 - .2 Grounding equipment and accessories.
 - .3 Main service entrance equipment and switches.
 - .4 Standby generator, transfer switch, and accessories.
 - .5 Electrical panelboards, circuit breakers, switches, fuses, and accessories.
 - .6 Wiring devices.
 - .7 Luminaires, lighting controls, and lighting system accessories.
 - .8 Exit signage.
 - .9 Fire alarm system.
 - .10 Voice / data and communications cables, trays, supports, faceplates, jacks, and accessories. Copy of Belden CSV certificate. Copy of RCDD certificate.
 - .6 Certificates:
 - .1 Submit test results of installed electrical systems and instrumentation.
 - .2 Permits and fees: in accordance with General Conditions of contract.
 - .3 Submit, upon completion of Work, load balance report as described in PART 3 - LOAD BALANCE.
 - .4 Submit certificate of acceptance from authority having jurisdiction upon completion of Work to Departmental Representative.
 - .7 Manufacturer's Field Reports: submit to Departmental Representative manufacturer's written report, within 4 days of review, verifying compliance of Work.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 11 00 - Summary of Work.

- .2 Operation and Maintenance Data: submit operation and maintenance data for incorporation into manual.
 - .1 Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.
 - .2 Operating instructions to include following:
 - .1 Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
 - .2 Start up, proper adjustment, operating, lubrication, and shutdown procedures.
 - .3 Safety precautions.
 - .4 Procedures to be followed in event of equipment failure.
 - .5 Other items of instruction as recommended by manufacturer of each system or item of equipment.
 - .3 Print or engrave operating instructions and frame under glass or in approved laminated plastic.
 - .4 Post instructions where directed.
 - .5 For operating instructions exposed to weather, provide weather-resistant materials or weatherproof enclosures.
 - .6 Ensure operating instructions will not fade when exposed to sunlight and are secured to prevent easy removal or peeling.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 11 00 - Summary of Work and with manufacturer's instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect equipment from mechanical injury, dust and contamination, nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 DESIGN REQUIREMENTS

- .1 Operating voltages: to CAN3-C235.
- .2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.
 - .1 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

- .3 Language operating requirements: provide identification labels for control items in English.

2.2 MATERIALS AND EQUIPMENT

- .1 Provide material and equipment in accordance with Section 01 11 00 - Summary of Work.
- .2 Equipment to be CSA or cUL certified. Where CSA or cUL certified equipment is not available, obtain special approval from inspection authorities before delivery to site. Inspected equipment shall bear a special inspection approval sticker.
- .3 Factory assemble control panels and component assemblies.

2.3 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS

- .1 Verify installation and co-ordination responsibilities related to motors, equipment and controls, as indicated.

2.4 WARNING SIGNS

- .1 Warning Signs: in accordance with requirements of authority having jurisdiction.

2.5 WIRING TERMINATIONS

- .1 Ensure lugs, terminals, screws used for termination of wiring are suitable for either copper or aluminum conductors.

2.6 EQUIPMENT IDENTIFICATION

- .1 Identify electrical equipment with labels as follows:
 - .1 Nameplates: lamicoid 3 mm thick matt white finish face, black core, lettering accurately aligned and engraved into core, mechanically attached with self tapping screws or adhesive where mechanical fasteners are not suitable.
 - .2 Sizes as follows:

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

- .2 Wording on labels to be approved by Departmental Representative prior to manufacture.
- .3 Allow for minimum of twenty-five (25) letters per label.
- .4 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .5 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
- .6 Terminal cabinets and pull boxes: indicate system and voltage.

- .7 Transformers: indicate capacity, primary and secondary voltages.

2.7 WIRING IDENTIFICATION

- .1 Identify wiring with permanent indelible identifying markings on both ends of phase conductors of feeders and branch circuit wiring.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour coding: to CSA C22.1.
- .4 Use colour coded wires in communication cables, matched throughout system.

2.8 CONDUIT AND CABLE IDENTIFICATION

- .1 Colour code conduits, boxes and metallic sheathed cables.
- .2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor.

2.9 FINISHES

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

Part 3 Execution

3.1 EXAMINATION

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

3.2 INSTALLATION

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

3.3 NAMEPLATES AND LABELS

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

3.4 CONDUIT AND CABLE INSTALLATION

- .1 Install conduit and sleeves prior to pouring of concrete.
 - .1 Sleeves through concrete: [schedule 40 steel pipe] [plastic] [sheet metal], sized for free passage of conduit, and protruding [50] mm.
- .2 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.
- .3 Install cables, conduits and fittings embedded or plastered over, close to building structure so furring can be kept to minimum.
- .4 Arrange for penetrations of exterior walls and roof to be flashed and made permanently weatherproof.
- .5 Arrange for cutting and patching of penetrations.

3.5 LOCATION OF OUTLETS

- .1 Do not install outlets back-to-back in wall; allow minimum 150 mm horizontal clearance between boxes. In rated wall assemblies, locate in separate stud spaces and provide firestop.
- .2 Change location of outlets at no extra cost or credit, providing distance does not exceed 4000 mm and information is given before works are enclosed or walls are finished.
- .3 Locate light switches on latch side of doors.
 - .1 Locate disconnect devices in mechanical and elevator machine rooms on latch side of floor.

3.6 MOUNTING HEIGHTS

- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
- .2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
- .3 Install electrical equipment at following heights unless indicated otherwise.
 - .1 Local switches: 1400 mm.
 - .2 Wall receptacles, voice and data outlets, television outlets:
 - .1 Coordinate with desk, furniture, and mill work locations.
 - .2 General: 400 mm.
 - .3 Above top of continuous baseboard heater: 200 mm.
 - .4 Above top of counters or counter splash backs: 175 mm.
 - .5 In mechanical rooms: 1400 mm.
 - .3 Panelboards: as required by Code or as indicated.
 - .4 Fire alarm stations: 1200 - 1400 mm (consistent throughout).
 - .5 Fire alarm horns: 2100 mm.

3.7 CO-ORDINATION OF PROTECTIVE DEVICES

- .1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings.
- .2 Provide Short Circuit and Coordination Study. Study shall be prepared by the Consultant. Cost shall be a Cash Allowance.

3.8 FIELD QUALITY CONTROL

- .1 Load Balance:
 - .1 Measure phase current to panelboards with normal loads lighting operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
 - .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
 - .3 Provide upon completion of work, load balance report , phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.
- .2 Conduct following tests in accordance with Section 01 11 00 - Summary of Work
 - .1 Power distribution system including phasing, voltage, grounding and load balancing.
 - .2 Power generation system including phasing, voltage, grounding and load balancing.
 - .3 Circuits originating from branch distribution panels.
 - .4 Lighting and its control.
 - .5 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
 - .6 Systems: fire alarm, voice, data, intrusion detection, emergency lighting, exit signs, alarms, and mechanical systems.
 - .7 Insulation resistance testing:
 - .1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
 - .2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
 - .3 Check resistance to ground before energizing.
- .3 Carry out tests in presence of Departmental Representative where so instructed.
- .4 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
- .5 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports.

- .2 Provide manufacturer's field services consisting of product use recommendations and site visits for inspection of product installation in accordance with manufacturer's instructions.
- .6 Full Commissioning is not required for this facility. The intent is to design, check and verify that all building systems are functioning to the design specifications.
- .7 Provide verification plan and verification sheets in advance of completion of the project for review by the Contract Administrator. Make modifications as requested.
- .8 Undertake verification and complete sheets.

3.9 SYSTEM STARTUP

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

3.10 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 11 00 - Summary of Work.
 - .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 11 00 - Summary of Work.
- .3 Clean equipment exteriors of dust and construction debris. Protect equipment interiors from dust and debris at all times.
- .4 Clean luminaire lenses and reflectors. Clean glass and chrome surfaces.

END OF SECTION

Part 1 General

1.1 REFERENCES

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

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 11 00 - Summary or Work.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for wire and box connectors and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 11 00 - Summary of Work.
- .2 Operation and Maintenance Data: submit operation and maintenance data for incorporation into manual.

Part 2 Products

2.1 MATERIALS

- .1 Pressure type wire connectors to: CAN/CSA-C22.2 No.65, suitable for copper wiring and for aluminum wiring.
- .2 Fixture type splicing connectors to: CAN/CSA-C22.2 No.65, suitable for copper wiring and for aluminum wiring.
- .3 Bushing stud connectors to consist of:
 - .1 Connector body and stud clamp for stranded, round, copper, or aluminum conductors.
 - .2 Clamp for stranded, round, copper, or aluminum conductors.
 - .3 Clamp for stranded aluminum or ACSR conductors.
 - .4 Stud clamp bolts.
 - .5 Bolts for copper conductors.

- .6 Bolts for aluminum conductors.
- .7 Size to suit conductor, required Ampacities, and temperature ratings.
- .4 Clamps or connectors for armoured cable, TECK cable, aluminum sheathed cable, mineral insulated cable, flexible conduit, and non-metallic sheathed cable as required to: CAN/CSA-C22.2 No.18.

Part 3 Execution

3.1 INSTALLATION

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

END OF SECTION

Part 1 General

1.1 PRODUCT DATA

- .1 Provide product data in accordance with Section 01 11 00 - Summary of Work.

Part 2 Products

2.1 GENERAL

- .1 Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.
- .2 Conductors: copper except where explicitly identified otherwise.

2.2 BUILDING WIRES

- .1 Conductor insulation: 600V cross-linked thermosetting polyethylene material rated RW90 XLPE or RWU90 XLPE.

2.3 TECK 90 CABLE

- .1 Conductor insulation:
 - .1 Cross-linked polyethylene XLPE.
 - .2 Rating: 1000 V.
- .2 Inner jacket: polyvinyl chloride material.
- .3 Armour: interlocking aluminum.
- .4 Overall covering: thermoplastic polyvinyl chloride, FT4.
- .5 Fastenings:
 - .1 One hole aluminum straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.
 - .2 Channel type supports for two or more cables at 1500 mm centers.
 - .3 Threaded rods: 6 mm diameter to support suspended channels.
- .6 Connectors:
 - .1 Watertight, approved for TECK cable. Explosion proof in hazardous locations.

2.4 ARMOURED CABLES

- .1 Type: AC90.
- .2 Armour: interlocking type fabricated from aluminum strip.
- .3 Connectors: anti short connectors.
- .4 Use limitations:
 - .1 Surface mount in unfinished service areas.

- .2 Short runs (up to 3m) within accessible ceiling spaces or for short (up to 3m) vertical drops into wall cavities where both ends of cable are accessible and cable can be readily removed and replaced after installation if so required.

2.5 ALUMINUM SHEATHED CABLE

- .1 Conductor insulation: cross linked polyethylene rated 1000 V.
- .2 Sheath: aluminum applied to form continuous sheath.
- .3 Outer jacket: thermoplastic applied over sheath and to be suitable for applicable Building Code classification for this project, direct burial, and wet locations.
- .4 Fastenings for aluminum sheathed cable:
 - .1 One hole aluminum straps to secure surface cables 25 mm and smaller. Two hole steel straps for cables larger than 25 mm. Use aluminum strap only with single conductor cable.
 - .2 Channel type supports for two or more cables at 1500 mm centers.
 - .3 Threaded rods: 6 mm diameter to support suspended channels.

2.6 CONTROL CABLES

- .1 Type: LVT: soft annealed copper conductors, sized as indicated:
 - .1 Insulation: thermoplastic.
 - .2 Sheath : thermoplastic jacket. Armour of closely wound aluminum where required.
- .2 Type: low energy 300 V control cable: stranded annealed copper conductors sized as indicated:
 - .1 Insulation: PVC, TW, TWH, polyethylene.
 - .2 Shielding: tape, coated tape, wire, or braid, over each conductor, pair, or group.
 - .3 Overall covering: PVC jackets, aluminum sheath or interlocked armour.
- .3 Type: 600 V stranded annealed copper conductors, sizes as indicated:
 - .1 Insulation: PVC, TW, TWH, RW90, R90, cross-linked polyethylene.
 - .2 Shielding: tape, coated tape, wire, or braid, over each conductor, pair, or group.
 - .3 Overall covering: PVC jackets, aluminum sheath or interlocked armour.

2.7 NON-METALLIC SHEATHED CABLE

- .1 Non-metallic sheathed cable, types NMD90XLPE, NMW90, NMWU90.
- .2 Use limitations:
 - .1 Only use where permitted by Code.
 - .2 Surface mount in unfinished service areas.
 - .3 Short runs (up to 3m) within accessible ceiling spaces or short vertical drops (up to 3m) into wall cavities where both ends of cable are accessible and cable can be readily removed and replaced after installation if so required.

Part 3 Execution

3.1 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Perform tests before energizing electrical system.

3.2 GENERAL CONDUCTOR INSTALLATION

- .1 Conductor length for parallel conductors to be identical.
- .2 Lace branch circuit conductors into panelboards providing min 400 mm extra length each conductor.
- .3 Wiring in and on walls: typically drop or loop vertically from above to better facilitate future renovations and to conserve wall space.
- .4 Branch circuit wiring for surge suppression receptacles and permanently wired computer and electronic equipment to be 2-wire circuits only, i.e. common neutrals not permitted.
- .5 Provide numbered wire collars for control wiring. Numbers to correspond to control shop drawing legend. Obtain wiring diagram for control wiring.
- .6 Conceal wiring in finished areas. Surface mount acceptable in service spaces.
- .7 Group cables wherever possible and run with even spacings.
- .8 Install wiring for a pleasing finished appearance. Install on plumbs and perpendiculars, following building lines for aesthetics.
- .9 Leave slack in cables where subject to movement, differential settling, or large temperature changes.
- .10 Provide expansion fittings on raceways subject to movement, differential settling, or large temperature changes.

3.3 INSTALLATION OF CONTROL CABLES

- .1 Install control cables.
- .2 Ground control cable shield.

3.4 INSTALLATION OF NON-METALLIC SHEATHED CABLE

- .1 Install cables.
- .2 Install straps and box connectors to cables as required.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American National Standards Institute /Institute of Electrical and Electronics Engineers (ANSI/IEEE)
 - .1 ANSI/IEEE 837-[02], IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding.
- .2 CSA International
 - .1 CSA Z32-[09], Electrical Safety and Essential Electrical Systems in Health Care Facilities.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 11 00 - Summary of Work.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for grounding equipment and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 11 00 - Summary of Work.
- .2 Operation and Maintenance Data: submit operation and maintenance data for grounding equipment for incorporation into manual.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 11 00 - Summary of Work and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

Part 2 Products

2.1 EQUIPMENT

- .1 Clamps for grounding of conductor: size as required to electrically conductive underground water pipe.
- .2 Rod electrodes:
 - .1 Copper clad steel 19 mm diameter.
 - .2 Drive rods to 6m depth by coupling two 3m rods, except where bedrock is less than 6m below surface.

- .3 Plate electrodes: copper, surface area 0.2 m², minimum 1.6 mm thick. Provide where rods cannot achieve adequate grounding.
- .4 Grounding conductors: bare stranded copper, soft annealed, size min #2/0 AWG.
- .5 Insulated grounding conductors: green, copper conductors. RW90 insulation in dry locations. RWU90 in wet or underground locations. Protect from mechanical injury.
- .6 Ground bus: copper, size 1/4"x2.5", complete with insulated supports, fastenings, connectors.
- .7 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:
 - .1 Grounding and bonding bushings.
 - .2 Protective type clamps.
 - .3 Bolted type conductor connectors.
 - .4 Thermit welded type conductor connectors.
 - .5 Bonding jumpers, straps.
 - .6 Pressure wire connectors.

Part 3 Execution

3.1 INSTALLATION GENERAL

- .1 Install complete permanent, continuous grounding system including, electrodes, conductors, connectors, accessories. Where EMT is used, run ground wire in conduit.
- .2 Install connectors in accordance with manufacturer's instructions.
- .3 Protect exposed grounding conductors from mechanical injury.
- .4 Make buried connections, and connections to conductive water main, electrodes, using copper welding by thermit process, approved permanent mechanical connectors or inspectable wrought copper compression connectors to ANSI/IEEE 837.
- .5 Use mechanical connectors for grounding connections to equipment provided with lugs.
- .6 Soldered joints not permitted.
- .7 Install bonding wire for flexible conduit, connected at both ends to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.
- .8 Install separate ground conductor to outdoor lighting standards.
- .9 Connect building structural steel and metal siding to ground.
- .10 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.
- .11 Bond single conductor, metallic armoured cables to cabinet at supply end, and provide non-metallic entry plate at load end.
- .12 Ground secondary service pedestals.

3.2 ELECTRODES

- .1 Make ground connections to continuously conductive underground water pipe on street side of water meter.
- .2 Install water meter shunt.
- .3 Install rod electrodes and make grounding connections.
- .4 Bond separate, multiple electrodes together.
- .5 Use size min 2/0 AWG copper conductors for connections to electrodes.
- .6 Make special provision for installing electrodes that will give resistance to ground value where rock or sand terrain prevails. Ground as indicated.

3.3 SYSTEM AND CIRCUIT GROUNDING

- .1 Install system and circuit grounding connections to neutral of secondary 120/208 V system.

3.4 EQUIPMENT GROUNDING

- .1 Install grounding connections to typical equipment included in, but not necessarily limited to following list. Service equipment, transformers, switchgear, duct systems, frames of motors, motor control centres, starters, control panels, building steel work, generators, elevators and escalators, distribution panels, outdoor lighting, cable trays.

3.5 GROUNDING BUS

- .1 Install copper grounding bus mounted on insulated supports on wall of electrical room and communication equipment room.
- .2 Ground items of electrical equipment in electrical room and IT equipment in communication equipment room to ground bus with individual bare stranded copper connections size 2/0AWG.

3.6 COMMUNICATION SYSTEMS

- .1 Install grounding connections for telephone, sound, fire alarm, security systems, intercommunication systems as follows:
 - .1 Telephones: make telephone grounding system in accordance with telephone company's requirements.
 - .2 Sound, fire alarm, security systems, intercommunication systems as indicated.

3.7 PERMAFROST

- .1 Bond non-current carrying metal parts together with size 2/0 AWG copper equipotential conductor. Run conductor from separate lug or service neutral bar to, but not necessarily limited to, following indoor systems and equipment:
 - .1 Hot water heating system.
 - .2 Main water pipe.
 - .3 Main building drain.

- .4 Telephone, radio/tv, emergency and fire alarm lead-in or service conduits, near panels.
- .5 Make connections to pipes on building side of main valves and tanks. Connect jumpers across boilers to supply and return hot water heating pipes.
- .2 Drive three -19 mm diameter x 3 m copper clad ground rods at least 1.8 m apart in original undisturbed ground. If rods will not penetrate permafrost, drive at angle not more than 60 degrees from vertical, and in same direction. Rods must be driven, not trenched.
- .3 Install ground wire from service neutral bar to rods and where buried use bare copper not smaller than size 2/0 AWG stranded, and at least 640 mm below grade. Bond ground conductor, or short tap from it, to outside metal sheathing of building close to power service conduit. Use lug or cast clamp, with bronze or plated bolt, nut and washers (not sheet metal screw or wood screw). Remove paint from sheathing for good contact. Conduit is required only on outside wall of building. Indoors, run bare and fasten as specified for equipotential bonding wire.
- .4 Install electrode interconnections where metal parts, circuits or grounding conductors and/or electrodes are in proximity to lightning rod conductors.

3.8 FIELD QUALITY CONTROL

- .1 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of local authority having jurisdiction over installation.
- .2 Perform tests before energizing electrical system.
- .3 Disconnect ground fault indicator during tests.

END OF SECTION

Part 1 General

1.1 NOT USED

- .1 Not used.

Part 2 Products

2.1 SUPPORT CHANNELS

- .1 U shape, size 41 x 41 mm, 2.5 mm thick.
- .2 Aluminum or hot dip galvanized steel.

Part 3 Execution

3.1 INSTALLATION

- .1 Secure equipment to masonry, tile and plaster surfaces with anchors and shields.
- .2 Secure equipment to poured concrete with expandable inserts.
- .3 Secure equipment to hollow masonry walls with toggle bolts.
- .4 Secure surface mounted equipment with twist clip fasteners to inverted T bar ceilings. Ensure that T bars are adequately supported to carry weight of equipment to be supported before installation.
- .5 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .6 Fasten exposed conduit or cables to building construction or support system using straps.
 - .1 One-hole steel straps to secure surface conduits and cables 50 mm and smaller.
 - .2 Two-hole steel straps for conduits and cables larger than 50 mm.
 - .3 Beam clamps to secure conduit to exposed steel work.
- .7 Suspended support systems.
 - .1 Support individual cable or conduit runs with 6 mm dia threaded rods and spring clips.
 - .2 Support 2 or more cables or conduits on channels supported by 6 mm dia threaded rod hangers where direct fastening to building construction is impractical.
- .8 For surface mounting of two or more conduits use channels at 1200 mm on centre spacing.
- .9 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.

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- .10 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .11 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .12 Do not use tie wraps to support or secure raceways or cables.
- .13 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval Owner and Consultant.
- .14 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.
- .15 Fastenings and supports shall be mounted tidily for a neat, professional finished appearance.
- .16 Group wiring and equipment to minimize supports required, minimize wall and ceiling space used, and to make the installation tidy.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.1-[06], Canadian Electrical Code, Part 1, 20th Edition.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 11 00 - Summary of Work.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.

Part 2 Products

2.1 SPLITTERS

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

2.2 JUNCTION AND PULL BOXES

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

2.3 CABINETS

- .1 Construction: welded sheet steel, hinged door, handle, lock.

Part 3 Execution

3.1 SPLITTER INSTALLATION

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

3.2 JUNCTION, PULL BOXES AND CABINETS INSTALLATION

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

3.3 IDENTIFICATION

- .1 Equipment Identification: to Section 26 05 00 - Common Work Results for Electrical.
- .2 Identification Labels: size 2 indicating system name, voltage and phase or as indicated.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 CSA C22.1, Part 1.

Part 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.
- .5 347 V outlet boxes for 347 V switching devices.
- .6 Combination boxes with barriers where outlets for more than one system are grouped.

2.2 SHEET STEEL OUTLET BOXES

- .1 Electro-galvanized steel single and multi gang flush device boxes for flush installation, minimum size 76 x 50 x 38 mm or as indicated. 102 mm square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.
- .2 Electro-galvanized steel utility boxes for outlets connected to surface-mounted EMT conduit, minimum size 102 x 54 x 48 mm.
- .3 102 mm square or octagonal outlet boxes for lighting fixture outlets.
- .4 102 mm square outlet boxes with extension and plaster rings for flush mounting devices in finished surfaces.

2.3 MASONRY BOXES

- .1 Electro-galvanized steel masonry single and multi gang boxes for devices flush mounted in exposed block walls.

2.4 CONCRETE BOXES

- .1 Electro-glvanized sheet steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.

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2.5 CONDUIT BOXES

- .1 Cast FS or FD boxes with factory-threaded hubs and mounting feet for surface wiring of outlets.

2.6 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.

Part 3 Execution

3.1 INSTALLATION

- .1 Support boxes independently of connecting conduits.
- .2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.
- .3 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.
- .4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CAN/CSA C22.2 No. 18, Outlet Boxes, Conduit Boxes, and Fittings and Associated Hardware.
 - .2 CSA C22.2 No. 45, Rigid Metal Conduit.
 - .3 CSA C22.2 No. 56, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
 - .4 CSA C22.2 No. 83, Electrical Metallic Tubing.
 - .5 CSA C22.2 No. 211.2, Rigid PVC (Unplasticized) Conduit.

Part 2 Products

2.1 CONDUITS

- .1 Rigid metal conduit: to CSA C22.2 No. 45, galvanized steel, threaded.
- .2 Electrical metallic tubing (EMT): to CSA C22.2 No. 83, with couplings.
- .3 Rigid pvc conduit: to CSA C22.2 No. 211.2.
- .4 Flexible metal conduit: to CSA C22.2 No. 56, aluminum liquid-tight flexible metal.

2.2 CONDUIT FASTENINGS

- .1 One hole steel straps to secure surface conduits 50 mm and smaller. Two hole steel straps for conduits larger than 50 mm.
- .2 Beam clamps to secure conduits to exposed steel work.
- .3 Channel type supports for two or more conduits at 1200 mm oc.
- .4 Threaded rods, 6 mm dia., to support suspended channels.

2.3 CONDUIT FITTINGS

- .1 Fittings: manufactured for use with conduit specified. Coating: same as conduit.
- .2 Factory "ells" where 90E bends are required for 25 mm and larger conduits.
- .3 Watertight connectors and couplings for EMT. Set-screws are not acceptable.

2.4 EXPANSION FITTINGS FOR RIGID CONDUIT

- .1 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection in all directions.
- .2 Weatherproof expansion fittings for linear expansion at entry to panel.

2.5 FISH CORD

- .1 Polypropylene.

Part 3 Execution

3.1 INSTALLATION

- .1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .2 Conceal conduits except in service areas and unfinished areas.
- .3 Use rigid galvanized steel threaded conduit in hazardous locations or where exposed to mechanical injury.
- .4 Use electrical metallic tubing (EMT) in general areas.
- .5 Use rigid pvc conduit underground and in corrosive areas and in wet areas not exposed to injury.
- .6 Use liquid tight flexible metal conduit for connection to motors and vibrating equipment, connection to recessed incandescent fixtures without a prewired outlet box, work in movable metal partitions.
- .7 Use explosion proof flexible connection for connection to explosion proof motors.
- .8 Install conduit sealing fittings for hazardous areas. Fill with compound.
- .9 Minimum conduit size for lighting and power circuits: 21 mm.
- .10 Bend metallic conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .11 Mechanically bend steel conduit over 21 mm dia.
- .12 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .13 Install fish cord in empty conduits.
- .14 Run 2-41 mm spare conduits up to ceiling space and 2-41 mm spare conduits down to ceiling space from each flush panel. Terminate these conduits in 152 x 152 x 102 mm

junction boxes in ceiling space or in case of an exposed concrete slab, terminate each conduit in surface type box.

- .15 Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.
- .16 Dry conduits out before installing wire.

3.2 SURFACE CONDUITS

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

3.3 CONCEALED CONDUITS

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

3.4 CONDUITS IN CAST-IN-PLACE CONCRETE

- .1 Locate to suit reinforcing steel. Install in centre one third of slab.
- .2 Protect conduits from damage where they stub out of concrete.
- .3 Install sleeves where conduits pass through slab or wall.
- .4 Provide oversized sleeve for conduits passing through waterproof membrane, before membrane is installed. Use cold mastic between sleeve and conduit.
- .5 Do not place conduits in slabs in which slab thickness is less than 4 times conduit diameter.
- .6 Encase conduits completely in concrete with minimum 25 mm concrete cover.
- .7 Organize conduits in slab to minimize cross-overs.

3.5 CONDUITS IN CAST-IN-PLACE SLABS ON GRADE

- .1 Run conduits 27 mm and larger below slab and encased in 75 mm concrete envelope. Provide 50 mm of sand over concrete envelope below floor slab.

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3.6

CONDUITS UNDERGROUND

- .1 Slope conduits to provide drainage.
- .2 Waterproof joints (pvc excepted) with heavy coat of bituminous paint.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 26 05 01 - Common Work Results - Electrical.

1.2 REFERENCES

- .1 Canadian Standards Association, (CSA International)
- .2 Insulated Cable Engineers Association, Inc. (ICEA)

Part 2 Products

2.1 CABLE PROTECTION

- .1 38 x 140 mm planks treated with CCA preservative.
- .2 Marker tape.

Part 3 Execution

3.1 DIRECT BURIAL OF CABLES

- .1 Provide sand bed.
- .2 Lay cables maintaining 75 mm clearance from each side of trench to nearest cable. Do not pull cable into trench.
- .3 Provide offsets for thermal action and minor earth movements. Offset cables 150 mm for each 60 m run, maintaining minimum cable separation and bending radius requirements.
- .4 Underground cable splices not acceptable.
- .5 Minimum permitted radius at cable bends for rubber, plastic or lead covered cables, 8 times diameter of cable; for metallic armoured cables, 12 times diameter of cables or in accordance with manufacturer's instructions.
- .6 Cable separation:
 - .1 Maintain 75 mm minimum separation between cables of different circuits.
 - .2 Maintain 300 mm horizontal separation between low and high voltage cables.
 - .3 When low voltage cables cross high voltage cables maintain 300 mm vertical separation with low voltage cables in upper position.
 - .4 At crossover, maintain 75 mm minimum vertical separation between low voltage cables and 150 mm between high voltage cables.

- .5 Maintain 300 mm minimum lateral and vertical separation for fire alarm and control cables when crossing other cables, with fire alarm and control cables in upper position.
- .6 Install treated planks on lower cables 0.6 m in each direction at crossings.
- .7 Provide sand protective cover.
- .8 Provide continuous cover of 38 x 140 mm treated planks to cover length of run.

3.2 MARKING TAPE

- .1 Mark underground runs.
- .2 Tape shall be midway between grade and cable.

3.3 FIELD QUALITY CONTROL

- .1 Perform tests using qualified personnel. Provide necessary instruments and equipment.
- .2 Check phase rotation and identify each phase conductor of each feeder.
- .3 Check each feeder for continuity, short circuits and grounds. Ensure resistance to ground of circuits is not less than 100 megohms.
- .4 Pre-acceptance tests.
 - .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.
- .5 Acceptance Tests
 - .1 Ensure that terminations and accessory equipment are disconnected.
 - .2 Ground shields, ground wires, metallic armour and conductors not under test.
- .6 Provide owner and Consultant with list of test results showing location at which each test was made, circuit tested and result of each test.
- .7 Remove and replace entire length of cable if cable fails to meet any of test criteria.

END OF SECTION

Part 1 General

1.1 REFERENCES

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

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 11 00 - Summary of Work.
- .2 Shop Drawings and Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for wiring devices and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 11 00 - Summary of Work.
- .2 Operation and Maintenance Data: submit operation and maintenance data for wiring devices for incorporation into manual.

Part 2 Products

2.1 SWITCHES

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

2.2 RECEPTACLES

- .1 Duplex receptacles, CSA type 5-15 R, 125 V, 15 A, U ground, to: CSA C22.2 No.42 with following features:
 - .1 [Ivory] [Brown] urea moulded housing.
 - .2 Suitable for No. 10 AWG for back and side wiring.
 - .3 Break-off links for use as split receptacles.
 - .4 Eight back wired entrances, four side wiring screws.
 - .5 Triple wipe contacts and rivetted grounding contacts.
- .2 Single receptacles CSA type 5-15 R, 125 V, 15 A, U ground with following features:
 - .1 [Ivory] [Brown] urea moulded housing.
 - .2 Suitable for No. 10 AWG for back and side wiring.
 - .3 Four back wired entrances, 2 side wiring screws.
- .3 Isolate Ground (I.G.) receptacles where so indicated.
- .4 Ground Fault Current Interrupt receptacles where so indicated and where required by Code.
- .5 Other receptacles with ampacity and voltage as indicated.
- .6 Receptacles of one manufacturer throughout project.

2.3 COVER PLATES

- .1 Cover plates for wiring devices to: CSA C22.2 No.42.1.
- .2 Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.
- .3 Stainless steel, vertically brushed, 1 mm thick cover plates for wiring devices mounted in flush-mounted outlet box.
- .4 Sheet metal or cast cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.
- .5 Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for duplex receptacles outdoors, in wet locations, or as indicated.
- .6 While-in-use covers for receptacles outdoors.

2.4 SOURCE QUALITY CONTROL

- .1 Cover plates from one manufacturer throughout project.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for wiring devices installation in accordance with manufacturer's written instructions.

- .1 Visually inspect substrate in presence of Departmental Representative.
- .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

- .1 Switches:
 - .1 Install single throw switches with handle in "UP" position when switch closed.
 - .2 Install switches in gang type outlet box when more than one switch is required in one location.
 - .3 Do not install back to back or within same stud space.
 - .4 Provide accessories to maintain fire ratings, insulation, vapor barrier, and sound dampening.
- .2 Receptacles:
 - .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
 - .2 Where split receptacle has one portion switched, mount vertically and switch upper portion.
 - .3 Do not install back to back or within same stud space.
 - .4 Provide accessories to maintain fire ratings, insulation, vapor barrier, and sound dampening.
- .3 Cover plates:
 - .1 Install suitable common cover plates where wiring devices are grouped.
 - .2 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 11 00 - Summary of Work.
 - .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 11 00 - Summary of Work.

3.4 PROTECTION

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

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 CSA Group
 - .1 CAN/CSA-C22.2 No.4-[04(R2009)], Enclosed and Dead-Front Switches (Tri-National Standard, with ANCE NMX-J-162-2004 and UL 98).
 - .2 CSA C22.2 No.39-[13], Fuseholder Assemblies.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 11 00 - Summary of Work.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets and include product characteristics, performance criteria, physical size, finish and limitations.

Part 2 Products

2.1 DISCONNECT SWITCHES

- .1 [Fusible, Non-fusible, and Horsepower rated disconnect switch in CSA enclosure to CAN/CSA-C22.2 No.4, size as indicated.
- .2 Provision for padlocking in on-off switch position.
- .3 Mechanically interlocked door to prevent opening when handle in ON position.
- .4 Fuses: size as indicated.
- .5 Fuseholders: to CSA C22.2 No.39.
- .6 Quick-make, quick-break action.
- .7 ON-OFF switch position indication on switch enclosure cover.

2.2 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification.
- .2 Indicate name of load controlled on size 4 nameplate.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for disconnect switches - fused and non-fused 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.

3.2 INSTALLATION

- .1 Install disconnect switches complete with fuses if applicable.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 11 00 - Summary of Work.
 - .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 11 00 - Summary of Work.

END OF SECTION

Part 1 General

1.1 REFERENCES

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

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 11 00 - Summary of Work.
- .2 Product Data and Shop Drawings:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 QUALITY ASSURANCE

- .1 Conduct tests in accordance with Section 26 05 00 - Common Work Results for Electrical.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 11 00 - Summary of Work.
- .2 Operation and Maintenance Data: submit operation and maintenance data for control devices for incorporation into manual.

Part 2 Products

2.1 AC CONTROL RELAYS

- .1 Control Relays: to CSA C22.2 No.14.
- .2 Coil and contact ratings to suit application.

2.2 RELAY ACCESSORIES

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

2.3 PUSHBUTTONS

- .1 Heavy duty, oil tight. Operator semi flush or mushroom type. Red for emergency applications. Black for non-emergency applications. With 1-NO and 1-NC contact. Comprehensive label indicating system controlled and pushbutton function.

2.4 SELECTOR SWITCHES

- .1 Maintained, 2 or 3 position. Label indicating system and switch position functions.

2.5 INDICATING LIGHTS

- .1 Heavy duty, oil tight, full voltage, LED type, lens colour: red, amber, green, white, to suit. Labels to indicate system, and significance of light.

2.6 CONTROL AND RELAY PANELS

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

2.7 CONTROL CIRCUIT TRANSFORMERS

- .1 Single phase, dry type.
- .2 Primary: 208, 240, 600 V, 60 Hz ac.
- .3 Secondary: 24, 120 V, AC.
- .4 Rating: 50, 150, 250, 350, 500 VA.
- .5 Secondary fuse.
- .6 Close voltage regulation as required by magnet coils and solenoid valves.

Part 3 Execution

3.1 EXAMINATION

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

3.2 INSTALLATION

- .1 Install devices and interconnect systems.

3.3 FIELD QUALITY CONTROL

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

3.4 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 11 00 - Summary of Work.
 - .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 11 00 - Summary of Work.

END OF SECTION

Approved: 2008-12-31

Part 1 General

1.1 REFERENCES

- .1 International Electrotechnical Commission (IEC)
 - .1 IEC 947-4-1-[2002], Part 4: Electromechanical contactors and motor-starters.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 11 00 - Summary of Work.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Provide shop drawings: in accordance with Section 01 11 00 - Summary of Work.
 - .1 Provide shop drawings for each type of starter to indicate:
 - .1 Mounting method, weight, and dimensions.
 - .2 Starter size and type.
 - .3 Layout and components.
 - .4 Enclosure types.
 - .5 Wiring diagram.
 - .6 Interconnection diagrams.

1.3 CLOSEOUT SUBMITTALS

- .1 Provide maintenance materials in accordance with Section 01 11 00 - Summary of Work.
- .2 Submit operation and maintenance data for each type and style of motor starter for incorporation into maintenance manual.
- .3 Extra Materials:
 - .1 Provide listed spare parts for each different size and type of starter. Turn over in packaging indicating the starter they are for, the part types, and part numbers.
 - .1 3 contacts, stationary.
 - .2 3 contacts, movable.
 - .3 1 contacts, auxiliary.
 - .4 1 control transformer.
 - .5 1 operating coil.
 - .6 2 fuses.
 - .7 10% indicating lamp bulbs used.

Part 2 Products

2.1 MATERIALS

- .1 Starters: to IEC 947-4 with AC4 utilization category.

2.2 MANUAL MOTOR STARTERS

- .1 Single and three phase manual motor starters of size, type, rating, and enclosure type as indicated, with components as follows:
 - .1 Switching mechanism, quick make and break.
 - .2 One or three overload heaters, manual reset, trip indicating handle.
- .2 Accessories:
 - .1 Pushbutton, toggle, or key switch: heavy duty, oil tight, labelled.
 - .2 Indicating light: heavy duty, oil tight, type and colour as indicated.
 - .3 Locking tab to permit padlocking in "ON" or "OFF" position.

2.3 FULL VOLTAGE 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 and c/w auxiliary contact.
 - .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 motor circuit interrupter or circuit breaker with operating lever on outside of enclosure, 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 Pushbuttons, selector switches: heavy duty, oil tight, labelled.
 - .2 Indicating lights: heavy duty, oil tight, type and color as indicated.
 - .3 1-N/O and 1-N/C spare auxiliary contacts unless otherwise indicated.

2.4 CONTROL TRANSFORMER

- .1 Single phase, dry type, control transformer with primary voltage as indicated and 24 V or 120 V secondary, complete with secondary fuse, installed in with starter as indicated.
- .2 Size control transformer for control circuit load plus 40% spare capacity.

2.5 ACCESSORIES

- .1 Pushbutton: heavy duty, oil tight as required.
- .2 Selector switches: heavy duty, oil tight as required.
- .3 Indicating lights: heavy duty, oil tight, type and colour as indicated.

2.6 FINISHES

- .1 Apply finishes to enclosure in accordance with Section 26 05 00 - Common Work Results for Electrical.

2.7 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Manual starter designation label, white plate, black letters, engraved. Indicate controlled load.
- .3 Accessories labels, white plate, black letters, engraved. Indicate functions of devices.

Part 3 Execution

3.1 INSTALLATION

- .1 Install starters and control devices in accordance with manufacturer's instructions.
- .2 Install and wire starters and controls as indicated.
- .3 Ensure correct fuses installed.
- .4 Confirm motor nameplate and adjust overload device to suit.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical and manufacturer's instructions.
- .2 Operate switches and contactors to verify correct functioning.
- .3 Perform starting and stopping sequences of contactors and relays.
- .4 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

3.3 CLEANING

- .1 Clean in accordance with Section 01 11 00 - Summary of Work.
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Diesel engine driven generator sets.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/American Petroleum Institute (API)
 - .1 ANSI/API 650, Welded Steel Tanks for Oil Storage Tenth Edition; Addendum 1.
- .2 American National Standards Institute (ANSI)/National Electrical Manufacturers' Association (NEMA)
 - .1 ANSI/NEMA MG1, Motors and Generators.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-3.6, Regular Sulphur Diesel Fuel.
- .4 International Organization for Standardization (ISO)
 - .1 ISO 3046-1, Reciprocating Internal Combustion Engines - Performance - Part 1: Declarations Of Power, Fuel And Lubricating Oil Consumptions, And Test Methods.
- .5 National Electrical Manufacturers Association (NEMA)
- .6 Underwriters' Laboratories of Canada (ULC)
 - .1 ULC-S601, Standard for Shop Fabricated Steel Aboveground Horizontal Tanks for Flammable and Combustible Liquids.
 - .2 CAN/ULC-S603, Standard for Steel Underground Tanks for Flammable and Combustible Liquids.
- .7 Canadian Standards Association (CSA)
 - .1 C282 Emergency Electrical Supply for Buildings.

1.3 SYSTEM DESCRIPTION

- .1 Generating system consists of:
 - .1 Enclosures.
 - .2 Diesel engine.
 - .3 Alternator.
 - .4 Alternator control panel.
 - .5 Battery charger and battery.
 - .6 Fuel supply system.
 - .7 Exhaust system.
 - .8 Steel mounting base.

- .9 Synchronizing panel.
- .10 Automatic load transfer equipment to:
 - .1 Monitor voltage on phases of normal power supply.
 - .2 Initiate cranking of standby generator unit on normal power failure or abnormal voltage on any one phase below preset adjustable limits for adjustable period of time.
 - .3 Transfer load from normal supply to standby unit when standby unit reaches rated frequency and voltage pre-set adjustable limits.
 - .4 Transfer load from standby unit to normal power supply when normal power restored, confirmed by sensing of voltage on phases above adjustable pre-set limit for adjustable time period.
 - .5 Shut down standby unit after running unloaded to cool down using adjustable time delay relay.
 - .6 Exercise the standby unit on a flexible user programmable schedule.
- .2 System designed to operate as standby power source.

1.4 **SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with Section 01 11 00 Summary of Work.
- .2 Include full physical, electrical, thermal, and finish details, with descriptions of operation and wiring diagrams:
 - .1 Engine: make and model, with performance curves.
 - .2 Alternator: make and model.
 - .3 Voltage regulator: make, model and type.
 - .4 Automatic transfer switch: make, model and type.
 - .5 Battery: make, type and capacity.
 - .6 Battery charger: make, type and model.
 - .7 Alternator control panel: make and type of meters and controls.
 - .8 Governor type and model.
 - .9 Cooling air requirements in m³/s.
 - .10 British standard or DIN rating of engine.
 - .11 Flow diagrams for:
 - .1 Diesel fuel.
 - .2 Cooling air.
 - .12 Dimensioned drawing showing complete generating set mounted on steel base, including vibration isolators, exhaust system, drip trays, and total weight.
 - .13 Continuous full load output of set at 0.8PF lagging.
 - .14 Description of set operation including:
 - .1 Automatic starting and transfer to load and back to normal power, including time in seconds from start of cranking until unit reaches rated voltage and frequency.
 - .2 Manual starting.

- .3 Automatic shut down and alarm on:
 - .1 Overcranking.
 - .2 Overspeed.
 - .3 High engine temp.
 - .4 Low lube oil pressure.
 - .5 Short circuit.
 - .6 Alternator overvoltage.
 - .7 Lube oil high temperature.
 - .8 Over temperature on alternator.

1.5 CLOSEOUT SUBMITTALS

- .1 Provide operation and maintenance data for diesel generator for incorporation into manual specified in Section 01 11 00 Summary of Work.
- .2 Include in Operation and Maintenance Manual instructions for particular unit supplied and not general description of units manufactured by supplier and:
 - .1 Operation and maintenance instructions for engine, alternator, control panel, automatic transfer switch, manual bypass switch, battery charger, battery, fuel system, exhaust system and accessories, to permit effective operation, maintenance and repair.
 - .2 Technical data:
 - .1 Illustrated parts lists with parts catalogue numbers.
 - .2 Schematic diagram of electrical controls.
 - .3 Flow diagrams for:
 - .1 Fuel system.
 - .2 Lubricating oil.
 - .3 Cooling system.
 - .4 Certified copy of factory test results.
 - .5 Maintenance and overhaul instructions and schedules.
 - .6 Precise details for adjustment and setting of time delay relays or sensing controls which require on site adjustment.
 - .3 Include in Operation and Maintenance Manual completed copies of all commissioning materials and training materials.

1.6 WARRANTY

- .1 For Work of this Section 12 month warranty period prescribed in subsection GC32.1 of General Conditions "C" is extended to 60 months or 1500 operating hours, whichever occurs first.

1.7 EXTRA MATERIALS

- .1 Provide maintenance materials in accordance with Section 01 11 00 Summary of Work.
- .2 Include:

- .1 2 fuel filter replacement elements.
- .2 2 lube oil filter replacement elements.
- .3 2 air cleaner filter elements.
- .4 2 sets of fuses for control panel.
- .5 Special tools for unit servicing.

Part 2 Products**2.1 PERFORMANCE**

- .1 The GenSet system shall be Kohler, Cummins ONAN, Caterpillar, or accepted equal.
 - .1 Meet performance of 350REOZJD genset with 4M4019 alternator, Dec 550 controller, KCS-ACTA-1600 auto transfer switch, and RAS II remote annunciator.
 - .2 Power rating: 350 kW at 0.8pf.
 - .3 Starting capability: start a 995 sKVA load with Vdip less than 35%.
 - .4 Starting capability: start a 520 sKVA load with Vdip less than 20%.
 - .5 Remote annunciator: audio visual type.
 - .6 Transfer switch: automatic, open transition, solid neutral.
 - .7 Enclosure:
 - .1 Winterized sound enclosure with critical grade silencer in enclosure interior.
 - .2 Max sound level 75 dBA @ 7 m.
 - .3 Sub base fuel tank with 24 hour fuel capacity at full load.
 - .8 Coordinate or arrange and pay for concrete pad for genset.
 - .9 Appurtenances and accessories:
 - .1 12 Vdc or 24 Vdc lead acid batteries c/w cables and mounting rack.
 - .2 10 A float / equalize battery charger.
 - .3 Safeguard breaker.
 - .4 Dry contact kits (ten status points, selectable).
 - .5 Low fuel level sensor (50%) and low low fuel level sensor (20%).

2.2 WINTERIZED SOUND ENCLOSURE

- .1 Enclosure shall be suitable for outdoor use to -40 C and shall maintain an interior temperature above 10 C in all outdoor conditions to CSA C282.
- .2 Exhaust silencer inside enclosure.
- .3 Door panels with lockable handles and hold opens. Door panels gasketed, tight fitting, secure, and removable. Door panels, handles, locks, hold opens, and hinges shall be high quality.
- .4 Insulation shall be adhesive, foil backed, ruggedized and resistant to cutting and tearing.

- .5 Snow hoods with actuated dampers. Select and arrange dampers such that freeze thaw cycles due to natural weather or due to operation of the genset do not result in ice build up liable to interfere with damper operation.
- .6 Normal power panelboard. Min rating 100A, 14 kAIC. Coordinate voltage and number of phases and number of wires with supply. Min 4 spare circuits with 15A circuit breakers. Connect:
 - .1 Light switch and interior lighting. Lighting shall be suitable for low temperatures. Provide guards for light fixtures.
 - .2 Battery charger.
 - .3 Interior space heaters with thermostatic controls.
 - .4 Block heater.
 - .5 Battery blanket/heater.
 - .6 Convenience receptacle.
- .7 The enclosure shall be sealed tight against weather, moisture, vermin and insects.
- .8 All fill and drain ports shall be easily accessible for convenient filling or changing of fluids.

2.3**DIESEL ENGINE**

- .1 Diesel engine: to ISO 3046-1.
 - .1 Engine: standard product of current manufacture, from company regularly engaged in production of such equipment.
 - .2 Turbo charged, synchronous speed 1800 r/min.
 - .3 Capacity:
 - .1 Rated continuous power in kW at rated speed, after adjustment for system losses in auxiliary equipment necessary for engine operation; to be calculated as follows:
Rated continuous output = Generator kW divided by Generator efficiency at full load.
 - .4 Cooling System:
 - .1 Liquid cooled: heavy duty industrial radiator mounted on generating set base with fan and ethylene glycol anti-freeze non-sludging above minus 46 degrees C.
 - .2 To maintain manufacturer's recommended engine temperature range at 10% continuous overload in ambient temperature of 40 degrees C.
 - .3 Block heater: thermostatically controlled lube oil or liquid coolant heater connected to line side of automatic transfer switch to allow engine to start in room ambient 0 degrees C.
 - .1 Switch and fuse in heater circuit, mounted in engine-alternator control cubicle and fed from line side of automatic transfer switch.
 - .5 Fuel to CAN/CGSB-3.6:
 - .1 Type A fuel oil or Arctic Grade 1 or Arctic Grade 2 per manufacturer recommendations.

- .6 Fuel system: solid injection, mechanical fuel transfer pump with hand primer, fuel filters and air cleaner, fuel rack solenoid energized when engine running.
- .7 Governor:
 - .1 Steady state speed band of plus or minus 0.5%.
 - .2 Speed regulation no load to full load 5% maximum.
 - .3 Electronic type, electric actuator, speed droop externally adjustable from isochronous to 5%, temperature compensated with steady state speed maintenance capability of plus or minus 0.25%.
- .8 Lubrication system:
 - .1 Pressure lubricated by engine driven pump.
 - .2 Lube oil filter: replaceable, full flow type, removable without disconnecting piping.
 - .3 Lube oil cooler.
 - .4 Engine sump drain valve.
 - .5 Oil level dip-stick.
- .9 Starting system:
 - .1 Positive shift, gear engaging starter 12 or 24V dc.
 - .2 Cranking limiter to provide 3 cranking periods of 10s duration, each separated by 5 s rest.
 - .3 Lead acid, 12 or 24V storage battery with sufficient capacity to crank engine for 1min at 0 degrees C without using more than 25% of ampere hour capacity.
 - .4 Battery charger : constant voltage, solid state, two stage from trickle charge at standby to boost charge after use. Regulation: plus or minus 1% output for plus or minus 10% input variation. Automatic boost for 6h every 30 days. Equipped with dc voltmeter, dc ammeter and on-off switch. Minimum charger capacity: 10 A.
- .10 Vibration isolated engine instrument panel with:
 - .1 Lube oil pressure gauge.
 - .2 Lube oil temperature gauge.
 - .3 Lube oil level gauge.
 - .4 Coolant temperature gauge.
 - .5 Coolant level gauge.
 - .6 Running time meter: non-tamper type.
- .11 Guards to protect personnel from hot and moving parts. Locate guards so that normal daily maintenance inspections can be undertaken without their removal.
- .12 Drip tray.

2.4 ALTERNATOR

- .1 Alternator: to ANSI/NEMA MG1.
- .2 Output at 40 degrees C ambient:

- .1 100% full load continuously.
- .2 110% full load for 1h.
- .3 150% full load for 1 min.
- .3 Revolving field, brushless, single bearing.
- .4 Drip proof.
- .5 Amortisseur windings.
- .6 Synchronous type.
- .7 Exciter: permanent magnet.
- .8 NEMA class H insulation on windings.
- .9 Temperature sensors embedded in stator winding and connected to alternator control circuitry.
- .10 Voltage regulator: thyristor controlled rectifiers with phase controlled sensing circuit:
 - .1 Stability: 0.25% maximum voltage variation at any constant load from no load to full load.
 - .2 Regulation: 1.0% maximum voltage deviation between no-load steady state and full-load steady state.
 - .3 Transient: 10% maximum voltage dip on one-step application of 0.8PF full load.
 - .4 Transient: 12% maximum voltage rise on one-step removal of 0.8PF full load.
 - .5 Transient: 1 s maximum voltage recovery time with application or removal of 0.8PF full load.
- .11 Alternator: capable of sustaining 300% rated current for period not less than 10s permitting selective tripping of down line protective devices when short circuit occurs.

2.5 STEEL MOUNTING BASE

- .1 Complete generating set mounted on structural steel base of sufficient strength and rigidity to protect assembly from stress or strain during transportation, installation and under operating conditions on suitable level surface.
- .2 Assembly fitted with vibration isolators and control console resiliently mounted.
 - .1 Spring type isolators with adjustable side snubbers and adjustable for levelling.
- .3 Sound insulation pads for installation between isolators and concrete base.

2.6 EXHAUST SYSTEM

- .1 Heavy duty horizontally mounted exhaust silencer with condensate drain, plug and flanged couplings.
- .2 Heavy duty flexible exhaust pipe with flanged couplings as required.

- .3 Fittings and accessories as required.
- .4 Expansion joints: stainless steel, corrugated, of suitable length, to absorb both vertical and horizontal expansion.

2.7 FUEL SYSTEM

- .1 Fuel storage tanks: to ANSI/API 650, ULC labelled.
 - .1 Above ground tank: to ULC-S601.
- .2 Fuel storage tank with fill and vent lines with weatherproofing.
- .3 Fuel level gauge and vent alarm.
- .4 Drain and end plug.
- .5 Feed and return lines, with flexible terminations at engine.
- .6 Shut-off cock.
- .7 Renewable cartridge filter.
- .8 Fire valve.
- .9 Isolating valves on lines serving auxiliaries.
- .10 Fuel level alarming for remote indication.

2.8 COOLING AIR SYSTEM

- .1 Engine ventilating system:
 - .1 Cold air inlet damper assembly with modulating motor.
 - .2 Air discharge damper assembly with modulating motor.
 - .3 Weatherhoods.
 - .4 Modulating thermostat.
 - .5 Replaceable air intake filters.

2.9 CONTROL PANEL

- .1 Totally enclosed, mounting base isolated from diesel generator.
- .2 Instruments:
 - .1 Digital 100% solid state circuitry indicating type 2 % accuracy, rectangular face, flush panel mounting:
 - .1 Voltmeter: ac, scale 0 to full nominal value plus 30%.
 - .2 Ammeter: ac, scale 0 to full nominal value plus 30%.
 - .3 Frequency meter: scale 55 to 65Hz.

- .2 Voltmeter selector switch, rotary, panel mounting, four position, labelled "Off-Phase A-Phase B-Phase C".
- .3 Ammeter selector switch, rotary, maintained contacts, panel mounting, designed to prevent opening of current circuits, four position labelled "OFF- Phase A-Phase B-Phase C".
- .3 Controls:
 - .1 Engine start button.
 - .2 Selector switch: Off-Auto-Manual - [Test full load test no load].
 - .3 Engine emergency stop button and provision for remote emergency stop button.
 - .1 Alternator output breaker:
 - .1 Circuit breaker, solid state sensing with:
 - .1 Frame containing breaker contacts, arc quenchers, manual mechanism, quick- make, quick-break, spring-loaded overcenter switching mechanism, mechanically trip free from handle, fixed type.
 - .2 Static sensor: current monitors detect overload, short-circuit and ground-fault currents, and send these signals through solid-state circuits to static sensor which acts to trip breaker. Adjustable for current values and time of tripping.
 - .3 Flux-transfer shunt trip- magnetic tripping device actuated by signal from static sensor to open breaker contacts. Requires no external source of power.
 - .2 Voltage control rheostat: mounted on inside of control panel.
 - .3 Operating lights, panel mounted:
 - .1 "Normal power" pilot light.
 - .2 "Emergency power" pilot light.
 - .3 Green pilot lights for breaker on and red pilot lights for breaker off.
 - .4 Solid state indicator lights for alarm with manually reset NO/NC contacts wired to terminal block for remote annunciation on:
 - .1 Low fuel level.
 - .2 Low low fuel level.
 - .3 Low battery voltage.
 - .4 Ventilation failure.
 - .5 Low coolant temperature.
 - .5 Solid state controller for automatic shutdown and alarms with [1set] manually reset NO/NC contacts wired to terminal block for remote annunciation on:
 - .1 Engine overcrank.
 - .2 Engine overspeed.
 - .3 Engine high temperature.
 - .4 Engine low lube oil pressure.
 - .5 Short circuit.

- .6 AC over voltage.
- .6 Lamp test button.
- .7 Provision for remote monitoring.

2.10 AUTOMATIC TRANSFER SWITCH

- .1 Instrument transformers: to CAN3-C13.
- .2 Contactors: to ANSI/NEMA ICS2.
- .3 Contact type transfer equipment:
 - .1 Contact Type Transfer Equipment: to CSA C22.2No.178.
 - .2 Two 3 phase contactors mounted on common frame, in double throw arrangement, mechanically and electrically interlocked.
 - .3 Main contacts: silver surfaced, protected by arc disruption means.
 - .4 Switch and relay contacts, coils, spring and control elements accessible for inspection and maintenance from front of panel without removal of switch panel or disconnection of drive linkages and power conductors.
 - .5 Auxiliary contact: silver plated, to initiate emergency generator start-up on failure of normal power.
 - .6 Lever to operate switch manually when switch is isolated.
- .4 Controls:
 - .1 Selector switch - four position "Test", "Auto", "Manual", "Engine start".
 - .1 Test position - Normal power failure simulated. Engine starts and transfer takes place. Return switch to "Auto" to stop engine.
 - .2 Auto position - Normal operation of transfer switch on failure of normal power; retransfers on return of normal voltage and shuts down engine.
 - .3 Manual position - Transfer switch may be operated by manual handle but transfer switch will not operate automatically and engine will not start.
 - .4 Engine start position - Engine starts but unit will not transfer unless normal power supply fails. Switch must be returned to "Auto" to stop engine.
 - .2 Control transformers: dry type with 120V secondary to isolate control circuits from:
 - .1 Normal power supply.
 - .2 Emergency power supply.
 - .3 Relays: continuous duty, industrial control type, with wiping action contacts rated 10 A minimum:
 - .1 Voltage sensing: 3 phase for normal power and on one phase only for emergency, solid state type, adjustable drop out and pick up, close differential, 2V minimum undervoltage and over voltage protection.
 - .2 Time delay: normal power to standby, adjustable solid state, 0s to 600s.
 - .3 Time delay on engine starting to override momentary power outages or dips, adjustable solid state, 0s to 600s.
 - .4 Time delay on retransfer from standby to normal power, adjustable 0s to 1800s.

- .5 Time delay for engine cool-off to permit standby set to run unloaded after retransfer to normal power, adjustable solid state, 0s to 1800s.
 - .6 Time delay during transfer to stop transfer action in neutral position to prevent fast transfer, adjustable, 5s intervals to 180s.
 - .7 Frequency sensing, to prevent transfer from normal power supply until frequency of standby unit reaches preset adjustable values.
 - .4 Solid state electronic in-phase monitor.
 - .5 Accessories:
 - .1 Pilot lights to indicate power availability normal and standby, switch position, green for normal, red for standby.
 - .2 Plant exerciser: 168h timer to start standby unit once each week for selected interval. Timer adjustable 0-168h in 15 min intervals.
 - .3 Auxiliary relay to provide 10 N.O. and 10 N.C. contacts for remote alarms.
- 2.11 EQUIPMENT IDENTIFICATION**
- .1 Provide equipment identification.
 - .2 Control panel:
 - .1 Size 4 nameplates for controls including alternator breakers and program selector switch.
 - .2 Size 2 nameplates for meters, alarms, indicating lights and minor controls.
- 2.12 FABRICATION**
- .1 Shop assemble generating unit including:
 - .1 Base.
 - .2 Engine and radiator.
 - .3 Alternator.
 - .4 Control panel.
 - .5 Battery and charger.
 - .6 Enclosure.
 - .7 Automatic transfer equipment.
- 2.13 FINISHES**
- .1 Supply 0.25L of touch-up enamel.
- 2.14 SOURCE QUALITY CONTROL**
- .1 Factory test generator set including engine, alternator, control panels, transfer switch and accessories. Test may be witnessed by Contract Administrator.
 - .2 Provide notification six working days in advance of date of factory test.
 - .3 Test procedure:

- .1 Prepare blank forms and check sheet with spaces to record data. At top of first sheet record:
 - .1 Date.
 - .2 Generator set serial no.
 - .3 Engine, make, model, serial no.
 - .4 Alternator, make, model, serial no.
 - .5 Voltage regulator, make and model.
 - .6 Rating of generator set, kW, kV.A, V, A, r/min, Hz.
 - .2 Mark check sheet and record data on forms in duplicate as test proceeds.
- .4 Tests:
- .1 With 100% rated load, operate set for 4 h, taking readings at 15 min intervals, and record following:
 - .1 Time of reading.
 - .2 Running time.
 - .3 Ambient temp in degrees C.
 - .4 Lube oil pressure in kPa.
 - .5 Lube oil temp in degrees C.
 - .6 Engine coolant temp in degrees C.
 - .7 Exhaust stack temp in degrees C.
 - .8 Alternator voltage: phase 1, 2, 3.
 - .9 Alternator current: phase 1, 2, 3.
 - .10 Power in kW.
 - .11 Frequency in Hz.
 - .12 Power Factor.
 - .13 Battery charger current in A.
 - .14 Battery voltage.
 - .15 Alternator cooling air outlet temp.
 - .2 After completion of run, demonstrate following shut down devices and alarms:
 - .1 Overcranking.
 - .2 Overspeed.
 - .3 High engine temp.
 - .4 Low lube oil pressure.
 - .5 Short circuit.
 - .6 Alternator overvoltage.
 - .7 Low battery voltage, or no battery charge.
 - .8 Manual remote emergency stop.
 - .9 High alternator temperature.
 - .3 Next install continuous strip chart recorders to record frequency and voltage variations during load switching procedures. Each load change delayed until steady state conditions exist. Switching increments to include:
 - .1 No load to full load to no load.

- .2 No load to 70% load to no load.
- .3 No load to 20% load to no load.
- .4 20% load to 40% load to no load.
- .5 40% load to 60% load to no load.
- .6 60% load to 80% load to no load.
- .5 Demonstrate:
 - .1 Automatic starting of set and automatic transfer of load on failure of normal power.
 - .2 Automatic shut down of engine on resumption of normal power.
 - .3 That battery charger reverts to high rate charge after cranking.
- .6 Demonstrate low oil pressure and high engine temperature shutdown devices operation without subjecting engine to these excesses.
- .7 Complete auto transfer switch equipment, including transfer mechanism, controls, relays and accessories to be factory assembled and tested.
 - .1 Tests:
 - .1 Operate equipment both mechanically and electrically to ensure proper performance.
 - .2 Check selector switch, in modes of operation Test, Auto, Manual, Engine Start and record results.
 - .3 Check voltage sensing and time delay relay settings.
 - .4 Check:
 - .1 Automatic starting and transfer of load on failure of normal power.
 - .2 Retransfer of load when normal power supply resumed.
 - .3 Automatic shutdown.

Part 3 Execution

3.1 INSTALLATION

- .1 Locate generating unit and install as indicated.
- .2 Install fuel supply system as indicated.
- .3 Install ventilating air system as indicated.
- .4 Pipe muffler drains.
- .5 Complete wiring and interconnections as indicated.
- .6 Start generating set and test to ensure correct performance of components.

3.2 FIELD QUALITY CONTROL

- .1 Notify Contract Administrator 10 working days in advance of test date.

- .2 Provide fuel for testing and leave full tanks on acceptance.
- .3 Demonstrate:
 - .1 Unit start, transfer to load, retransfer to normal power, unit shut down, on "Automatic" control.
 - .2 Unit start and shut down on "Manual" control
 - .3 Unit start and transfer on "Test" control.
 - .4 Unit start on "Engine start" control.
 - .5 Operation of manual bypass switch.
 - .6 Operation of automatic alarms and shut down devices.
- .4 Run unit on load for minimum period of 4 hours to show load carrying ability, stability of voltage and frequency, and satisfactory performance of dampers in ventilating system to provide adequate engine cooling.
- .5 At end of test run, check battery voltage to demonstrate battery charger has returned battery to fully charged state.
- .6 Energize transfer equipment from normal power supply.
- .7 Set selector switch in "Test" position to ensure proper standby start, running, transfer, retransfer. Return selector switch to "Auto" position to ensure standby shuts down.
- .8 Set selector switch in "Manual" position and check to ensure proper performance.
- .9 Set selector switch in "Engine start" position and check to ensure proper performance. Return switch to "Auto" to stop engine.
- .10 Set selector switch in "Auto" position and open normal power supply disconnect. Standby should start, come up to rated voltage and frequency, and then load should transfer to standby. Allow to operate for 3 min, then close main power supply disconnect. Load should transfer back to normal power supply and standby should shutdown.
- .11 Perform load pick up tests as directed by Contract Administrator on site.

END OF SECTION

Approved: 2008-12-31

Part 1 General

1.1 REFERENCES

- .1 American National Standards Institute (ANSI)
 - .1 ANSI C82.1-[04], Lamp Ballasts-Line Frequency Fluorescent Lamp Ballast.
 - .2 ANSI C82.4-[02(R2007)], Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps Multi Supply Type.
- .2 American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE)
 - .1 ANSI/IEEE C62.41-[1991], Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
- .3 ASTM International Inc.
 - .1 ASTM F1137-[00(2006)], Standard Specification for Phosphate/Oil and Phosphate/Organic Corrosion Protective Coatings for Fasteners.
- .4 Canadian Standards Association (CSA International)
- .5 ICES-005-[07], Radio Frequency Lighting Devices.
- .6 Underwriters' Laboratories of Canada (ULC)

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 11 00 Summary of Work.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Provide complete photometric data prepared by independent testing laboratory for luminaires where specified, for review by Departmental Representative.
 - .3 Provide point by points of lit areas. appx 1-3 foot spacings for points. Lighting levels in fc, to one decimal point.
 - .4 Photometric data to include: VCP Table where applicable and spacing criterion.

Part 2 Products

2.1 LAMPS

- .1 Fluorescent lamps to be - T8, 32 Watt, medium bi-pin, 4100 K, 30,000 hour lamp life, 2950 initial lumens, CRI 80+; or as indicated.
- .2 Compact fluorescent lamps to be - 18 Watt, G24q-2 base, 12,000 hour lamp life, 12,000 initial lumens, 4100 K, CRI 80+; or as indicated.

2.2 BALLASTS

- .1 Fluorescent ballast: CBM and CSA certified, energy efficient type, IC electronic.
 - .1 Rating: voltage as indicated, 60 Hz.
 - .2 Totally encased and designed for 40 degrees Celsius ambient temperature.
 - .3 Power factor: minimum 95 % with 95% of rated lamp lumens.
 - .4 Current crest factor: 1.7 maximum.
 - .5 Harmonics: 10 % maximum THD.
 - .6 Operating frequency of electronic ballast: 20 kHz minimum.
 - .7 Ballast factor: greater than 0.90.
 - .8 Sound rated: Class A.
 - .9 Mounting: integral with luminaire.
 - .10 PowerSmart. Premium ballasts.
 - .11 EMI / RFI shielded.

2.3 FINISHES

- .1 Light fixture finish and construction to meet ULC listings and CSA certification related to intended installation.

2.4 LUMINAIRES

- .1 As indicated in luminaire schedule.

Part 3 Execution

3.1 INSTALLATION

- .1 Locate and install luminaires as indicated.
- .2 Provide adequate support to suit ceiling system.

3.2 LUMINAIRE SUPPORTS

- .1 For suspended ceiling installations support luminaires from ceiling grid in accordance with local inspection requirements.

3.3 LUMINAIRE ALIGNMENT

- .1 Align luminaires mounted in continuous rows to form straight uninterrupted line.
- .2 Align luminaires mounted individually parallel or perpendicular to building grid lines.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.2 No.141-[02], Unit Equipment for Emergency Lighting.
 - .2 CSA C860-[01(December 2002)], Performance of Internally-Lighted Exit Signs.
- .2 National Research Council Canada
 - .1 National Building Code 2010 Article 3.4.5.1.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 11 00 Summary of Work.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.

Part 2 Products

2.1 STANDARD UNITS

- .1 Exit lights: to CSA C22.2 No.141 and CSA C860.
- .2 Housing: cold rolled steel minimum 1.0 mm thick. Polymer in wet locations.
- .3 Lamps: LED.

2.2 SELF-POWERED UNITS

- .1 Exit lights: to CSA C22.2 No.141 and CSA C860.
- .2 Housing: cold rolled steel minimum 1.0 mm thick. Polymer in wet locations.
- .3 Lamps: LED.
- .4 Supply voltage: 120 V, ac.
- .5 Output voltage: 12 V dc.
- .6 Operating time: 60 minimum.
- .7 Recharge time: 12 hours
- .8 Battery: sealed, maintenance free.
- .9 Charger: solid state, voltage/current regulated, inverse temperature compensated, short circuit protected, with regulated output of plus or minus 0.01 V for plus or minus 10% V input variation.
- .10 Solid state transfer circuit.

- .11 Signal lights: solid state, for 'AC Power ON', 'High Charge', 'Fault' condition.
- .12 Mounting: suitable for universal mounting directly on junction box and c/w knockouts for conduit.
 - .1 Removable or hinged front panel for easy access to batteries.
- .13 Auxiliary equipment:
 - .1 Lamp disconnect switch.
 - .2 Test switch.
 - .3 AC/DC output terminal blocks inside cabinet.
 - .4 RFI suppressor.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install exit lights to manufacturer's recommendations, listing requirements, NFPA, and local regulatory requirements.
- .2 Connect fixtures to exit light circuits.
- .3 Connect emergency lamp sockets to emergency circuits.
- .4 Ensure that exit light circuit breaker is locked in on position.

3.3 CLEANING

- .1 Proceed in accordance with Section 01 11 00 Summary of Work.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Supply and installation of structured data communication cabling, and cable terminations.
- .2 Supply and installation of structured voice communication cabling, and cable terminations at field ends.
- .3 Supply of two patch cables (one - 1.2 m and one - 3 m) for each data drop and each voice drop.
- .4 Supply and installation of patch panels.
- .5 Cable tray, raceways, boxes, outlets, jacks, and faceplates.
- .6 Fire stop for the entire system.

1.2 RELATED SECTIONS

- .1 Section 26 05 01 - Common Work Results - Electrical.
- .2 Section 01 33 00 - Submittal Procedures.

1.3 REFERENCES

- .1 Canadian Standards Association, (CSA International)
 - .1 CSA-T529-[95(R2000)], Telecommunications Cabling Systems in Commercial Buildings (Adopted ANSI/EIA TIA 568a with modifications).
 - .2 CSA-C22.2 No. 214-[02], Communications Cables (Bi-national Standard, with UL 444).
 - .3 CAN/CSA-C22.2 No. 182.4-[M90(R2001)], Plugs, Receptacles, and Connectors for Communication Systems.
- .1 Canadian Open Systems Application Criteria (COSAC)
 - .1 "Telecommunications Wiring System in Government Owned and Leased Buildings".
- .2 Treasury Board Information and Technology Standards
 - .1 TBITS 6.9: Canadian Open Systems Application Criteria (COSAC), Telecommunications wiring system in Government-Owned and leased buildings - Implementation Criteria
- .3 Telecommunications Industry Association (TIA)
 - .1 TIA/EIA-568, Commercial Building Telecommunications Cabling Standards Set.
- .4 Nordx
 - .1 Published best practices.

- .5 Owner's Wiring Specification and Structured Wiring Guidelines
 - .1 Available from Owner upon request on award of project.

1.4 SYSTEM DESCRIPTION

- .1 Structured system of telecommunications cables installed within buildings for distributing voice and data signals.
- .2 Installed in physical star configuration. Horizontal cables link patch panels to work areas and distribution points, and link distribution points to work areas. Patch panels are linked to central equipment room by backbone cables.
- .3 In this project, all work area outlets are

1.5 SUBMITTALS

- .1 Submit product data in accordance with Section 01 11 00 Summary of Work.
- .2 Include full data and factory performance sheets on communication cables.
- .3 Include shop drawings and product data for
 - .1 Cable management.
 - .2 Patch panels.
 - .3 Outlets.
 - .4 Bix mounts, connector, and adaptors.
- .4 Submit copy of Belden Certified System Vendor (CSV) Accreditation and copy of RCDD certification with shop drawings. Include copies in O&M Manuals.
- .5 Submit an itemized list of all equipment to be supplied.
- .6 Include copies of Warranties in O&M Manual.
- .7 On request, submit an itemized list fully breaking down labor costs for the works of this section.

1.6 WARRANTY

- .1 For all works of this section performed by the Contractor, the 12 months warranty period is extended to 300 (three hundred) months, with no-charge replacement during the entire period.
 - .1 All replacement parts provided under the extended warranty shall be new and shall be provided at no cost to the Owner.
 - .2 All labor, disbursements, and associated works under the extended warranty shall be provided at no cost to the Owner.
 - .3 All wiring and termination equipment shall be covered by this extended warranty.

- .4 On-site maintenance for any problems encountered with cabling or termination equipment or workmanship shall be covered, at no cost to the Owner, while the equipment is under warranty.
- .2 The Contractor shall obtain product warranties in excess of one year from the manufacturer on behalf of the Owner. The warranties shall be issued from the manufacturer in the name of the Owner.
- .3 The 25 year Extended Product Warranty and Lifetime Application Assurance Warranty for the Communications Network shall be backed by the manufacturer and taken over by the manufacturer or his representative if the Contractor fails to follow through on the requirements of the Warranty.
- .4 The Communications Network is defined as all required passive equipment and cabling, including hardware, termination, and jacks, configured to provide data and voice connectivity from each data or voice outlet provided by the Contractor in this Contract.
- .5 The System Assurance shall cover the applications that the installed system is designed to support for a twenty five (25) year period.
- .6 The Extended Product Warranty and the Systems Assurance together comprise the Structured Cabling Systems Quality Assurance Program.
- .7 Upon successful completion of the Structure Cabling System installation and subsequent testing by certified technical personnel the Contractor shall provide to the Owner a numbered certificate registering the installation.

Part 2 Products

2.1 GENERAL

- .1 Wiring shall be Belden/CDT (Nordx) certified. All cabling shall be by one manufacturer.
- .2 Belden Certified System Vendor (CSV) Accreditation required for Contractor. Contractor shall have manufacturer training and experience in all aspects of the placement, termination, connection, and testing.
- .3 The Contractor shall have a minimum of one (1) Registered Communications Distribution Designer (RCDD) recognized by BICSI on staff at local offices within the Province of Manitoba.
- .4 The Contractor shall have experience in all aspects of this work and shall, on request, submit evidence of direct experience on similar systems. Provide details demonstrating experience on at least three projects in the last two years that include design and installation of Cat 5e, Cat 6, or Cat 6A balanced twisted pair structured cabling systems. Provide name and contact info for each of three projects. The Contractor shall own and maintain the tools and equipment for successful installation and testing of premise distribution systems and shall have personnel who are adequately trained in their use.

- .5 Cable colors, jack colors, faceplate arrangements, and labeling schemes shall be approved by Owner. Submit plan for faceplate arrangements, labeling schemes, and coloring schemes for review.

2.2 HORIZONTAL CABLING AND PATCH CABLES

- .1 4 pair, Cat 6, 22 AWG or 24 AWG, FT4.
- .2 To EIT/TIA 568A.
- .3 Provide horizontal cabling.
- .4 Provide one - one meter patch cable and one - three meter patch cable for each drop.
- .5 Confirm preferred jacket colors with Owner and Consultant. Patch cables are generally to be grey unless otherwise instructed.
- .6 All cabling to match.
- .7 Provide one 2U finger type cable manager per 24 horizontal LAN drops.

2.3 PATCH PANELS

- .1 Patch panels shall be 48 port high density, 2U.
- .2 Provide separate patch panels by function (voice, data, telephone trunk lines).
- .3 Provide 2U cable management below each patch panel.
- .4 Provide patch panels compatible with wiring system and Owner-supplied racks.
- .5 Panels shall fit standard width communication cabinet and have integral rear support bar for horizontal cabling support.
- .6 Jacks shall be RJ45 and comply with requirements for Category 6 connectors.

Part 3 Execution

3.1 INSTALLATION PERSONNEL

- .1 Meet Owner requirements for security clearances for access to restricted areas.
- .2 Installation personnel are subject to approval by the Owner. Provide alternative personnel to the satisfaction of the Owner where the Owner so requests due to a perceived lack of suitable skills. In such an instance alternative personnel will be provided at no cost to the Owner.
- .3 Provide a single point of contact (Service Representative) for all telephone assistance, service calls, and installation coordination.

3.2 SYSTEM

- .1 Comply with TBITS 6.9. Notwithstanding, Cat 6 cabling shall be the minimum standard
- .2 Comply with Nordx best practices where applicable, and TIA/EIA 568B best practices otherwise.
- .3 Obtain and review Wiring Specification and Structured Wiring Guidelines upon award of Contract. Documents are available from the Owner upon request after award of Contract.
- .4 Installed in physical star configurations.
- .5 Horizontal cabling shall be in home runs. Maximum one transition between different forms of the same cable run between work area and termination point.
- .6 Horizontal cables link work areas to telecommunications patch panels in racks or to distribution points. Racks linked to central equipment room by backbone cables.

3.3 INSTALLATION OF HORIZONTAL CABLING

- .1 Install horizontal data communication cables from patch panels to outlets. Terminate both ends.
- .2 Install horizontal voice communication cables from patch panels to outlets. Terminate both ends.
- .3 Label each cable clearly with permanent, indelible, professional self laminating wire labels at no more than 0.2 m from the work area and at the termination point.
- .4 Label each jack on the cross connection hardware with printed numbers from professional device. Numbering scheme shall be to the approval of the Owner.
- .5 Coordinate labeling scheme to suit Owner.
- .6 Maximum cable length is 90 m.
- .7 Leave 3 m extra length at work area end and 2 m at telecommunications closet end. Do not coil extra length. Use 'U' or 'S' shape.
- .8 Do not use tie wraps or zip ties to bundle or organize cabling. 3/8 inch wide hook-and-loop strapping acceptable.

3.4 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 01 - Common Work Results - Electrical.
- .2 Perform acceptance testing.
- .3 Copper cabling shall be tested to Cat 6 level.
- .4 All testing shall be carried out using the same model of tester. Where multiple tester models are used, all reports must indicate tester models.

- .5 Submit hard and soft copy of all test data on all cables.

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 11 00 Summary of Work.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for communication raceway systems and include product characteristics, performance criteria, physical size, finish and limitations.

Part 2 Products

2.1 SYSTEM DESCRIPTION

- .1 Provide complete raceways system including outlet boxes, cover plates, conduits, cable trays, pull boxes, sleeves and caps, fish wires, and service fittings for all communication systems and outlets.
- .2 Provide structured cabling for voice / data systems as described.
- .3 Provide cabling for CCVE, audio (microphone), Intrusion Detection and Access Control systems as described.

2.2 MATERIAL

- .1 Provide conduits, trays, overhead distribution, junction boxes, cabinets, outlet boxes, fish wire, and all associated equipment for a complete functional installation.

Part 3 Execution

3.1 INSTALLATION

- .1 Install raceway system including miscellaneous and positioning material to constitute complete system.
- .2 Fire stop penetrations in rated surfaces and assemblies.
- .3 Coordinate outlets and connections in furniture and millwork.
- .4 Follow manufacturer instructions.
- .5 System shall allow ready addition, modification, and removal of wiring in future.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Provision of complete functional new fire alarm system.
- .2 Inspection and verification.

1.2 RELATED SECTIONS

- .1 Section 26 05 01 - Common Work Results - Electrical.

1.3 REFERENCES

- .1 NBC, National Building Code of Canada.
- .2 Government of Canada
 - .1 TB OSH Chapter 3-03, Treasury Board of Canada, Occupational Safety and Health, Chapter 3-03, Standard for Fire protection Electronic Data Processing Equipment.
 - .2 TB OSH Chapter 3-04, Treasury Board of Canada, Occupational Safety and Health, Chapter 3-04, Standard for Fire Alarm Systems.
- .3 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S524, Installation of Fire Alarm Systems.
 - .2 ULC-S525, Audible Signal Appliances.
 - .3 CAN/ULC-S526, Visual Signal Appliances, Fire Alarm.
 - .4 CAN/ULC-S527, Control Units.
 - .5 CAN/ULC-S528, Manual Pull Stations.
 - .6 CAN/ULC-S529, Smoke Detectors.
 - .7 CAN/ULC-S530, Heat Actuated Fire Detectors.
 - .8 CAN/ULC-S531, Smoke Alarms.
 - .9 CAN/ULC-S536, Inspection and Testing of Fire Alarm Systems.
 - .10 CAN/ULC-S537, Verification of Fire Alarm Systems.

1.4 DESCRIPTION OF SYSTEM

- .1 System includes:
 - .1 Control panel to carry out fire alarm and protection functions including receiving alarm signals, initiating alarm, supervising system continuously, actuating zone annunciators, initiating trouble signals, and transmitting dry contact alarm, trouble, and supervisory conditions.
 - .2 Trouble signal devices.
 - .3 Power supply facilities.
 - .4 Manual alarm stations.
 - .5 Automatic alarm initiating devices.

- .6 Audible and visual signal devices.
 - .7 End-of-line devices.
 - .8 Isolation devices.
 - .9 Annunciators.
 - .10 Ancillary devices, relays, modules, and accessories.
 - .11 Two means of communication to central monitoring facility.
 - .12 Auxiliary 'Alarm' output suitable for monitoring by the RCMP security panel (see specifications).
 - .13 Auxiliary 'Trouble' output suitable for monitoring by the RCMP security panel (see specifications).
 - .2 All fire alarm system components to be by one manufacturer.
- 1.5 REQUIREMENTS OF REGULATORY AGENCIES**
- .1 System:
 - .1 To TB OSH Chapter 3-04.
 - .2 Subject to Fire Commissioner of Canada (FC) approval.
 - .3 Subject to FC inspection for final acceptance.
- 1.6 SHOP DRAWINGS**
- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Include:
 - .1 Equipment data for each component.
 - .2 Layout of equipment.
 - .3 Zoning.
 - .4 Riser diagram.
 - .5 Complete wiring diagram, including schematics of modules.
- 1.7 CLOSEOUT SUBMITTALS**
- .1 Provide operation and maintenance data for Fire Alarm System for incorporation into manual specified in Section 01 11 00 Summary of Work.
 - .2 Include:
 - .1 Operation and maintenance instructions for complete fire alarm system to permit effective operation and maintenance.
 - .2 Technical data - illustrated parts lists with parts catalogue numbers.
 - .3 Copy of approved shop drawings.
 - .4 List of recommended spare parts for system.
- 1.8 EXTRA MATERIALS**
- .1 Provide maintenance materials in accordance with Section 01 11 00 Summary of Work.

- .2 Include:
 - .1 4 spare glass rods for manual pull box stations if applicable.

1.9 MAINTENANCE

- .1 Include one year maintenance with two inspections by manufacturer during warranty period. Inspection tests to conform to CAN/ULC-S536. Submit inspection report to Owner.
- .2 The Owner reserves the right to select a maintenance service provider.

Part 2 Products

2.1 SYSTEM OPERATION

- .1 Single stage operation. Operation of any alarm initiating device to:
 - .1 Cause audible signal devices to sound throughout building.
 - .2 Make dry contact signals available for transmission to Owner's monitoring forces.
 - .3 Cause zone of alarm device to be indicated on control panel.
 - .4 Cause air conditioning and ventilating fans to shut down or to function so as to provide required control of smoke movement.
 - .5 Cause fire doors and smoke control doors if normally held open, to close automatically.

2.2 MATERIALS

- .1 Equipment and devices: ULC listed and labelled and supplied by single manufacturer.
- .2 Power supply: to CAN/ULC-S524.
- .3 Audible signal devices: to ULC-S525.
- .4 Visual signal devices: to CAN/ULC-S526.
- .5 Control unit: to CAN/ULC-S527.
- .6 Manual pull stations: to CAN/ULC-S528.
- .7 Thermal detectors: to CAN/ULC-S530.
- .8 Smoke detectors: to CAN/ULC-S529.
- .9 Smoke alarms: to CAN/ULC-S531.

2.3 GENERAL

- .1 All fire alarm system components to be by one manufacturer.

2.4 CONTROL PANEL (FACP)

- .1 Single stage, addressable.
- .2 Up to six addressable loops, Class A. Four Class B notification appliance circuits (NACs).
- .3 Temporal.
- .4 Enclosure: CSA Enclosure 1, c/w lockable concealed hinged door, viewing window, lock and 2 keys. Coordinate flush, semi flush, or surface mount. Surface not acceptable in finished areas.
- .5 LED and LCD display.
- .6 Supervised, modular design with plug-in modules:
 - .1 Alarm receiver with trouble and alarm indications.
 - .2 Spare zones: compatible with smoke detectors and open circuit devices.
 - .3 Space for future modules.
 - .4 Latching type supervisory receiver circuits. Discrete indication for both off-normal and trouble.
- .7 Components:
 - .1 Alarm receiver panel with trouble and alarm indications.
 - .2 Temporal audible signal control panel.
 - .3 Common control and power units:
 - .1 Control panel containing following indications and controls:
 - .1 "Power on" LED (green) to monitor primary source of power to system.
 - .2 "Power trouble" indication.
 - .3 "Ground trouble" indication.
 - .4 "System trouble" indication.
 - .5 "System trouble" buzzer and silence switch c/w trouble resound feature.
 - .6 System reset switch.
 - .7 "LED test" switch if applicable.
 - .8 "Alarm silence" switch to silence signals manually. If new alarm occurs after signals have been silenced, signals to resound.
 - .9 "Signals silenced" indication.
 - .2 Master power supply panel to provide 24Vdc to system from 120Vac, 60Hz input.
 - .3 Fire department connections:
 - .1 Plug-in module for municipal box.
 - .2 Fire department bypass switch c/w indicator for trouble at panel.
 - .4 Auxiliary relays: plug-in type, dust cover, supervised against unauthorized removal by common trouble circuit.

- .1 Contacts: 2.0A, 120Vac, for functions such as release of door holders or initiation of fan shut down.
- .2 Contact terminal size: capable of accepting 22-12AWG wire.
- .3 Auxiliary 'Alarm' output suitable for monitoring by the RCMP security panel. Provide Form C dry contact output. RCMP security panel will monitor NC connection which shall be open during Alarm condition, and closed during normal condition. Provide 1 kOhm resistor (R1) in line with 'Common' terminal. Provide 1 kOhm resistor (R2) jumpered between 'Common' and 'NC' terminals. Thus the circuit as seen by the security panel will be 1 kOhm in Normal (non-alarm) status (as R2 is shorted by closed NC contact) and 2 kOhm in Alarm status.
- .4 Auxiliary 'Trouble' output suitable for monitoring by the RCMP security panel, configured identically to the auxiliary 'Alarm' output.
- .5 Ethernet
- .8 Edwards EST3X series FACP, or equivalent. Edwards 3X-SFS1B control panel. 3X-ETH1 ethernet adapter. 4X-12/SR1RY control and display module with 12 switches and one red, one yellow LED per switch.

2.5 POWER SUPPLY

- .1 120V AC 60Hz input, 24Vdc output from rectifier to operate alarm and signal circuits, with standby power of gel cell batteries minimum expected life of 4 years, sized in accordance with NBC.

2.6 REMOTE ANNUNCIATOR

- .1 Features:
 - .1 4 x 20 character backlit LCD.
 - .2 24 pair LEDs.
 - .3 Status LED and internal buzzer.
 - .4 Common controls.
 - .5 Mounts on standard 4" square box.
- .2 Edwards RLCD-C annunciator. Edwards RLED24 expansion for 24 LED display. Edwards RA-ENC2 enclosure to house annunciator and LED display.

2.7 MANUAL ALARM STATIONS

- .1 Manual alarm stations: pull lever, wall mounted semi-flush or surface type to suit, single pole normally open contact for single stage, bilingual signage. SIG-270.

2.8 AUTOMATIC ALARM INITIATING DEVICES

- .1 Heat detectors, combination fixed temperature and rate of rise, self-restoring rate of rise 57 C, rate of rise, 8 C per minute.
- .2 Heat detectors, fixed temperature, 57 C.

- .3 Heat detectors, moisture proof, combination fixed temperature and rate of rise, self-restoring rate of rise, 57 C, rate of rise, 8 C per minute.
- .4 Smoke and heat detector: ionization and photoelectric.
 - .1 Addressable. Plug-in type with fixed base. Wire-in base assembly with integral red and green LEDs. SIGA2-IPHS.
 - .2 For use in cells with ULC and Owner approved guard, EST 6255-004.
- .5 Smoke and heat detector: photoelectric.
 - .1 Addressable. Plug-in type with fixed base. Wire-in base assembly with integral red and green LEDs. SIGA2-PHS.
- .6 Smoke detector: photoelectric.
 - .1 Addressable. Plug-in type with fixed base. Wire-in base assembly with integral red and green LEDs. SIGA2-PS.
- .7 Heat detector: rate of rise.
 - .1 Addressable. 8 C per minute. Plug-in type with fixed base. Wire-in base assembly with integral red and green LEDs. SIGA2-HRS.
- .8 Heat detector: fixed temp.
 - .1 Addressable. 54 C to 60 C. Plug-in type with fixed base. Wire-in base assembly with integral red and green LEDs. SIGA2-HFS.
- .9 Smoke detector: air duct type.
 - .1 Addressable. Base assembly with red and green LEDs and local test capability. Sampling tube to suit ductwork. SIGA-SD.
- .10 Sounder base.
 - .1 Configurable for high or low dB output. Configurable for single or group operation. SIGA-AB4GT audible sounder base, SIGA-TCDR temporal generator, SIGA-RM1 riser monitor module.

2.9 AUDIBLE AND VISUAL ALARM SIGNAL DEVICES

- .1 Horn / strobe type: Selectable 15, 30, 75, or 110 cd. Selectable high dB or low dB. G1-HDVM.
- .2 Ceiling horn / strobe type: Selectable 15, 30, 75, or 95 cd. Selectable high dB or low dB. GC-HDVM.
- .3 High output ceiling horn / strobe type: Selectable 95, 100, 150, or 177 cd. Selectable high dB or low dB. GC-HDVMH.
- .4 Strobe type: Selectable 15, 30, 75, or 110 cd. G1-VM.
- .5 Ceiling strobe type: Selectable 15, 30, 75, or 95 cd. GC-VM.
- .6 High output ceiling strobe type: Selectable 95, 115, 150, or 177 cd. GC-VMH.

- .7 Outdoor rated horn / strobe: Selectable cd output. Selectable high or low audible output. WG4RN-HVMC.
- .8 High output outdoor rated Horn / strobe: Selectable cd output. Selectable high or low audible output. WG4RN-HVMHC.
- .9 Harsh environment strobe: outdoor rated, 15/75 cd. CS405-7A-T with 449 surface mount box, gray.

2.10 END-OF-LINE DEVICES

- .1 For Class B circuits provide end-of-line devices to control supervisory current in 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.

2.11 ANCILLARY DEVICES

- .1 Remote relay unit to initiate fan shutdown.
- .2 Remote relay to communicate alarm, trouble, and supervisory condition remotely.
- .3 Input modules SIGA-CT2.
- .4 Control relay modules SIGA-CR.
- .5 Isolator module SIGA-IM.

2.12 REMOTE MONITORING

- .1 Provide dialler at telephone backboard for communication with remote monitoring station.
- .2 Provide auxiliary 'Alarm' output and auxiliary 'Trouble' output as described for connection to Owner's security monitoring system

Part 3 Execution

3.1 INSTALLATION

- .1 Install systems in accordance with CAN/ULC-S524 and TB OSH Chapter 3-04.
- .2 Install main control panel and connect to ac power supply.
- .3 Locate and install isolator modules.
- .4 Locate and install manual alarm stations and connect to alarm circuit wiring.
- .5 Locate and install detectors and connect to alarm circuit wiring. Do not mount detectors within 1 m of air outlets. Maintain at least 600 mm radius clear space on ceiling, below and around detectors. Locate duct type detectors in straight portions of ducts.

- .6 Connect alarm circuits to main control panel.
- .7 Locate and install horns, horn strobes, and strobes and connect to signalling circuits.
- .8 Connect signalling circuits to main control panel.
- .9 Install end-of-line devices.
- .10 Locate and install remote relay units to control fan shut down.
- .11 Locate and install ancillary devices.
- .12 Provide remote indication of alarm, trouble, and supervisory conditions via dry contacts.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical and CAN/ULC-S537.
- .2 Fire alarm system:
 - .1 Test each device and alarm circuit to ensure manual stations, heat detectors, and smoke detectors transmit alarm to control panel and actuate first stage alarm and ancillary devices.
 - .2 Ensure zones are shown correctly.
 - .3 Simulate grounds and breaks on alarm and signalling circuits to ensure proper operation of system.

3.3 TRAINING

- .1 Arrange and pay for on-site lectures and demonstrations by fire alarm equipment manufacturer to train operational personnel in use and maintenance of fire alarm system.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 31 23 10 - Excavation, Trenching and Backfilling.

1.2 DEFINITIONS

- .1 Clearing consists of cutting off trees and brush vegetative growth to not more than a specified height above ground and disposing of felled trees, previously uprooted trees and stumps, and surface debris.
- .2 Close-cut clearing consists of cutting off standing trees, brush, scrub, roots, stumps and embedded logs, removing at, or close to, existing grade and disposing of fallen timber and surface debris.
- .3 Clearing isolated trees consists of cutting off to not more than specified height above ground of designated trees, and disposing of felled trees and debris.
- .4 Underbrush clearing consists of removal from treed areas of undergrowth, deadwood, and trees smaller than 50 mm trunk diameter and disposing of all fallen timber and surface debris.
- .5 Grubbing consists of excavation and disposal of stumps and roots boulders and rock fragments of specified size to not less than a specified depth below existing ground surface.

1.3 STORAGE AND PROTECTION

- .1 Prevent damage to fencing, trees, landscaping, natural features, bench marks, existing buildings, existing pavement, utility lines, site appurtenances, water courses and/or root systems of trees which are to remain.
 - .1 Repair any damaged items to approval of Consultant.
 - .2 Replace any trees designated to remain, if damaged, as directed by Consultant.

Part 2 Execution

2.1 PREPARATION

- .1 Inspect site and verify with Consultant, items designated to remain.
- .2 Locate and protect utility lines. Preserve in operating condition active utilities traversing site.
- .3 Notify utility authorities before starting clearing and/or grubbing.

2.2 CLEARING

- .1 Clear as indicated by Consultant, by cutting at a height of not more than 300 mm above ground. In areas to be subsequently grubbed, height of stumps left from clearing operations to be not more than 1000 mm above ground surface.
- .2 Cut off branches and cut down trees overhanging area cleared as directed by Consultant.
- .3 Cut off unsound branches on trees designated to remain as directed by Consultant.

2.3 CLOSE CUT CLEARING

- .1 Close cut clearing to ground level.
- .2 Perform close cut clearing by hand so that existing muskeg is not damaged.
- .3 Cut off branches and/or down trees overhanging area cleared as directed by Consultant.
- .4 Cut off unsound branches on trees designated to remain as directed by Consultant.

2.4 ISOLATED TREES

- .1 Cut off isolated trees as indicated by Consultant at height of not more than 300 mm above ground surface.
- .2 Grub out isolated tree stumps.

2.5 UNDERBRUSH CLEARING

- .1 Clear underbrush from areas as indicated at ground level.

2.6 GRUBBING

- .1 Grub out stumps and roots to not less than 200 mm below ground surface.
- .2 Grub out visible rock fragments and boulders, greater than 300 mm in greatest dimension, but less than 0.25 m³.

2.7 REMOVAL AND DISPOSAL

- .1 Remove cleared and grubbed materials off site to disposal area as designated by Consultant.
- .2 Cut timber greater than 125 mm diameter to 375 mm lengths and stockpile as indicated. Stockpiled timber becomes property of Owner.
- .3 Dispose of cleared and grubbed materials by burning and burying.
- .4 Burn only in area designated by Consultant. Burn under constant care of competent watchmen, at such times and so that surrounding vegetation, adjacent property or anything to remain will not be jeopardized.

- .5 Bury to approval of Consultant by:
 - .1 Consolidating.
 - .2 Covering with minimum 500 mm of mineral soil.
 - .3 Finishing surface.
- .6 Chip or mulch and stockpile cleared and grubbed vegetative material on site as directed by Consultant.
- .7 Remove diseased trees identified by Consultant and dispose of this material to approval of Consultant.

2.8 FINISHED SURFACE

- .1 Leave ground surface in condition suitable for immediate grading operation to approval of Consultant.

END OF SECTION

Part 1 General

.1 REFERENCES

- .1 American Society for Testing and Materials (ASTM)
 - .1 ASTM D698-00a, Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort 12,400 ft lb/f³.

1.2 EXISTING CONDITIONS

- .1 Examine subsurface investigation report which is available for inspection at Consultant's Office.
- .2 Known underground and surface utility lines and buried objects are as indicated on site plan.
- .3 Refer to dewatering in Section 31 23 10 – Excavating, Trenching and Backfilling.

1.3 PROTECTION

- .1 Protect and/or transplant existing fencing, tree, landscaping, natural features, bench marks, buildings, pavement, surface or underground utility lines which are to remain as directed by Consultant. If damaged, restore to original or better condition unless directed otherwise.
- .2 Maintain access roads to prevent accumulation of construction related debris on roads. This will be strictly enforced by the Consultant.

Part 2 Products

2.1 MATERIALS

- .1 Fill material: Engineered fill in accordance with Paragraph 2.1, Section 31 23 10 – Excavating, Trenching and Backfilling.
- .2 Excavated or graded material existing on site may be suitable to use as fill for grading work, if approved by Consultant.

Part 3 Execution

3.1 GRADING

- .1 Rough grade to levels, profiles and contours allowing for surface treatment as

indicated.

- .2 Rough grade to following depths below finished grades:
 - .1 135 mm for sodded areas.
 - .2 300 mm for flowerbeds.
 - .3 500 mm for shrub beds.
 - .4 600 mm for concrete paving, walks and precast paving units.
- .3 Slope rough grade away from building 1:50 minimum and as indicated or as directed by Consultant.
- .4 Grade ditches to depth as indicated and as directed.
- .5 Prior to placing fill over existing ground, scarify surface to depth of 150 mm. Maintain fill and existing surface at approximately same moisture content to facilitate bonding.
- .6 Compact filled and disturbed areas to standard maximum dry density as follows:
 - .1 85% under landscaped areas, 90% under non-landscaped areas.
 - .2 95% under paved and walk areas.
- .7 Do not disturb soil within branch spread of trees or shrubs to remain.

3.2 TESTING

- .1 Inspection and testing of soil compaction will be carried out by testing laboratory approved by the Consultant. Costs of tests will be paid by Contractor.
- .2 Submit testing procedure, frequency of tests, testing laboratory as designated by ULC or certified testing personnel to Consultant for approval.

3.3 SURPLUS MATERIAL

- .1 Remove surplus material and material unsuitable for fill, grading or landscaping off site as directed by Consultant.

END OF SECTION

Part 1 General**1.1 REFERENCES**

- .1 American Society for Testing and Materials (ASTM)
 - .1 ASTM C117-95, Standard Test Method for Material Finer Than 0.075 mm (No. 200) Sieve in Mineral Aggregates by Washing.
 - .2 ASTM C136-96a, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .3 ASTM D422-98, Standard Test Method for Particle Size Analysis of Soils.
 - .4 ASTM D698-00a, Standard Test Methods for Laboratory Compaction Characteristics of Soil using Standard Effort (12,400 ft-lbf/ft³) (600 kN-m/m³)
 - .5 ASTM D4318-00, Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.
- .3 Canadian Standards Association (CSA)
 - .1 CAN/CSA-A3000-98-A5-98, Portland Cement.
 - .2 CAN/CSA-A23.1-00, Concrete Materials and Methods of Concrete Construction.

1.2 DEFINITIONS

- .1 Excavation classes: two classes of excavation will be recognized: common excavation and rock excavation.
 - .1 Rock: any solid material in excess of 0.25 m³ and which cannot be removed by means of heavy duty mechanical excavating equipment with 0.95 to 1.15 m³ bucket. Frozen material not classified as rock.
 - .2 Common: excavation of materials of whatever nature, which are not included under definitions of rock excavation.
- .2 Unclassified excavation: excavation of deposits of whatever character encountered in Work.
- .3 Topsoil: Material capable of supporting good vegetative growth and suitable for use in top dressing, landscaping and seeding.
- .4 Waste material: excavated material unsuitable for use in Work or surplus to requirements.
- .5 Borrow material: material obtained from locations outside area to be graded, and required for construction of fill areas or for other portions of Work.

.6 Unsuitable materials:

- .1 Weak and compressible materials under excavated areas.
- .2 Frost susceptible materials under excavated areas.
- .3 Frost susceptible materials:

- .1 Fine grained soils with plasticity index less than 10 when tested to ASTM D4318 and gradation within limits specified when tested to ASTM D422 and ASTM C136. Sieve sizes to CAN/CGSB-8.2.
- .2 Table

Sieve Designation	% Passing
2.00 mm	100
0.10 mm	45-100
0.02 mm	10-80
0.005 mm	0-45

- .3 Coarse grained soils containing more than 20% by mass passing 0.075 mm sieve.

.7 Unshrinkable fill: very weak mixture of Portland Cement, concrete aggregates and water that resists settlement when placed in utility trenches and capable of being readily excavated.

1.3 SUBMITTALS

.1 Samples:

- .1 Submit samples in accordance with Section 01 33 00.
- .2 Inform Consultant at least 4 weeks prior to commencing Work, of proposed source of fill materials and provide access for sampling.
- .3 Submit 70 kg samples of type of fill specified including representative samples of excavated material.

1.4 QUALITY ASSURANCE

- .1 Qualification Statement: submit proof of insurance coverage for professional liability.
- .2 Submit design and supporting data at least 2 weeks prior to commencing Work.
- .3 Design and supporting data submitted to bear stamp and signature of qualified Professional Engineer registered or licensed in the Province of Manitoba, Canada.
- .5 Keep design and supporting data on site.
- .6 Engage services of qualified Professional Engineer who is registered or

licensed in the Province in which Work is to be carried out to design and inspect cofferdams, shoring, bracing and underpinning required for Work.

1.5 PROTECTION OF EXISTING FEATURES

- .1 Protect existing features in accordance with applicable local regulations.
- .2 Existing buried utilities and structures:
 - .1 Size, depth and location of existing utilities and structures as indicated are for guidance only. Completeness and accuracy are not guaranteed.
 - .2 Prior to commencing excavation Work, notify applicable Consultant or Authorities Having Jurisdiction, establish location and state of use of buried utilities and structures. Consultant or Authorities Having Jurisdiction to clearly mark such locations to prevent disturbance during Work.
 - .3 Confirm locations of buried utilities by careful test excavations.
 - .4 Maintain and protect from damage, water, sewer, gas, electric, telephone and other utilities and structures encountered.
 - .5 Where utility lines or structures exist in area of excavation, obtain direction of Construction Manager before removing/re-routing.
 - .6 Record location of maintained, re-routed and abandoned underground lines.
 - .7 Confirm locations of recent excavations adjacent to area of excavation.
- .3 Existing buildings and surface features:
 - .1 Conduct, with Consultant, condition survey of existing buildings, trees and other plants, lawns, fencing, service poles, wires, rail tracks, pavement, survey bench marks and monuments which may be affected by Work.
 - .2 Protect existing buildings and surface features from damage while Work is in progress. In the event of damage, immediately make repair to approval of Consultant.

2.1 MATERIALS

- .1 Type 1 and Type 2 fill: shall conform to properties of the following requirements:
 - .1 Crushed, pit run or screened stone, gravel or sand.
 - .2 Gradations to be within limits specified when tested to ASTM C136 and ASTM C117. Sieve sizes to CAN/CGSB-8.2.

.3 Table

Sieve Designation	% Passing Type 1	% Passing Type 2
75 mm	-	100
50 mm	-	-
37.5 mm	-	-

Sieve Designation	% Passing Type 1	% Passing Type 2
25 mm	100	-
19 mm	75-100	-
12.5 mm	-	-
9.5 mm	50-100	-
4.75 mm	30-70	22-85
2.00 mm	20-45	-
0.425 mm	10-25	5-30
0.180 mm	-	-
0.075 mm	3-8	0-10

- .2 Type 3 fill: selected material from excavation or other sources, approved by Consultant for use intended, unfrozen and free from rocks larger than 75 mm, cinders, ashes, sods, refuse or other deleterious materials.

Part 3 Execution

3.1 SITE PREPARATION

- .1 Remove obstructions, ice and snow, from surfaces to be excavated within limits indicated.

3.2 STRIPPING OF TOPSOIL

- .1 Commence topsoil stripping of areas as directed by Consultant after area has been cleared of brush, weeds and grasses and removed from site.
- .2 Strip topsoil to depths as directed by Consultant. Do not mix topsoil with subsoil.
- .3 Stockpile in locations as directed by Consultant. Stockpile height not to exceed 2 m.
- .4 Dispose of unused topsoil as directed by Consultant.

3.3 STOCKPILING

- .1 Stockpile fill materials in areas designated by Consultant. Stockpile granular materials in manner to prevent segregation.
- .2 Protect fill materials from contamination.

3.4 DEWATERING AND HEAVE PREVENTION – N/A

3.5 EXCAVATION

- .1 Excavate to lines, grades, elevations and dimensions as indicated.

- .2 Excavation must not interfere with bearing capacity of adjacent foundations.
- .3 Do not disturb soil within branch spread of trees or shrubs that are to remain. If excavating through roots, excavate by hand and cut roots with sharp axe or saw.
- .4 For trench excavation, unless otherwise authorized by Consultant in writing, do not excavate more than 30 m of trench in advance of installation operations and do not leave open more than 15 m at end of day's operation.
- .5 Keep excavated and stockpiled materials a safe distance away from edge of trench as directed by Consultant.
- .6 Restrict vehicle operations directly adjacent to open trenches.
- .7 Dispose of surplus and unsuitable excavated material in approved location on site or off site as directed by Consultant.
- .8 Do not obstruct flow of surface drainage or natural watercourses.
- .9 Earth bottoms of excavations to be undisturbed soil, level, free from loose, soft or organic matter.
- .10 Notify Consultant when bottom of excavation is reached.
- .11 Obtain Consultant approval of completed excavation.
- .12 Remove unsuitable material from trench bottom to extent and depth as directed by Consultant.
- .13 Correct unauthorized over-excavation as follows:
 - .1 Fill under bearing surfaces and footings with fill concrete.
 - .2 Fill under other areas with fill compacted to not less than 95% of standard maximum dry density. Hand trim, make firm and remove loose material and debris from excavations. Where material at bottom of excavation is disturbed, compact foundation soil to density at least equal to undisturbed soil. Clean out rock seams and fill with concrete mortar or grout to approval of Consultant.

3.6 FILL TYPES AND BACKFILL

- .1 A minimum thickness of 150 bedding sand shall be placed prior to the layout of the utilities. Once the utilities have been placed, the pipes should be covered with a minimum 300 mm thickness of said prior to applying compaction effort.

Native sand materials are considered to be acceptable as backfill. The remainder of the trench to sub-grade elevation to be backfilled and compacted with Type 1 fill. Backfill under slab pavements and sidewalks to be compacted to 98% Standard Proctor Density,

in landscaped area to be 90% Standard Proctor Density.

3.7 BEDDING AND SURROUND OF UNDERGROUND SERVICES

- .1 Place and compact granular material for bedding and surround of underground services as indicated.
- .2 Place bedding and surround material in unfrozen condition.

3.8 BACKFILLING

- .1 Do not proceed with backfilling operations until Consultant has inspected and approved installations.
- .2 Areas to be backfilled to be free of debris, snow, ice, water and frozen ground.
- .3 Do not use backfill material which is frozen or contains ice, snow or debris.
- .4 Place backfill material in uniform layers not exceeding 150 mm compacted thickness up to grades indicated. Compact each layer before placing succeeding layer.
- .5 Backfilling around installations:
 - .1 Place bedding and surround material as specified elsewhere.
 - .2 Do not backfill around or over cast-in-place concrete within 24 hours after placing of concrete.
 - .3 Place layers simultaneously on both sides of installed Work to equalize loading. Where temporary unbalances earth pressures are liable to develop on walls or other structures:
 - .1 Permit concrete to cure for minimum 14 days or until it has sufficient strength to withstand earth and compaction pressure and approval is obtained from Consultant, or:
 - .2 If approved by Consultant, erect bracing or shoring to counteract unbalance, and leave in place until removal is approved by Consultant.

3.9 RESTORATION

- .1 Upon completion of Work, remove waste materials and debris, trim slopes and correct defects as directed by Consultant.
- .2 Replace topsoil as directed by Consultant.
- .3 Reinstate lawns to elevation which existed before excavation.
- .4 Reinstate pavements and sidewalks disturbed by excavation to thickness, structure and elevation which existed before excavation.

.5 Clean and reinstate areas affected by Work as directed by Consultant.

END OF SECTION

Part 1 General**1.1 REFERENCES**

- .1 American Society for Testing and Materials (ASTM)
 - .1 ASTM C117-95, Standard Test Methods for Material Finer Than 0.075mm Sieve in Mineral Aggregates by Washing.
 - .2 ASTM C131-96, Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
 - .3 ASTM C136-96a, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .4 ASTM D422-63(1998), Standard Test Method for Particle Size Analysis of Soils.
 - .5 ASTM D699 00(a), Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort 12,400ft-lbf/ft³.
 - .6 ASTM D4318-00, Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN./CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.

Part 2 Products**2.1 MATERIALS**

- .1 Granular sub-base material: in accordance with the following requirements:

- .1 Crushed, pit run or screened stone, gravel or sand.
- .2 Gradations to be within limits specified when tested to ASTM C136 and ASTM C117. Sieve sizes to CAN/CGSB-8.2.
- .3 Table

Sieve Designation	% Passing
75 mm	100
25 mm	55-100
4.75 mm	25-100
2.00 mm	15-80
0.425 mm	4-50
0.075 mm	0-8

- .4 Other Properties as follows:
 - .1 Liquid Limit: to ASTM D4318, Maximum 25.
 - .2 Plasticity Index: to ASTM D4318, Maximum 6.
 - .3 Los Angeles degradation: to ASTM C131. Max % Loss by mass: 40.

- .4 Particles smaller than 0.02 mm: to ASTM D422, Maximum 3%.

Part 3 Execution**3.1 PLACING**

- .1 Place granular sub-base after subgrade is inspected and approved by Consultant.
- .2 Construct granular sub-base to depth and grade in areas indicated.
- .3 Ensure no frozen material is placed.
- .4 Place material only on clean unfrozen surface, free from snow or ice.
- .5 Begin spreading sub-base material on crown line or high side of one-way slope.
- .6 Place granular sub-base materials using methods which do not lead to segregation or degradation.
- .7 For spreading and shaping material, use spreader boxes having adjustable templates or screeds which will place material in uniform layers of required thickness.
- .8 Place material to full width in uniform layers not exceeding 150 mm compacted thickness. Consultant may authorize thicker lifts (layers) if specified compaction can be achieved.
- .9 Shape each layer to smooth contour and compact to specified density before succeeding layer is placed.
- .10 Remove and replace portion of layer in which material has become segregated during spreading.

3.2 COMPACTION

- .1 Compaction equipment to be capable of obtaining required material densities.
- .2 Compact to density of not less than 98% standard maximum dry density in accordance with ASTM D698 00(a).
- .3 Shape and roll alternately to obtain smooth, even and uniformly compacted sub-base.
- .4 Apply water as necessary during compaction to obtain specified density.
- .5 In areas not accessible to rolling equipment, compact to specified density with mechanical tampers approved by Consultant.
- .3 Correct surface irregularities by loosening and adding or removing material until surface is within specified tolerance.

3.3 PROOF ROLLING

- .1 For proof rolling, use standard roller of 45,400 kg gross mass with four pneumatic tires each carrying 11,350 kg and inflated to 620 kPa. Four tires arranged abreast with centre to centre spacing of 730 mm maximum.
- .2 Obtain approval from Consultant to use non-standard proof rolling equipment.
- .3 Proof roll at level in sub-base as indicated. If non-standard proof rolling equipment is approved, Consultant to determine level of proof rolling.
- .4 Make sufficient passes with proof roller to subject every point on surface to three separate passes of loaded tire.
- .5 Where proof rolling reveals areas of defective subgrade:
 - .1 Remove sub-base and subgrade material to depth and extent as directed by Consultant.
 - .2 Backfill excavated subgrade with sub-base material and compact in accordance with this section.
 - .3 Replace sub-base material and compact.
- .6 Where proof rolling reveals areas of defective sub-base, remove and replace in accordance with this section at no extra cost.

3.4 SITE TOLERANCES

- .1 Finished sub-base surface to be within 10 mm of elevation as indicated but not uniformly high or low.

3.5 PROTECTION

- .1 Maintain finished sub-base in condition conforming to this section until succeeding base is constructed, or until granular sub-base is accepted by Consultant.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American Society for Testing and Materials (ASTM)
 - .1 ASTM C117-95, Standard Test Methods for Material Finer Than 0.075 mm Sieve in Mineral Aggregates by Washing.
 - .2 ASTM C131-96, Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
 - .3 ASTM C136-96a, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .4 ASTM 698 00(a).
 - .5 ASTM D4318-00, Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.

1.2 DELIVERY, STORAGE AND HANDLING

- .1 Deliver and stockpile aggregates in accordance with Section 31 05 17 – Aggregate Materials. Stockpile minimum 50% of total aggregate required prior to beginning operation.
- .2 Store cement in weather-tight bins or silos that provide protection from dampness and easy access for inspection and identification of each shipment.

Part 2 Products

2.1 MATERIALS

- .1 Granular base: material in accordance with Section 31 05 17 – Aggregate Materials and following requirements:
 - .1 Crushed stone or gravel.
 - .2 Gradations to be within limits specified when tested to ASTM C136 and ASTM C117. Sieve sizes to CAN/CGSB-8.2.
 - 1. Gradation to:

Sieve Designation	% Passing
25 mm	100
12.5 mm	65-100

Sieve Designation	% Passing
4.75 mm	35-60
2.00 mm	22-45
0.425 mm	10-25
0.075 mm	3-8

- .2 Liquid limit: to ASTM D4318, maximum 25.
- .3 Plasticity index: to ASTM D4318, maximum 6
- .4 Los Angeles degradation: to ASTM C131. Max % loss by weight: 45.
- .5 Crushed particles: at least 60% of particles by mass within each of the following sieve designation ranges to have at least 1 freshly fractured face. Material to be divided into ranges using methods of ASTM C136.

Passing		Retained on
25 mm	to	19.0 mm
19.0 mm	to	4.75 mm

Part 3 Execution

3.1 SEQUENCE OF OPERATION

- .1 Place granular base after sub-base surface is inspected and approved by Consultant.
- .2 Placing:
 - .1 Construct granular base to depth and grade in areas indicated.
 - .2 Ensure no frozen material is placed.
 - .3 Place material only on clean unfrozen surface, free from snow and ice.
 - .4 Begin spreading base material on crown line or on high side of one-way slope.
 - .5 Place material using methods which do not lead to segregation or degradation of aggregate.
 - .6 For spreading and shaping material, use spreader boxes having adjustable templates or screeds which will place material in uniform layers of required thickness.
 - .7 Place material to full width in uniform layers not exceeding 150 mm compacted thickness. Consultant may authorize thicker lifts (layers) if specified compaction can be achieved.
 - .8 Shape each layer to smooth contour and compact to specified density before succeeding layer is placed.
 - .9 Remove and replace that portion of layer in which material becomes segregated during spreading.
- .3 Compaction Equipment:
 - .1 Compaction equipment to be capable of obtaining required material densities.

- .4 Compacting:
 - .1 Compact to density not less than 100% standard maximum dry density ASTM D698-00(a)
 - .2 Shape and roll alternately to obtain smooth, even and uniformly compacted base.
 - .3 Apply water as necessary during compacting to obtain specified density.
 - .4 In areas not accessible to rolling equipment, compact to specified density with mechanical tampers approved by Consultant.
 - .5 Correct surface irregularities by loosening and adding or removing material until surface is within specified tolerance.

- .5 Proof Rolling
 - .1 For proof rolling use standard roller of 45,400 kg gross mass with four pneumatic tires each carrying 11,350 kg and inflated to 620 kPa. Four tires arranged abreast with centre to centre spacing of 730 mm.
 - .2 Obtain approval from Consultant to use non-standard proof rolling equipment.
 - .3 Proof roll at level in granular base as indicated. If use of non-standard proof rolling equipment is approved, Consultant to determine level of proof rolling.
 - .4 Make sufficient passes with proof roller to subject every point on surface to three separate passes of loaded tire.
 - .5 Where proof rolling reveals areas of defective subgrade:
 - .1 Remove base, sub-base and subgrade material to depth and extent as directed by Consultant.
 - .2 Backfill excavated subgrade with sub-base material and compact in accordance with Section 31 11 19 – Granular Sub-Base.
 - .3 Replace sub-base material and compact in accordance with Section 32 11 19 – Granular Sub-Base.
 - .4 Replace base material and compact in accordance with this Section.
 - .6 Where proof rolling reveals defective base or sub-base, remove defective materials to depth and extent as directed by Consultant and replace with new materials in accordance with Section 32 11 19 – Granular Sub-Base and this section at no extra cost.

3.2 SITE TOLERANCES

- .1 Finished base surface to be within plus or minus 10 mm of established grade and cross section but not uniformly high or low.

3.3 PROTECTION

- .1 Maintain finished base in condition conforming to this Section until succeeding material is applied or until acceptance by Consultant.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 03 30 00 – Cast-in-Place Concrete

1.2 REFERENCES

- .1 American Society for Testing and Materials (ASTM)
 - .1 ASTM D698-00(a), Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort 12,400ft-lbf/ft³
 - .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.2 98, Boiled Linseed Oil.
 - .2 CAN/CGSB-3.3 99, Kerosene.
 - .3 Canadian Standards Association (CSA)
 - .1 CAN/CSA-A23.1/A23.2- 94, Concrete Materials and Methods of Concrete Construction/Methods of Testing for Concrete.

Part 2 Products

2.1 MATERIALS

- .1 Concrete mixes and materials: to Section 03 30 00 - Cast-in-Place Concrete.
- .2 Joint Filler/Curing Compound: to Section 03 30 00 = Cast-in-Place Concrete.
- .3 Granular base: to Section 31 23 10 – Excavating, Trenching and Backfilling.
- .5 Non-staining mineral type form release agent: Chemically active release agents containing compounds that react with free lime to provide water soluble soap.

Part 3 Execution

3.1 GRANULAR SUB-BASE AND BASE

- .1 Place and compact granular base course.

3.2 CONCRETE SIDEWALK

- .1 The Contractor shall construct the proposed concrete sidewalk with block-outs for

unit pavers with a minimum 100 mm (4") depth of concrete as shown on the Drawings.

- .2 The concrete sidewalk shall be poured such that the block-outs and remaining sidewalk act as a monolithic section.
- .3 The concrete sidewalk adjacent to the building wall, curbs and planters are to be thickened to depths indicated on the drawings to ensure a minimum 150 mm (6") thickness below all unit paving. All costs in connection with this work are incidental to the price bid for this project.
- .4 All costs in connection with the additional forming and placement of concrete as a result of the "block-outs" and additional depths in areas as shown on the Drawing are incidental and shall be included in the price bid for this project. Compacted granular base course shall be included in price bid for this project.
- .5 Construction of all sidewalk ramps is incidental and shall be included in the price bid for this project.
- .6 Sidewalk to be poured adjacent to planter and buildings with approved bond breaker. Cost of bond breaker is incidental and shall be included in the price bid for this project.
- .7 All saw cutting required is incidental and shall be included in the price bid for this project. All sawcut joints shall be laid out as shown on the Drawings and as directed by the Consultant on site for review and approval prior to construction.

3.3 CONCRETE CURBS

- .1 Pinned curb to be constructed as per detail. All curbs to have rubbed finish.
- .2 Layout of all curbs to be reviewed and approved by Consultant prior to construction.

3.4 TOLERANCES

- .1 Finish surfaces to within 3mm in 3m as measured with 3m straight edge placed on surface.

3.5 EXPANSION AND CONTRACTION JOINTS

- .1 Install tooled transverse contraction joints after floating, when concrete is stiff, but still plastic, at intervals specified by the Consultant.
- .2 Sawcuts to be maximum 1.5 m apart, perpendicular to the path of travel. Contractor to provide sawcut line drawing prior to placement of concrete for review and

approval.

- .3 Install expansion joints as indicated, as directed by Consultant.
- .4 When sidewalk is adjacent to curb, make joints of curb, gutters and sidewalk coincide.
- .5 Joints are not to occur at utilities or sign posts.

3.6 ISOLATION JOINTS

- .1 Install isolation joints around manholes and catch basins and along length adjacent to concrete curbs, catch basins, buildings or permanent structure.
- .2 Install joint filler in isolation joints as indicated.
- .3 Seal isolation joints with sealant approved by Consultant.

3.7 CURING

- .1 Cure concrete by adding moisture continuously in accordance with CAN/CSA 23.1 to exposed finished surfaces for at least 1 day after placing, or sealing moisture in by curing compound approved by Consultant.
- .2 Where burlap is used for moist curing, place two prewetted layers on concrete surface and keep continuously wet during curing period.
- .3 Apply curing compound evenly to form continuous film in accordance with manufacturer's requirements.

3.8 BACKFILL

- .1 Allow concrete to cure for 7 days prior to backfilling.
- .2 Backfill to designated elevations with material approved by Consultant. Compact and shape to required contours as indicated or as directed by Consultant.

3.9 WEATHER CONDITIONS

- .1 The Contractor shall be responsible for taking all necessary measures to protect freshly laid concrete from adverse weather conditions, including hot weather, wind, rain, sleet, snow and cold weather, to the satisfaction of the Consultant.
- .2 Concrete shall be adequately protected from freezing for a minimum of five (5) days after completion of placing operations, or longer as required to ensure that the pavement opening requirements are met. A minimum requirement for protection

shall be provided as follows when the air temperature as forecast by Environment Canada is:

- .1 0° to 3°: concrete shall be covered with polyethylene file.
- .2 Below -3°C: tow (2) sheets of polyethylene film covering separated by 300mm (12") of dry straw.
- .3 Concrete damaged as a result of inadequate protection against weather conditions shall be removed and replaced by the Contractor at his own expense.

3.10 QUALITY CONTROL

- .1 All workmanship and all materials furnished and supplied under this specification are subject to close and systematic inspection and testing by the Consultant, including all operations from the selection and production of materials through to final acceptance of the specified work. The Contractor shall be wholly responsible for the control of all operations incidental thereto notwithstanding an inspection or approval that may have been previously given. The Consultant reserves the right to reject any materials or works which are not in accordance with the requirements of this specification.

END OF SECTION

Part 1 General**1.1 MEASUREMENT AND PAYMENT**

- .1 Measure supply and erection of chain link fence in metres erected including gates.
- .2 Measure supply and erection of chain link fence gates as units of each size erected.

1.2 REFERENCES

- .1 ASTM International
 - .1 ASTM A53/A53M-10, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
 - .2 ASTM A90/A90M-09, Standard Test Method for Weight Mass of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
 - .3 ASTM A121-07, Standard Specification for Zinc-Coated (Galvanized) Steel Barbed Wire.
 - .4 A653/A653M-10, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .5 ASTM C618-08a, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
 - .6 ASTM F1664-08, Standard Specification for Poly(Vinyl Chloride) (PVC)-Coated Steel Tension Wire Used with Chain-Link Fence.
 - .7 ASTM A123/A123M-09, Standard Specification for Zinc (Hot Dip Galvanized) coatings on Iron and Steel Products.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-138.1-96, Fabric for Chain Link Fence.
 - .2 CAN/CGSB-138.2-96, Steel Framework for Chain Link Fence.
 - .3 CAN/CGSB-138.3-96, Installation of Chain Link Fence.
 - .4 CAN/CGSB-138.4-96, Gates for Chain Link Fence.
 - .5 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.
- .3 CSA International
 - .1 CSA A23.1/A23.2-09, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.
 - .2 CAN/CSA-A3000-08, Cementitious Materials Compendium.
- .4 Master Painters Institute (MPI)
 - .1 Architectural Painting Specification Manual - current edition.
- .5 U.S. Environmental Protection Agency (EPA) / Office of Water
 - .1 EPA 832/R-92-005, Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices.

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 concrete mixes, fences, posts and gates 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.
- .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 accordance with manufacturer's recommendations.
 - .2 Store and protect fence and gate materials from damage.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 MATERIALS

- .1 **Chain-link fence fabric:** to CAN/CGSB-138.1 and as indicated;
 - a) 50 mm x 50 mm (2"x2") diamond pattern, galvanized fabric, minimum thickness wire of 3.69 mm, No. 9 gauge (.145"). Top and bottom selvage to be knuckled. Fabric shall have a minimum tensile strength of 415 Mpa.
 - b) Height of wire, as specified in the Contract Documents.
- .2 Concrete mixes and materials, when specified: CAN/CSA-A23.1.
 - a) Nominal coarse aggregate size: 20 mm max size, 5 mm min.
 - b) Compressive strength: 20 MPa minimum at 28 days.
 - c) Water/ cement ratio to CAN 3-A23.1-M77 Table 7 for Class A exposure 60 mm slump
 - d) Air entrainment: 5 to 7 %
 - e) Concrete piles to be minimum 300mm x 1500mm, when specified or deemed required.
- .3 Posts and rails: standard seamless, continuous weld, Schedule 40 hot dip galvanized steel pipe, lengths and diameters as per the following, for pushed, pounded or concrete pier installations;

Fence mesh height mm (ft)	Line post diameter mm (in)	End, gate, corner post diam, mm (in)	Pipe length mm (ft)
914 (3 feet)	60.3 (2 3/8")	73.0 (2 7/8")	2134 (7 feet)

1220 (4 feet)	60.3 (2 3/8")	73.0 (2 7/8")	2440 (8 feet)
1525 (5 feet)	60.3 (2 3/8")	73.0 (2 7/8")	2744 (9 feet)
1830 (6 feet)	73.0 (2 7/8")	88.9 (3 1/2")	3200 (10.5 feet)

Top rails shall be a minimum 43 mm outside diameter and 6700mm long for full lengths. Coupling locations to be within **.2 m (8")** of a line post cap location to prevent sagging of the top rail joint. Sleeve couplings to be minimum 171 mm in length. Couplings and receptacles to be 43 mm inside diameter. All posts to be provided with weatherproof caps.

- .4 Bottom tension wire: single strand, galvanized steel wire, No. 6 gauge, attached to bottom of fabric with hog rings. Provide one turnbuckle per single continuous run of wire.
- .5 Tie wire fasteners: single strand, No. 9 gauge aluminium alloy wire.
- .6 Tension bar: 5mm x 19 mm (1/4"x 3/4") minimum galvanized flat steel bars not less than 50mm shorter than the height of the fabric. Cut ends of the bars to be ground smooth and galvanized.
- .7 Tension and brace bands: 3mm x 19 mm (1/8"x 3/4") minimum, galvanized steel with 8 x 32 mm galvanized carriage bolts and nuts.
- .8 Gates: to CAN/CGSB-138.4. Space gate posts 1220 mm (4'0") clear width, unless specified otherwise, and to match the specified height of the adjacent fence.
- .9 Gate frames: to ASTM A53, galvanized steel pipe, standard weight 45 mm outside diameter pipe for outside frame, 35 mm outside diameter pipe for interior bracing.
 - a) Fabricate gates as indicated with electrically welded joints, and hot-dip galvanized after welding.
 - b) Furnish gates with galvanized malleable iron hinges, latch and latch catch with provision for padlock which can be attached and operated from either side of installed gate.
 - c) Furnish double gates with chain hook to hold gates open and centre rest with drop bolt for closed position.
- .10 Fittings and hardware: cast aluminium alloy, galvanized steel or malleable or ductile cast iron. Post caps/tops to provide waterproof fit, to fasten securely over posts and to carry top rail. Turnbuckles to be drop forged galvanized steel with sufficient adjustment to make the bottom tension wire taut.
- .11 Organic zinc rich coating: to CGSB 1-GP-181M.

2.2 Finishes

- .1 Galvanizing:
 - a) For chain link fabric: to CAN/CGSB-138.1 Grade 2.
 - b) For pipe: 550 g/m² minimum to ASTM A90.
 - c) For other fittings: to CSA G164.

Part 3 Execution**3.1 EXAMINATION**

- .1 Verification of Conditions: verify conditions of substrate previously installed under other Sections or Contracts are acceptable for fence and gate installation in accordance with manufacturer's written instructions.

3.2 PREPARATION

- .1 Temporary Erosion and Sedimentation Control:
 - .1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction sediment and erosion control drawings sediment and erosion control plan, specific to site, that complies with EPA 832/R-92-005 or requirements of authorities having jurisdiction, whichever is more stringent.
 - .2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
 - .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.
- .2 Grading:
 - .1 Remove debris and correct ground undulations along fence line to obtain smooth uniform gradient between posts.
 - .1 Provide clearance between bottom of fence and ground surface of 30 mm to 50 mm.

3.3 ERECTION OF FENCE

- .1 Erect fence along lines as indicated and to CAN/CGSB-138.3.
- .2 Excavate post holes to dimensions indicated.
- .3 Space line posts 3 m apart, measured parallel to ground surface.
- .4 Space straining posts at equal intervals not to exceed 150 m if distance between end or corner posts on straight continuous lengths of fence over reasonably smooth grade, is greater than 150 m.
- .5 Install additional straining posts at sharp changes in grade and where directed by Consultant.
- .6 Install corner post where change in alignment exceeds 10 degrees.

- .7 Install end posts at end of fence and at buildings.
 - .1 Install gate posts on both sides of gate openings.
- .8 Place concrete in post holes then embed posts into concrete to minimum mm depth.
 - .1 Extend concrete 50 mm above ground level and slope to drain away from posts.
 - .2 Brace to hold posts in plumb position and true to alignment and elevation until concrete has set.
- .9 Install fence fabric after concrete has cured, minimum of 5 days.
- .10 Install brace between end and gate posts and nearest line post, placed in centre of panel and parallel to ground surface.
 - .1 Install braces on both sides of corner and straining posts in similar manner.
- .11 Install overhang tops and caps.
- .12 Install top rail between posts and fasten securely to posts and secure waterproof caps and overhang tops.
- .13 Install bottom tension wire, stretch tightly and fasten securely to end, corner, gate and straining posts with turnbuckles and tension bar bands.
- .14 Lay out fence fabric. Stretch tightly to tension recommended by manufacturer and fasten to end, corner, gate and straining posts with tension bar secured to post with tension bar bands spaced at 300 mm intervals.
 - .1 Knuckled selvedge at bottom.
 - .2 Twisted selvedge at top.
- .15 Secure fabric to top rails, line posts and bottom tension wire with tie wires at 450 mm intervals.
 - .1 Give tie wires minimum two twists.
- .16 Install barbed wire strands and clip securely to lugs of each projection.
- .17 Install grounding rods as indicated.

3.4 INSTALLATION OF GATES

- .1 Install gates in locations as indicated.
- .2 Level ground between gate posts and set gate bottom approximately 40 mm above ground surface.
- .3 Determine position of centre gate rest for double gate.
 - .1 Cast gate rest in concrete as directed.
 - .2 Dome concrete above ground level to shed water.
- .4 Install gate stops where indicated.

3.5 TOUCH UP

- .1 Clean damaged surfaces with wire brush removing loose and cracked coatings. Apply two coats of organic zinc-rich paint to damaged areas as indicated.

- .1 Pre-treat damaged surfaces according to manufacturers' instructions for zinc-rich paint.

3.6 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

Part 1 General**1.1 SECTION INCLUDES:**

- .1 Materials and installation for water mains, hydrants, valves, valve boxes and valve chambers, including service connections.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 – Submittal Procedures
- .2 Section 01 78 00 – Closeout Submittals.
- .3 Section 31 23 10 – Excavating, Trenching and Backfilling.

1.3 REFERENCES

- .1 American National Standards Institute/American Water Works Association (ANSI/AWWA)
 - .1 ANSI/AWWA B300-99, Hypochlorites
 - .2 ANSI/AWWA B301-99, Liquid Chlorine
 - .3 ANSI/AWWA B303-00, Sodium Chlorite
 - .4 ANSI/AWWA C500-02, Metal-Seated Gate Valves for Water Supply Service (Includes Addendum C500a-95)
 - .5 ANSI/AWWA C651-99, Disinfecting Water Mains
 - .6 ANSI/AWWA C800-01, Underground Service Line Valves and Fittings (also included: Collected Standards for Service Line Materials).
 - .7 ANSI/AWWA C900-97, Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 inch through 12 inch (100 mm – 300 mm), for water distribution.
- .2 American Society for Testing and Materials (ASTM)
 - .1 ASTM A307-02, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile.
 - .2 ASTM B88M-99, Standard Specification for Seamless Copper Water Tube [metric].
 - .3 American Water Works Association (AWWA)/Manual of Practice
 - .1 AWWA M17-1989, Installation, Field Testing and Maintenance of Fire Hydrants.
- .4 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-M88, Sieves, Testing, Woven Wire, Metric.
- .5 Canadian Standards Association – Not Applicable
- .6 Department of Justice Canada (Jus)
 - .1 Canadian Environment Protection Act, 1999 (CEPA),
- .7 Transport Canada (TC)
 - .1 Transportation of Dangerous Goods Act, 1992 (TDGA).
- .8 The Master Painters Institute (MPI)

- .1 Architectural Painting Specification Manual – March 1998 (R2002).
- .9 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S520-1991, Hydrants
 - .2 CAN4-S543-1984, Internal Lug, Quick Connect Couplings for Fire Hose Submittals.
- .10 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures.
- .11 Submit complete shop drawings and construction schedule for water mains 600 mm diameter and larger. Include method for installation of water main.
- .12 Submit samples in accordance with Section 01 33 00 – Submittal Procedures.
- .13 Inform Consultant of proposed source of bedding materials and provide access for sampling at least 4 weeks prior to commencing Work.
- .14 Submit to Consultant for testing at least 4 weeks prior to beginning work, samples of materials proposed for use, as follows:
 - .1 Water Main and valves
 - .2 Hydrants and fittings
- .15 Submit manufacturer's test data and certification that pipe materials meet requirements of this section at least 4 weeks prior to beginning work. Include manufacturer's drawings, information and shop drawings where pertinent.
- .16 Pipe certification to be on pipe.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide data to produce record drawings, including directions for operating valves, list of equipment required to operate valves, details of pipe material, location of air and vacuum release valves, hydrant details, maintenance and operating instructions in accordance with Section 01 78 00 – Closeout Submittals.
 - .1 Include top of pipe, horizontal location of fittings and type, valves, valve boxes, valve chambers and hydrants.

1.5 SCHEDULING OF WORK

- .1 Schedule work to minimize interruptions to existing services.
- .2 Submit schedule of expected interruptions to Consultant for approval and adhere to interruption schedule as approved by Consultant.
- .3 Notify Consultant a minimum of 24 hours in advance of interruption in service.
- .4 Do not interrupt water service for more than 3 hours and confine this period between 10:00 and 16:00 hours local time unless otherwise authorized.

- .5 Notify fire department of any planned or accidental interruption of water supply to hydrants.
- .6 Provide "Out of Service" sign on hydrant not in use.
- .7 Advise local police department of anticipated interference with movement of traffic.

1.6 EXTRA MATERIALS

- .1 Provide Consultant with the following tools (one of each):
 - .1 Service post wrenches for curb stops.
 - .2 Hydrant wrenches.
 - .3 Tee-handle operating keys for valves.

Part 2 Products**2.1 PIPE, JOINTS AND FITTINGS**

- .1 Fittings:
 - .1 PVC fittings to AWWAC907.
- .2 Polyvinyl chloride pressure pipe to ANSI/AWWA C900, pressure class 150, DR 18, 1 MPa gasket bell end, cast iron outside diameter.
 - .1 Acceptable material: DR 18, CCASI 150.
 - .2 CSA-B137.3, PVC series 160, 1.1 MPa elastomeric gasket / coupling.
 - .3 Acceptable material: PVC.
 - .4 Composite epoxy impregnated fibreglass, PVC pipe to ASTM D2996, class H. Unplasticized PVC core over wrapped with bonded fibreglass reinforced epoxy resin. Pressure class 300, 2.4 MPa with cast iron outside diameter and integral bell gasketed joints to ANSI/ASTM D2992. Material to ASTM D2310, classification RTRP-11 HZ-5001-PVC-13323.
 - .5 Pipe and hydrants to conform with City of Winnipeg specifications.

2.2 PIPE PROTECTION

- .1 Provide means of protection for iron pipe in corrosive soils in accordance with local practices and authorities having jurisdiction to ANSI/AWWA C105/A21.5.

2.3 VALVES AND VALVE BOXES

- .1 Valves to open counter clockwise – conform with local standard.
- .2 Gate valves to ANSI/AWWA C509, standard iron body, bronze mounted double disc valves with non-rising stems suitable for 1 Kpa service with push on joints to match pipe.
- .3 Cast iron valve boxes in accordance with drawings.
 - .1 Base to be large round type with minimum diameter of 300 mm.
 - .2 Top of box to be marked "WATER"/"EAU".

2.4 SERVICE CONNECTIONS

- .1 Copper tubing to ASTM B88M type K, annealed.
- .2 Copper tubing joints: compression type suitable for 1 MPa working pressure.
- .3 Brass corporation stops: red brass.
- .4 Brass inverted key-type curb stops; red brass to ASTM B62, compression type with drains.
 - .1 Curb stops to have adjustable bituminous coated cast iron service box with stem to suit depth of bury.
 - .2 Top of cast iron box marked "WATER"/"EAU".
- .5 Service connections for PVC pipe:
 - .1 Service connections less than 100 mm: Corporation stop, tapped to main using AWWA threads, complete with stainless service saddle. Service saddle to consist of circumferential band type complete with side bars and fingers, keeper bar, stud bolts, nuts, washers and gaskets.
 - .2 Service connections 100 mm and over: Use tee fitting or tapping valve and sleeve.
- .6 Bronze type service clamps for PVC pipe service connections.
 - .1 Service clamps to be of strap-type, with confined "O" ring seal cemented in place.
 - .2 Clamps to be tapped with threads to ANSI/AWWA C800.
- .7 Tee connections for services above NPS 1. Tee connections to be fabricated of same material and to same standards as specified pipe fittings and to have ends matching pipe to which they are joined.
- .8 Double strap service clamps, for taps NPS 1 ½ and larger in asbestos-cement pipe, with galvanized malleable iron bodies, with neoprene gasket cemented to body, and cadmium plated or stainless steel mounting hardware.

2.5 HYDRANTS

- .1 Hydrants: compression type hydrant, designed for working pressure of 1035 kPa with two 65 mm threaded hose outlets, one 100 mm threaded pumper connection, 125 mm bottom valve and 150 mm connection for main.
 - .1 Hydrants to open to local standard, threads to local standard, fittings to be internal lug quick-connect to CAN4-S543. Provide metal caps and chains.
 - .2 Provide key operated gate valve located 1 m from hydrant.
 - .3 Depth of bury to 3.00m.
- .2 Hydrant paint: exterior enamel to CAN./CGSB-1.88 MPI #96, to local standard.

2.6 PIPE BEDDING AND SURROUND MATERIAL

- .1 Granular material to CBSCS and the following requirements:
 - .1 Crushed or screened stone, gravel or sand.
 - .2 Gradations to be within limits specified when tested to ASTM C136 / ASTM C117. Sieve sizes to CAN/CGSB-8..
 - .3 Table:

Sieve Designation	% Passing Stone/Gravel	Gravel/Sand
200 mm	-	-
75 mm	-	-
50 mm	-	-
38.1 mm	-	-
25 mm	100	-
19 mm	-	-
12.5 mm	65-90	100
9.5 mm	-	-
4.75 mm	35-55	80-100
2.00 mm	-	50-90
0.425 mm	10-25	10-50
0.180 mm	-	-
0.075 mm	0-8	0-10

- .2 Concrete mixes and materials required for bedding cradles, encasements, supports, thrust blocks: to Section 03 30 00 – Cast-in-Place Concrete.

2.7 BACKFILL MATERIAL

- .1 Type 3, in accordance with Section 31 23 10 – Excavating, Trenching and Backfilling.

2.8 PIPE DISINFECTION

- .1 Sodium hypochloride to ANSI/AWWA B300 and ANSI/AWWA B301 to disinfect water mains.
- .2 Undertake disinfection of water mains in accordance with ANSI/AWWA C651.

Part 3 EXECUTION

3.1 PREPARATION

- .1 Clean pipes, fittings, valves, hydrants and appurtenances of accumulated debris and water before installation.
 - .1 Inspect materials for defects to approval of Consultant.
 - .2 Remove defective materials from site as directed by Consultant.

3.2 TRENCHING

- .1 Do trenching work in accordance with Section 31 23 10 – Excavating, Trenching and Backfilling.
- .2 Trench depth to provide cover over pipe of not less than 3.0 m from finished grade or as indicated in the drawings.
- .3 Trench alignment and depth require Consultant's approval prior to placing bedding material and pipe.

3.3 GRANULAR BEDDING

- .1 Place granular bedding material in uniform layers not exceeding 150 mm compacted thickness.
- .2 Do not place material in frozen condition.
- .3 Shape bed true to grade to provide continuous uniform bearing surface for pipe.
- .4 Shape transverse depressions in bedding as required to suit joints.
- .5 Compact each layer full width of bed to at least 95% of standard maximum dry density to ASTM D698-00a.
- .6 Fill authorized or unauthorized excavation below design elevation of bottom of specified bedding in accordance with Section 31 23 10 – Excavating, Trenching and Backfilling, with compacted bedding material.

3.4 PIPE INSTALLATION

- .1 Terminate building water service 1 m outside building wall opposite point of connection to main. Install coupling necessary for connection to building plumbing. If plumbing is already installed, make connection; otherwise cap or seal end of pipe and place temporary marker to locate pipe end.
- .2 Lay pipes to manufacturer's standard instructions and specifications. Do not use blocks except as specified.
- .3 Join pipes in accordance with manufacturer's recommendations.
- .4 Bevel or taper ends of PVC pipe to match fittings.
- .5 Handle pipe by methods approved by Consultant and recommended by pipe manufacturer. Do not use chains or cables passed through pipe bore so that weight of pipe bears on pipe ends.
- .6 Lay pipes on prepared bed, true to line and grade.
 - .1 Ensure barrel of each pipe is in contact with shaped bed throughout its full length.
 - .2 Take up and replace defective pipe.
 - .3 Correct pipe which is not in true alignment or grade or pipe which shows differential settlement after installation greater than 10 mm in 3 m.

- .7 Face socket ends of pipe in direction of laying. From mains on a grade of 2% or greater, face socket ends up-grade.
- .8 Do not exceed permissible deflection at joints as recommended by pipe manufacturer.
- .9 Keep jointing materials and installed pipe free of dirt and water and other foreign materials.
 - .1 Whenever work is stopped, install a removable watertight bulkhead at open end of last pipe laid to prevent entry of foreign materials.
- .10 Position and join pipes with equipment and methods approved by Consultant.
- .11 Cut pipes in approved manner as recommended by pipe manufacturer, without damaging pipe or its coating and to leave smooth end at right angles to axis of pipe.
- .12 Align pipes before jointing.
- .13 Install gaskets to manufacturer's recommendations. Support pipes with hand slings or crane as required to minimize lateral pressure on gasket and maintain concentricity until gasket is properly positioned.
- .14 Avoid displacing gasket or contaminating with dirt or other foreign material.
 - .1 Remove disturbed or contaminated gaskets.
 - .2 Clean, lubricate and replace before jointing is attempted again.
- .15 Complete each joint before laying next length of pipe.
- .16 Minimize deflection after joint has been made.
- .17 Apply sufficient pressure in making joints to ensure that joint is completed to manufacturer's recommendations.
- .18 Ensure completed joints are restrained by compacting bedding material alongside and over installed pipes or as otherwise approved by Consultant.
- .19 When stoppage of work occurs, block pipes in an approved manner to prevent creep during down time.
- .20 Recheck plastic pipe joints assembled above ground after placing in trench to ensure that no movement of joint has taken place.
- .21 Do not lay pipe on frozen bedding.
- .22 Do hydrostatic and leakage test and have results approved by Consultant before surrounding and covering joints and fittings with granular material.
- .23 Backfill remainder of trench.

3.5 VALVE INSTALLATION

- .1 Install valves to manufacturer's recommendations at locations as indicated.
- .2 Support valves located in valve boxes or valve chambers in accordance with drawings. Valves not to be supported by pipe.

3.6 SERVICE CONNECTIONS

- .1 Terminate building water service 1 m outside building wall opposite point of connection to main.
 - .1 Install coupling necessary for connection to building plumbing.
 - .2 If plumbing is already installed, make connection, otherwise cap or seal end of pipe and place temporary marker to locate pipe end.
- .2 Do not install service connections until satisfactory completion of hydrostatic and leakage tests of water main.
- .3 Construct service connections at right angles to water main unless otherwise directed. Locate curb stops 300 mm inside right-of-way.
- .4 Tappings on asbestos cement may be threaded without service clamps.
 - .1 Double strap service connections with galvanized malleable iron body and neoprene gasket cemented in place may be used.
 - .2 Tappings for asbestos cement or PVC-C900 pipe to conform to the following:

Pipe Diameter (mm)	Maximum Tap Without Clamp (mm)	Maximum Tap With Clamp (mm)
100	20	25
150	20	40
200	25	50
250	25	50
300	40	75

- .5 Maximum direct tappings (mm) for ductile iron pipe to conform to:

Nominal Pipe Size (mm)	Pressure Class/Max.				
	150	200	250	300	350
75	-	-	-	-	19
102	-	-	-	-	19
152	-	-	-	-	25
203	-	-	-	-	25
254	-	-	-	-	25
305	-	-	-	-	32
356	-	-	32	38	38
406	-	-	38	50	50
457	-	-	50	50	50

Nominal Pipe Size (mm)	Pressure Class/Max.				
	150	200	250	300	350
508	-	-	50	50	50
610	-	50	50	50	50
762	50	50	50	50	50

- .6 Tappings on PVC pipe to be either PVC valve tees or bronze type service clamps, strap type with "O" ring seal cemented in place.
- .7 Employ only competent workmen equipped with suitable tools to carry out tapping of mains, cutting and flaring of pipes.
- .8 Install single and multiple tap service connections on top half of main, between 45 degrees and 90 degrees measured from apex of pipe.
- .9 Install multiple corporation stops, 30 degrees apart around circumference of pipe and minimum of 300 mm apart along pipe.
- .10 Tap main at 2:00 or 10:00 position only, not closer to joint nor closer to adjacent service connections than recommended by manufacturer, or 1 m, whichever is greater.
- .11 Leave corporation stop valves fully open.
- .12 In order to relieve strain on connections, install service pipe in "Goose Nick" form "laid over" into horizontal position.
- .13 Install rigid stainless steel liners in small diameter plastic pipes with compression fittings.
- .14 Install curb stop with corporation box on services NPS 2 or less in diameter.
 - .1 Equip larger services with gate valve and cast iron box. Set box plumb over stop and adjust top flush with final grade elevation.
 - .2 Leave curb stop valves fully closed.
- .15 Place temporary location marker at ends of plugged or capped unconnected water lines.
 - .1 Each marker to consist of 38 X 89 mm stake extending from pipe end at pipe level to 60 mm above grade.
 - .2 Paint exposed portion of stake red with designation "WATER SERVICE LINE" in black.

3.7 HYDRANTS

- .1 Install hydrants at locations as indicated.
- .2 Install hydrants in accordance with drawings.
- .3 Install 150 mm gate valve and cast iron valve box on hydrant service leads as indicated by drawings.
- .4 Set hydrants plumb, with hose outlets parallel with edge of pavement or curb line, with pumper

connection facing roadway and with body flange set at elevation of 50 mm above final grade.

- .5 Place concrete thrust blocks as indicated and specified, ensuring that drain holes are unobstructed.
- .6 Drain holes to be plugged as shown on the drawings.
- .7 Place appropriate sign on installed hydrants indicating whether or not they are in service during construction.

3.8 THRUST BLOCKS AND RESTRAINED JOINTS

- .1 For thrust blocks: do concrete work in accordance with the drawings.
- .2 Place concrete thrust blocks between valves, tees, plugs, caps, bends, changes in pipe diameter, reducers, hydrants and fittings and undisturbed ground as indicated or as directed by Consultant.
- .3 Keep joints and couplings free of concrete.
- .4 Do not backfill over concrete within 24 hours after placing.
- .5 For restrained joints: only use restrained joints approved by Consultant.

3.9 HYDROSTATIC AND LEAKAGE TESTING

- .1 Do tests in accordance with ANSI/AWWA C600 C603.
- .2 Provide labour, equipment and materials required to perform hydrostatic and leakage tests hereinafter described.
- .3 Notify Consultant at least 24 hours in advance of proposed tests.
 - .1 Perform tests in presence of Consultant.
- .4 Where section of system is provided with concrete thrust blocks, conduct tests at least 5 days after placing concrete or 2 days if high early strength concrete is used.
- .5 Test pipeline in sections not exceeding 365 m in length, unless otherwise authorized by Consultant.
- .6 Upon completion of pipe laying and after Consultant has inspected work in place, surround and cover pipes between joints with approved granular material placed to dimensions indicated, as directed by Consultant.
- .7 Leave hydrants, valves, joints and fittings exposed.
- .8 When testing is done during freezing weather, protect hydrants, valves, joints and fittings from freezing.
- .9 Strut and brace caps, bends, tees and valves, to prevent movement when test pressure is applied.
- .10 Open valves.

- .11 Expel air from main by slowly filling main with potable water.
 - .1 Install corporation stops at high points in main where no air-vacuum release valves are installed.
 - .2 Remove stops after satisfactory completion of test and seal holes with plugs.
- .12 Fill asbestos cement pipe and concrete pipe at least 24 hours before testing to allow water absorption by pipe material.
- .13 Thoroughly examine exposed parts and correct for leakage as necessary.
- .14 Apply hydrostatic test pressure in accordance with elevation of lowest point in main and corrected to elevation of test gauge, for a period of 1 hour.
- .15 Examine exposed pipe, joints, fittings and appurtenances while system is under pressure.
- .16 Remove joints, fittings and appurtenances found defective and replace with new sound material and make watertight.
- .17 Repeat hydrostatic test until defects have been corrected.
- .18 Apply leakage test pressure in accordance with AWWA-C600, C603 after complete backfilling of trench, based on elevation of lowest point in main and corrected to elevation of gauge, for period of 2 hours.
- .19 Define leakage as amount of water supplied from water meter in order to maintain test pressure for 2 hours.
- .20 Do not exceed allowable leakage as specified by AWWA C600, C603, including lateral connections.
- .21 Locate and repair defects if leakage is greater than amount specified.
- .22 Repeat test until leakage is within specified allowance for full length of water main.

3.10 PIPE SURROUND

- .1 Upon completion of pipe laying and after Consultant has inspected work in place, surround and cover pipes as indicated.
- .2 Hand place surround material in uniform layers not exceeding 150 mm compacted thickness as indicated.
 - .1 Do not dump material within 60 m of pipe.
- .3 Place layers uniformly and simultaneously on each side of pipe.
- .4 Do not place material in frozen condition.
- .5 Compact each layer from pipe invert to mid-height of pipe in conformance with CBSCS.

- .6 Compact each layer from mid-height of pipe to underside of backfill in accordance with CBSCS.

3.11 BACKFILL

- .1 Place backfill material, above pipe surround, in uniform layers not exceeding 150 mm compacted thickness up to grades as indicated.
- .2 Do not place backfill in frozen condition.
- .3 Under paving and walks, compact backfill to at least 95% corrected maximum dry density.
 - .1 In other areas, compact to at least 90% corrected maximum dry density.

3.12 HYDRANT FLOW TESTS

- .1 Conduct flow tests on every hydrant to determine fire flows prior to painting hydrant caps and ports.

3.13 PAINTING OF HYDRANTS

- .1 After installation, paint hydrants in accordance with local standard.
- .2 After hydrant flow tests, paint caps and ports to meet colour selections approved by authority having jurisdiction.

3.14 FLUSHING AND DISINFECTING

- .1 Flushing and disinfecting operations: witnessed by Consultant.
 - .1 Notify Consultant at least 4 days in advance of proposed date when disinfecting operations will begin.
- .2 Flush water mains through available outlets with a sufficient flow of potable water to produce velocity of 1.5 m/s, within pipe for minimum of 10 minutes, or until foreign materials have been removed and flushed water is clear.

- .3 Flushing flows as follows:

Pipe Size NPS	Flow (L/s) Minimum
6 and below	38
8	75
10	115
12	150

- .4 Provide connections and pumps for flushing as required.
- .5 Open and close valves, hydrants and service connections to ensure thorough flushing.
- .6 When flushing has been completed to Consultant approval, introduce strong solution of chlorine as approved by Consultant in to water main and ensure that it is distributed throughout

entire system.

- .7 Disinfect water mains. Specialist contractor to perform disinfection with local authority standard.
- .8 Rate of chlorine application to be proportional to rate of water entering pipe.
- .9 Chlorine application to be close to point of filling water main and to occur at same time.
- .10 Operate valves, hydrants and appurtenances while main contains chlorine solution.
- .11 Flush line to remove chlorine solution after 24 hours.
- .12 Measure chlorine residuals at extreme end of pipe line being tested.
- .13 Perform bacteriological tests on water main, after chlorine solution has been flushed out.
 - .1 Take samples daily for minimum of two days.
 - .2 Should contamination remain or recur during this period, repeat disinfecting procedure.
 - .3 Specialist contractor to submit certified copy of test results.
- .14 Take water samples at hydrants and service connections, in suitable sequence, to test for chlorine residual.
- .15 After adequate chlorine residual not less than 50 ppm has been obtained, leave system charged with chlorine solution for 24 hours.
 - .1 After 24 hours, take further samples to ensure that there is still not less than 10 ppm of chlorine residual remaining throughout system.

3.15 SURFACE RESTORATION

- .1 After installing and backfilling over water mains, restore surface to original condition as directed by Consultant.

END OF SECTION

1 General

1.1 REFERENCES

- .1 ASTM D3034-88, Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and fittings.
- .2 CSA B181.12-1967, Recommended Practice for the Installation of PVC Drain, Waste and Vent Pipe Fittings.

1.2 MATERIAL CERTIFICATION

- .1 At least 2 weeks prior to commencing work submit manufacturer's test data and certification that pipe materials meet requirements of this section.
- .2 At least two weeks prior to commencing work provide sample of bedding materials to be used.

2 Products

2.1 SEWER MAINS - PIPE

- .1 Pipe and Fittings: Meet or exceed all the requirements of ASTM Specification D3034 and CSA Standards B182.1 and B182.2, BNQ 3624-130. DR35 minimum.
- .2 Standard lengths: 4 or 6 metres nominal.
- .3 Pipe: Manufactured from clean, virgin approved class 12454-B compound conforming to ASTM D1784.

2.2 SERVICE CONNECTION

- .1 PVC pipe: to CAN / CSA B182.1, with push-on joints.
- .2 Fittings and accessories manufactured and furnished by the pipe supplier and have bell and/or spigot configurations similar to that of the pipe.
- .3 Service connections to sewer mains: Use a prefabricated PVC tee service saddle and stainless steel clamps.

2.3 PIPE BEDDING AND SURROUND MATERIAL

- .1 Use bedding sand as specified - Excavating, Trenching, and Backfilling

2.4 BACKFILL MATERIAL

- .1 Type 3 in accordance with - Excavating, Trenching, and Backfilling.

3 Execution

3.1 PREPARATION

- .1 Pipes and fittings to be clean and dry before installation.

- .2 Remove defective material from site.
- .3 Prior to installation, obtain Consultant's approval of pipes and fittings.

3.2 TRENCHING

- .1 Do trenching work in accordance with - Excavating, Trenching and Backfilling.
- .2 Complete units as pipe laying progresses.
- .3 Trench alignment and depth require approval of Consultant prior to placing bedding material and pipe.

3.3 BEDDING

- .1 Place bedding materials in accordance with - Excavating, Trenching and Backfilling

3.4 INSTALLATION

- .1 Lay and join pipes in accordance with manufacturer's recommendations.
- .2 Handle pipe using methods approved by Consultant. Do not use chains or cables passed through rigid pipe bore so that weight of pipe bears upon pipe ends.
- .3 Lay pipes on prepared bed, true to line and grade, with pipe invert smooth and free of sags or high points. Ensure barrel of each pipe is in contact with shaped bed throughout its full length.
- .4 Commence laying at outlet and proceed in upstream direction with socket ends of pipe facing upgrade.
- .5 Do not exceed maximum joint deflection recommended by pipe manufacturer.
- .6 Do not allow water to flow through pipe during construction, except as may be permitted by Consultant.
- .7 Whenever work is suspended, install removable watertight bulkhead at open end of last pipe laid to prevent entry of foreign materials.
- .8 Position and join pipes by methods recommended by manufacturer.
- .9 Install PVC pipe and fittings in accordance with CSA B181.12.
- .10 Pipe jointing:
 - .1 Install gaskets in accordance with manufacturer's recommendations.
 - .2 Support pipes with hand slings or crane as required to minimize lateral pressure on gasket and maintain concentricity until gasket is properly positioned.
 - .3 Align pipes carefully before joining.
 - .4 Maintain pipe joints free from mud, silt, gravel and other foreign material.

- .5 Avoid displacing gasket or gasket contaminating with dirt or other foreign material. Gaskets so disturbed shall be removed, cleaned and lubricated and replaced before joining is attempted.
- .6 Complete each joint before laying next length of pipe.
- .7 Minimize joint deflection after joint has been made to avoid joint damage.
- .8 At rigid structures, install pipe joints not more than 1.2m from side of structure.
- .9 Apply sufficient pressure in making joints to ensure that joint is complete as outlined in manufacturer's recommendations.
- .11 When any stoppage of work occurs, block pipes to prevent creep during down time.
- .12 Cut pipes as required for special inserts, fittings or closure pieces in a neat manner, as recommend by pipe manufacturer, without damaging pipe or its coating and to leave smooth end at right angles to axis of pipe.
- .13 Make watertight connections to manholes. Use shrinkage compensating grout when suitable gaskets are not available.

3.6

BACKFILL

- .1 Place backfill material in accordance with - Excavating, Trenching and Backfilling.
- .2 For HDPE pipe complete the following backfilling procedures in addition to .1 above:
 - .1 Complete pipe haunching in successive lifts of 150 mm to the spring line of the pipe. Compact to 95% Standard Proctor Density.
 - .2 Initial Backfill from the springline to 300 mm above the crown of pipe to be the same material as the initial haunching and compacted to 95 % Standard Proctor Density.

3.7

LINE AND GRADE

- .1 Install sewer pipe to the line and grade shown on the drawings and as set in the field by the Consultant.
- .2 Ensure vertical variance from grade does not exceed the following limits: invert 50 mm below the design grade nor more than 25 mm above the design grade and there shall be no dips which will allow ponding of water to a depth of more than 50 mm.
- .3 Horizontal variance from line shall not exceed 100 mm.
- .4 Sharp bends will not be permitted even though the sewer pipe remains within these tolerances.

- .1 For piping following a radius in the road allowance use 4 m pipe lengths and ensure deflection does not exceed 4%.

3.8 TELEVISION INSPECTION

- .1 Complete television inspection by personnel skilled and qualified in the use of television inspection equipment.
- .2 The lighting and equipment used shall be specifically designed for use in sewer mains and shall provide a clear picture of the entire periphery of the pipe.
- .3 The speed shall not exceed 9 m per minute.
- .4 The camera, TV monitor and other components of the system shall be capable of producing picture quality satisfactory to the Consultant.
- .5 Picture shall clearly state the position of the camera and related background data.
- .6 Results of the inspection shall be logged by the Contractor and bound as a report.
- .7 Report shall clearly show all points of significance such as locations of building sewer connections, unusual conditions. Provide minimum 3 copies.
- .8 Take pictures of problem areas and general conditions, minimum of 1 picture between manholes.
- .9 Provide 1 copy of the video recording of the waste water sewer on VHS and DVD.
- .10 All televising and videotape equipment shall be of a type approved by Consultant.
- .11 Inspection shall be between manholes or other appropriate locations where the equipment may be installed or removed.
- .12 Rectify any deformation, misalignment, etc. which are deemed unsuitable by the Consultant upon review of the tape.
- .13 Flush and clean sewer before the television inspection is done utilizing high-velocity sewer cleaning equipment capable of removing all dirt, sand, rocks, grease and other solid and semisolid material. All dirt, sand, rocks, grease and other solid and semisolid material shall be removed at the downstream manhole of the section being cleaned. Passing material from manhole section to manhole section will not be permitted.
- .14 Cleaning of the new mains and the lift station is incidental to television inspection.

3.9 MANDREL TESTING

- .1 Complete a mandrel test after installation works are complete.

- .2 The minimum contact length of the mandrel shall be 250 mm. The mandrel shall be cylindrical in shape, constructed of 9 evenly spaced arms.
- .3 Provide and check the mandrel with a go-no-go proving ring sized. The proving ring shall have a diameter equal to the computed deflected diameter \pm 0.1 mm. An acceptable ring shall be fabricated from 6 mm thick steel.
- .4 Mandrel and proving ring dimensions for DR 35 flexible sewer pipe are shown in the following table:

Nominal Pipe Size (mm)	Mandrel Arm Radius (mm)	Mandrel Contact Length (mm)	Proving Ring Inside Diameter (mm)
200	92.74	150	185.48
250	115.70	200	231.40

- .5 Mandrel and proving ring dimensions for Polyethylene Land Drainage pipe are shown in the following table:

Nominal Pipe Size (mm)	Mandrel Diameter (mm)
300	269.0
375	336.4
450	403.5
525	470.7
600	538.0

Pipe larger than 600 mm diameter is to be televised but not mandrel tested.

- .6 If the mandrel does not readily pass through the sewer, repair or replace the defective sewer and repeat the test.
- .7 Mandrel testing is incidental to television inspection.

END OF SECTION

1.1 SECTION INCLUDES

- .1 Materials and installation for pipe culverts.

1.2 RELATED SECTIONS

- .1 Section 31 23 10 – Excavating, Trenching and Backfilling.
- .2 Section 03 30 00 – Cast-in-Place Concrete.

1.3 REFERENCES

- .1 American Society for Testing and Materials International (ASTM).
 - .1 ASTM C14M-99, Standard Specification for Concrete Sewer, Storm Drain and Culvert Pipe (Metric).
 - .2 ASTM C76M-02, Standard Specification for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe (Metric).
 - .3 ASTM C117-95, Standard Test Method for Material Finer Than 0.075 mm (No. 200) Sieve in Mineral Aggregates by Washing
 - .4 ASTM C136-01. Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .5 ASTM C144-02, Standard Specification for Aggregate for Masonry Mortar.
 - .6 ASTM C443M-02. Standard Specification for Joints for Concrete Pipe and Manholes, Using Robber Gaskets (Metric).
 - .7 ASTM D698-00a, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort 12,400 ftlb/ft³ .
 - .8 ASTM D1248-02. Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
 - . ASTM F667-97, Standard Specification for Large Diameter Corrugated Polyethylene Pipe and Fittings.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-8.1 88, Sieves, Testing, Woven Wire, Inch Series.
 - .2 CANCGSB-8.2 M88, Sieves, Testing, Woven Wire, Metric.
- .3 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-A3000-98(April 2001), Cementitious Materials Compendium (Consists of A5-98, A8-98, A23.5-98, A362-98, A363-98, A456.1-98, A456.2-98, A456.3-98).
 - .1 CAN/CSA-A5-98, Portland Cement.
 - .2 CAN/CSA-A257 Series-M92(R1998), Standards for Concrete Pipe.
 - .3 CSA-G401-01, Corrugated Steel Pipe Products.

1.4 SUBMITTALS

- .1 Inform Consultant at least 4 weeks prior to beginning Work, of proposed source of bedding materials and provide access for sampling.
- .2 Submit to Consultant for testing, at least 4 weeks prior to beginning Work, samples of materials proposed for use.
- .3 Submit manufacturer's test data and certification at least 4 weeks prior to beginning Work,
- .4 Certification to be marked on pipe.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver and store materials in a safe place.

1.6 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal materials from landfill to metal recycling facility as approved by Consultant.
- .5 Divert unused concrete materials from landfill to local facility as approved by Consultant.
- .6 Divert unused aggregate materials from landfill to facility as approved by Consultant.
- .7 Fold up metal banding, flatten and place in designated area for recycling.

Part 2 Products

2.1 CORRUGATED STEEL PIPE

- .1 Corrugated steel pipe to CSA-G401.
- .2 Water- tight cut-off collars as indicated.

2.2 CONCRETE PIPE

- .1 Non-reinforced concrete pipe to CAN/CSA-A257, dia, Class as indicated.
- .2 Reinforced concrete pipe to CAN/CSA-A257 dia,, strength classification as indicated.
- .3 Rubber gaskets for joints to CAN/CSA-A257dia, strength classification as indicated.
- .4 Cement mortar joint filler:
 - .1 Portland cement to CAN/CSA A% type 10.
 - .2 Sand to ASTM C144.
 - .3 Mortar: one part by volume of cement to two parts of clean, sharp sand mixed dry. Add sufficient water after mixing to give optimum consistency for hand application.

2.3 CORRUGATED POLYETHYLENE PIPE AND FITTINGS

- .1 To ASTM F667.
- .2 Weathering resistance to ASTM D1248, Class C.

2.4 GRANULAR BEDDING

- .1 Granular bedding and backfill material to the following requirements:
 - .1 Crushed pit run or screened stone, gravel or sand.
 - .2 Gradations to be within limits specified when tested to ASTM C136 and ASTM C117. Sieve sizes to CAN/CGSB-82.

- .2 Table

Sieve Designation	% Passing
200 mm	-
75 mm	100
50 mm	-
38.1 mm	-
25 mm	-
19 mm	-
12.5 mm	-
9.5 mm	-
4.75 mm	25-85
2.00 mm	-
0.425 mm	5-30
0.180 mm	-
0.075 mm	0-10

- .3 Concrete mixes and materials for bedding, cradles, encasements, supports to Section 03 30 00 – Cast-in-Place Concrete.

Part 3 Execution

3.1 TRENCHING

- .1 Do trenching work in accordance with Section 31 23 10 – Excavating, Trenching and Backfilling.
- .2 Obtain Consultant's approval of trench line and depth prior to placing bedding material or pipe.

3.2 BEDDING

- .1 Dewater excavation, as necessary, to allow placement of culvert bedding in dry condition.
- .2 Place minimum thickness of 200 mm of approved granular material on bottom of excavation and compact to minimum 95% of corrected maximum dry density, maximum density to ASTM D698.
- .3 Shape bedding to fit lower segment of pipe exterior so that width of at least 50% of pipe diameter is in close contact with bedding and camber as indicated or as directed by Consultant.
- .4 Place bedding in unfrozen condition.

3.3 LAYING CORRUGATED STEEL PIPE CULVERTS

- .1 Begin pipe placing at downstream end.
- .2 Ensure bottom of pipe is in contact with shaped bed or compacted fill throughout its length.
- .3 Lay pipe with outside circumferential laps facing upstream and longitudinal laps or seams at side or quarter points.
- .4 Lay paved invert or partially lined pipe with longitudinal centre line of paved segment coinciding with flow line.
- .5 Do not allow water to flow through pipes during construction except as permitted by Consultant.

3.4 JOINTS: CORRUGATED STEEL CULVERTS

- .1 Corrugated steel pipe:
 - .1 Match corrugations or indentations of coupler with pipe sections before tightening.
 - .2 Tap couplers firmly as they are being tightened, to take up slack and ensure snug fit.
 - .3 Insert and tighten bolts.
 - .4 Repair spots where damage has occurred to spelter coating by applying two coats of asphalt paint or two coats of zinc rich epoxy paint approved by Consultant.
- .2 Structural plate:
 - .1 Erect in final position by connecting plates with bolts at longitudinal and circumferential seams.
 - .2 Drift pins may be used to facilitate matching of holes.
 - .3 Place plates in sequence recommended by manufacturer with joints staggered so that not more than three plates come together at one point.
 - .4 Draw bolts up tight, without overstress, before beginning backfill.
 - .5 Repair spots where damage has occurred to spelter coating by applying two coats of asphalt paint or two coats of zinc rich epoxy paint approved by Consultant.

3.5 LAYING CONCRETE PIPE CULVERTS

- .1 Begin at downstream end of culvert with flanged end of first pipe section facing upstream.
- .2 Ensure barrel of each pipe is in contact with shaped bed throughout its length.
- .3 Do not allow water to flow through pipes during construction except as permitted by Consultant.

3.6 JOINTS: CONCRETE PIPE CULVERTS

- .1 Joints may be made with rubber gaskets, bituminous jointing compound or Portland cement mortar where specific joint type is not otherwise specified.
 - .1 Rubber gasket joints:
 - .1 Install to manufacturer's recommendations.
 - .2 Ensure that tapered ends are fully entered into flanged ends.
 - .2 Bituminous filled joint:

- .1 Make joint with excess of filler to form continuous bead around outside of pipe and finish smooth on inside.
- .3 Mortar joints:
 - .1 Prepare mortar as specified herein.
 - .2 Clean pipe ends and wet with water before joint is made.
 - .3 Place mortar in lower half of flanged end of pipe section in place.
 - .4 Apply mortar to upper half of tapered end of pipe section being installed.
 - .5 Join pipe ends and force joint up tight, taking care to ensure inner surfaces of abutting pipe sections are flush and even.
 - .6 Clean inside of pipe and annular space between ends of pipes after each joint is made.
 - .7 Fill joint with mortar and finish smooth and even.
 - .8 For pipes 800 mm or less diameter, fill joints before mortar in joints has set.
 - .9 for pipes over 800 mm diameter, postpone filling joint until backfilling has been completed. Re-clean joints before applying mortar.

3.7 LAYING CORRUGATED POLYETHYLENE PIPE CULVERTS

- .1 Begin laying at downstream end of culvert.
- .2 Install pipe in trench by lowering.
- .3 Ensure bottom of pipe is in contact with shaped bedding throughout pipe length.
- .4 Do not allow water to flow through pipes during construction except as permitted by Consultant

3.8 JOINTS FOR POLYETHYLENE CULVERTS

- .1 Install couplings in accordance with manufacturer's instructions.

3.9 BACKFILLING

- .1 Backfill around and over culverts as indicated or as directed by Consultant.
- .2 Place granular backfill material, approved by Consultant, in 150 mm layers to full width, alternately on each side of culvert, so as not to displace it laterally or vertically.
- .3 Compact each later to 95% corrected maximum dry density maximum density to ASTM D698 taking special care to obtain required density under haunches,
- .4 Protect installed culvert with minimum mm cover of compacted fill before heavy

Facility Building

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equipment is permitted to cross. During construction, width of fill, at its top, to be at least twice diameter or span of pipe and with slopes not steeper than 1:2.

- .5 Place backfill in unfrozen condition.

END OF SECTION