

SPECIFICATIONS

VOLUME 2 PROJECT MANUAL

Contract Documents

December 11, 2025

South Winnipeg Recreation Campus Phase 1

City of Winnipeg

Tender No. 63-2025B

15 Ruth Crossing & 25 Ruth Crossing

Winnipeg, MB

Consultant Project No: 220007

City of Winnipeg Project No: 2020-127

Diamond Schmitt Architects

384 Adelaide Street West, Suite 100

Toronto, Ontario

M5V 1R7

Tel: 416-862-8800

1.1 Document Responsibility

- .1 Refer to Project Manual, Section 00 01 10 - Table of Contents, for indication of document responsibility (DR). Abbreviations for entity responsible for document preparation are as follows:
 - .1 A - Denotes documents prepared by Architect.
 - .2 C - Denotes documents prepared by Civil Engineer.
 - .3 CW - Denotes documents prepared by City of Winnipeg.
 - .4 E - Denotes documents prepared by Electrical Engineer.
 - .5 L - Denotes documents prepared by Landscape Architect.
 - .6 M - Denotes documents prepared by Mechanical Engineer.
 - .7 S - Denotes documents prepared by Structural Engineer.
 - .8 SD – Denotes documents prepared by Sustainable Design (LEED) Consultant.
- .2 Professional seals if applied next to company names in the project directory (below) govern only those specification sections and schedules identified by the corresponding document responsibility (DR) abbreviation in Section 00 01 10.

1.2 Project Directory

- .1 Owner (the City):

The City of Winnipeg
Assets & Project Management Department
Municipal Accommodations Division
3-65 Garry Street
Winnipeg, Manitoba
R3C 4K4
- .2 Architect (Prime Consultant):

Diamond Schmitt Architects
384 Adelaide Street West, Suite 100
Toronto, Ontario
M5V 1R7
Tel: 416-862-8800
- .3 Architect (the Contract Administrator):

Brook McIlroy Architects
91 Albert Street, Unit 1
Winnipeg, Manitoba
R3B 1G5
Tel: 204-515-0780

.4 Structural Engineer:

Entuitive Corporation

120 Bremner Blvd, 4th Floor
Toronto, Ontario
M5J 0A8
Tel: 416-477-5832

.5 Mechanical Engineer:

Smith + Andersen (Winnipeg)

161 Portage Avenue E, Unit 700
Winnipeg, Manitoba
R3B 0Y4
Tel: (204) 885-6668

.6 Electrical Engineer:

Smith and Andersen Consulting Engineering

1100 - 100 Sheppard Avenue East
Toronto, Ontario
M2N 6N5
Tel: 416-487-8151

.7 Sustainable Design Consultant:

Smith + Andersen (Winnipeg)

161 Portage Avenue E, Unit 700
Winnipeg, Manitoba
R3B 0Y4
Tel: (204) 885-6668

.8 Landscape Architect:

Brook McIlroy

91 Albert Street, Unit 1
Winnipeg, Manitoba
R3B 1G5
Tel: (204) 515-0780

.9 Civil Engineer:

J R Cousin Consultants Ltd

91 Scurfield Boulevard
Winnipeg, Manitoba
R3Y 1G4
Tel: (204) 489-0474

END OF SECTION

DR - indicates entity responsible for preparation of listed documents (see Section 00 01 05)

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01 25 00 Substitution Procedures.....	A	3	December 11, 2025
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01 31 00 Project Management and Coordination.....	A	5	December 11, 2025
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01 33 00 Submittal Procedures.....	A	9	December 11, 2025
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01 33 29 Schedule S1 Material Information Data Sheet.....	SD	2	December 11, 2025
01 45 00 Quality Requirements	A	8	December 11, 2025
01 51 00 Temporary Utilities	A	2	December 11, 2025
01 52 00 Temporary Facilities.....	A	3	December 11, 2025
01 56 00 Temporary Barriers and Enclosures.....	A	3	December 11, 2025
01 57 00 Temporary Controls	A	3	December 11, 2025
01 57 13 Temporary Erosion and Sediment Control	SD	8	December 11, 2025
01 57 13 Schedule E1 Erosion and Sediment Control Inspection Log	SD	2	December 11, 2025
01 60 00 Product Requirements	A	5	December 11, 2025
01 71 00 Examination and Preparation.....	A	3	December 11, 2025
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01 74 00 Cleaning	A	3	December 11, 2025
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01 77 00 Closeout Procedures	A	3	December 11, 2025
01 78 00 Closeout Submittals	A	6	December 11, 2025
01 78 36 Warranties	A	1	December 11, 2025
01 79 00 Demonstration and Training.....	A	2	December 11, 2025
01 81 19 Indoor Air Quality Requirements	SD	10	December 11, 2025
01 81 19 Schedule I1 Indoor Air Quality Inspection Log.....	SD	2	December 11, 2025
01 91 13 General Commissioning Requirements.....	CX	17	December 11, 2025

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03 20 00 Concrete Reinforcement	S	6	December 11, 2025
03 30 00 Cast-in-Place Concrete	S	13	December 11, 2025
03 35 00 Concrete Floor Finishing	A	4	December 11, 2025
03 45 00 Architectural Precast Concrete Base	A	10	December 11, 2025
03 48 19 Precast Concrete Stairs	A	4	December 11, 2025
03 53 00 Cementitious Underlayment	A	4	December 11, 2025
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04 05 13 Mortar and Grout for Masonry	A	4	December 11, 2025
04 05 19 Masonry Reinforcement and Connectors	A	3	December 11, 2025
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04 22 23 Architectural Concrete Masonry Units	A	3	December 11, 2025
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05 12 00 Structural Steel	S	25	December 11, 2025
05 31 10 Steel Deck	S	9	December 11, 2025
05 41 13 Lateral Load-Bearing Cold-Formed Metal Framing	A	5	December 11, 2025
05 50 00 Metal Fabrications	A	7	December 11, 2025
05 50 10 Architectural Metal Fabrications	A	10	December 11, 2025
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06 17 33 Wood I-Joists	S	7	December 11, 2025
06 40 00 Architectural Woodwork	A	12	December 11, 2025
06 80 00 Plastic Lumber Fabrications	A	4	December 11, 2025
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07 08 00 Commissioning of Thermal and Moisture Protection Systems	CX	11	December 11, 2025
07 13 54 Modified Bituminous Sheet Waterproofing	A	5	December 11, 2025
07 16 16 Surface Applied Crystalline Waterproofing	A	4	December 11, 2025
07 17 18 Bentonite Waterstop	A	4	December 11, 2025

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07 18 13 Service Room Traffic Coatings	A	4	December 11, 2025
07 21 00 Thermal Insulation	A	4	December 11, 2025
07 21 10 Below Grade and Perimeter Insulation.....	A	3	December 11, 2025
07 21 29 Sprayed-Applied Foamed-in-Place Air Barrier Insulation	A	7	December 11, 2025
07 26 16 Below-Grade Vapour Barrier.....	A	5	December 11, 2025
07 27 00 Air Barrier Systems	A	6	December 11, 2025
07 46 16 Aluminum Composite Panel Cladding System	A	9	December 11, 2025
07 46 19 Metal Cladding Systems	A	9	December 11, 2025
07 52 16 Modified Bituminous Membrane Roofing.....	A	15	December 11, 2025
07 62 00 Metal Flashing	A	7	December 11, 2025
07 72 33 Roof Hatches	A	3	December 11, 2025
07 81 00 Sprayed Fire-Resistive Materials (SFRM).....	A	3	December 11, 2025
07 81 23 Intumescent Fire-Resistive Materials (IFRM)	A	5	December 11, 2025
07 84 00 Joint Firestopping and Smoke Seals.....	A	7	December 11, 2025
07 92 00 Joint Sealants	A	12	December 11, 2025
07 95 13 Expansion Joint Cover Assemblies	A	4	December 11, 2025
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08 08 00 Commissioning of Openings	CX	8	December 11, 2025
08 11 13 Steel Doors and Frames	A	13	December 11, 2025
08 12 16 Interior Aluminum Screens and Doors.....	A	5	December 11, 2025
08 14 00 Flush Wood Doors	A	8	December 11, 2025
08 31 13 Architectural Access Doors	A	3	December 11, 2025
08 31 14 Floor Access Door	A	3	December 11, 2025
08 33 12 Coiling Metal Counter Doors	A	5	December 11, 2025
08 33 13 Rolling Fire Shutters	A	5	December 11, 2025
08 42 29 Automatic Sliding Entrance Doors.....	A	10	December 11, 2025
08 44 00 Aluminum Framed Glazing Systems	A	24	December 11, 2025
08 54 13 Fibreglass Windows.....	A	8	December 11, 2025
08 71 00 Finish Hardware.....	H	45	December 11, 2025
08 80 00 Glass and Glazing	A	16	December 11, 2025
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08 87 00 Applied Films	A	3	December 11, 2025
08 91 19 Louvres.....	A	5	December 11, 2025
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09 29 00 Gypsum Board.....	A	15	December 11, 2025
09 29 90 Gypsum Sheathing Board.....	A	3	December 11, 2025
09 31 00 Tiling.....	A	18	December 11, 2025

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09 51 13 Acoustical Panel Ceiling Systems	A	5	December 11, 2025
09 51 23 Acoustical Tile Ceiling Systems	A	8	December 11, 2025
09 54 23 Linear Metal Ceilings	A	6	December 11, 2025
09 54 26 Linear Wood Ceilings.....	A	5	December 11, 2025
09 62 90 Tactile Attention Indicators.....	A	4	December 11, 2025
09 64 66 Wood Athletic Flooring System	A	9	December 11, 2025
09 65 13 Resilient Base and Accessories	A	7	December 11, 2025
09 65 15 Rubber Sheet Flooring.....	A	10	December 11, 2025
09 65 17 Vinyl Sheet Flooring.....	A	10	December 11, 2025
09 65 66 Resilient Athletic Flooring.....	A	7	December 11, 2025
09 67 00 Fluid-Applied Floor Coatings.....	A	7	December 11, 2025
09 68 00 Carpet.....	A	8	December 11, 2025
09 77 13 Acoustic Wall Panels	A	6	December 11, 2025
09 78 13 Metal Wall Panels	A	5	December 11, 2025
09 91 00 Painting.....	A	11	December 11, 2025
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10 21 13 Solid Phenolic Partitions	A	5	December 11, 2025
10 22 26 Operable Partition System	A	6	December 11, 2025
10 26 13 Corner Guard and Wall Protection	A	4	December 11, 2025
10 28 00 Washroom and Janitor Accessories.....	A	4	December 11, 2025
10 51 13 Prefinished Metal Lockers.....	A	3	December 11, 2025
10 51 26 Solid Phenolic Lockers.....	A	3	December 11, 2025
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11 24 00 Fall Arrest Anchors and Horizontal Lifelines.....	A	6	December 11, 2025
11 66 23 Athletic and Gym Equipment.....	A	5	December 11, 2025
11 66 43 Indoor Scoreboards	A	4	December 11, 2025
11 66 53 Gymnasium Curtain	A	4	December 11, 2025
11 70 00 Patient Lift and Track.....	A	4	December 11, 2025
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12 24 13 Roller Window Shades.....	A	7	December 11, 2025
12 48 16 Entrance Floor Grilles	A	3	December 11, 2025
12 67 23 Bleachers and Chairs.....	A	4	December 11, 2025
12 93 13 Bicycle Racks	A	3	December 11, 2025

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14 21 24 Electric MRL Traction Elevators	A	16	December 11, 2025
DIVISION 31 - EARTHWORK			
31 05 19.13 Geotextiles.....	C	1	December 11, 2025
31 11 00 Clearing & Grubbing	L	3	December 11, 2025
31 22 13 Rough Grading	C	3	December 11, 2025
31 23 00 Excavation and Backfill	A	4	December 11, 2025
31 23 10 Excavating and Backfilling for Trenching.....	C	3	December 11, 2025
31 24 13 Roadway Embankment and Subgrade.....	C	1	December 11, 2025
31 61 00 Pile Foundations	S	7	December 11, 2025
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32 14 13 Precast Concrete Unit Paving	L	5	December 11, 2025
32 16 00 Curbs, Gutters and Sidewalks.....	C	4	December 11, 2025
32 17 23 Pavement Markings	L	2	December 11, 2025
32 17 26 Tactile Warning Surfacing	L	3	December 11, 2025
32 31 13 Fences and Gates	L	4	December 11, 2025
32 33 00 Site Furnishings	L	6	December 11, 2025
32 91 21 Topsoil Placement and Grading	L	6	December 11, 2025
32 92 23 Sodding	L	9	December 11, 2025
32 93 00 Planting of Trees, Shrubs and Ground Covers.....	L	10	December 11, 2025
32 94 51 Soil Cells.....	L	16	December 11, 2025
32 94 56 Planting Soil for Soil Cells	L	5	December 11, 2025
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33 05 13 Manholes and Structures	C	2	December 11, 2025
33 11 00 Pressure Pipeline.....	C	3	December 11, 2025
33 31 13 Public Sanitary Utility Sewerage Piping.....	C	4	December 11, 2025
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20 05 02 As-built drawings	M	4	December 11, 2025
20 05 03 Shop Drawings	M	3	December 11, 2025
20 05 13 Electric Motors	M	3	December 11, 2025
20 05 14 Wiring and Starters	M	1	December 11, 2025
20 05 15 Variable Frequency Drives	M	7	December 11, 2025
20 05 19 Indicating Instruments	M	4	December 11, 2025
20 05 29 Hangers and Supports	M	5	December 11, 2025
20 05 33 Electric Tracing	M	4	December 11, 2025
20 05 48 Vibration and Noise Control	M	13	December 11, 2025
20 05 53 Pipe and Ductwork Identification	M	2	December 11, 2025
20 05 54 Nameplates	M	1	December 11, 2025
20 05 55 Valve Tags and Charts	M	2	December 11, 2025
20 05 63 Access Doors and Accessibility	M	2	December 11, 2025
20 05 73 Excavation and Backfill for Mechanical Work	M	3	December 11, 2025
20 05 83 Sleeves and Escutcheons	M	2	December 11, 2025
20 05 88 Cutting and Patching	M	2	December 11, 2025
20 07 00 Insulation	M	25	December 11, 2025
20 08 00 Mechanical System Commissioning	M	7	December 11, 2025
20 08 02 Cleaning and Protection	M	1	December 11, 2025
20 08 03 Operating and Maintenance Instructions	M	4	December 11, 2025
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21 13 00 Sprinkler Systems	M	12	December 11, 2025
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22 05 76 Cleanouts	M	1	December 11, 2025
22 05 79 Service Connections	M	1	December 11, 2025
22 11 13 Pipes, Valves and Fittings (Plumbing System)	M	14	December 11, 2025
22 11 23.29 Circulators	M	1	December 11, 2025
22 13 19.13 Floor Drains	M	3	December 11, 2025
22 13 19.26 Interceptors	M	2	December 11, 2025
22 13 29.13 Sump Pumps and Sump Pits	M	3	December 11, 2025
22 14 26.13 Roof Drains	M	1	December 11, 2025
22 33 00 Domestic Electric Hot Water Heaters	M	2	December 11, 2025
22 42 00 Fixtures and Trim	M	3	December 11, 2025

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<u>Document Identification</u>	<u>DR</u>	<u>Pgs</u>	<u>Issued</u>
22 42 46 Fixture Carriers	M	62	December 11, 2025
22 42 49 Hydrants (Plumbing Systems)	M	2	December 11, 2025
22 47 13 Refrigerated Drinking Fountains and Bottle Fillers	M	1	December 11, 2025
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23 05 93.13 Testing and Balancing Piping Systems	M	5	December 11, 2025
23 05 93.23 Testing and Balancing Air Systems	M	5	December 11, 2025
23 09 00 Building Automation System (BAS)	M	46	December 11, 2025
23 09 23 Sequence of Operation for BAS	M	16	December 11, 2025
23 11 23 Natural Gas Piping Systems	M	3	December 11, 2025
23 21 13.23 Piping, Valves & Fittings (Except Plumbing)	M	11	December 11, 2025
23 21 23 Centrifugal Pumps	M	3	December 11, 2025
23 22 53 Pressure Relief Valves	M	1	December 11, 2025
23 23 01 Refrigerant Piping	M	7	December 11, 2025
23 25 13 Heating System Chemical Treatment	M	2	December 11, 2025
23 25 14 Pipe System Filters	M	1	December 11, 2025
23 25 16 Chilled Water Treatments	M	2	December 11, 2025
23 25 26 Cleaning and Filling	M	3	December 11, 2025
23 26 13 Pipe Expansion Joints, Guides and Anchors	M	3	December 11, 2025
23 26 16 Flexible Pipe Connectors	M	1	December 11, 2025
23 31 13 Ductwork and Specialties	M	14	December 11, 2025
23 32 39 Intake and Exhaust Air Plenums	M	3	December 11, 2025
23 34 13 Axial Flow Fans, Mixed Flow Fans, and Centrifugal Fans	M	6	December 11, 2025
23 34 53 Room Ventilators	M	1	December 11, 2025
23 34 63 Roof Mounted Fans	M	4	December 11, 2025
23 36 16 Variable Volume Boxes	M	2	December 11, 2025
23 37 13 Diffusers, Grilles and Registers	M	4	December 11, 2025
23 41 16 Disposable Filters	M	2	December 11, 2025
23 51 33 Positive Pressure Vent and Chimney Systems	M	4	December 11, 2025
23 52 16 Condensing Boilers	M	4	December 11, 2025
23 57 19.13 Heat Exchangers - Plate Type	M	2	December 11, 2025
23 63 13 Air Cooled Condensing Units	M	4	December 11, 2025
23 72 16 Reverse Flow Energy Recovery Dual Cores	M	2	December 11, 2025
23 73 23 Custom Air Conditioning Units	M	5	December 11, 2025
23 77 13 Expansion Tanks	M	3	December 11, 2025
23 81 26 Unitary Air Conditioning Units	M	2	December 11, 2025
23 81 43 Modular Packaged Air-to-Water Heat Pumps	M	9	December 11, 2025
23 82 16 Coils	M	2	December 11, 2025
23 82 36 Wall Fin Convectors	M	4	December 11, 2025
23 82 39 Unit Heaters	M	1	December 11, 2025

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23 82 39.13 Cabinet Heaters	M	1	December 11, 2025
23 84 13 Humidifiers	M	2	December 11, 2025

SCHEDULES

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Child Care ASHRAE 62.1 – 2016 Minimum Ventilation Calculations	M	1	December 11, 2025
Child Care Condensing Unit Schedule	M	1	December 11, 2025
Child Care Cooling Coil Schedule	M	1	December 11, 2025
Child Care Domestic Hot Water Heater Schedule	M	1	December 11, 2025
Child Care Expansion Tank Schedule	M	1	December 11, 2025
Child Care Fan Schedule	M	1	December 11, 2025
Child Care Heating Coil Schedule	M	1	December 11, 2025
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Rec Centre Expansion Tank Schedule	M	1	December 11, 2025
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26 01 00 Operating and Maintenance Instructions	E	3	December 11, 2025
26 05 01 General Instructions for Electrical Sections	E	26	December 11, 2025
26 05 03 As-Built Drawings	E	3	December 11, 2025
26 05 04 Submittals/Shop Drawings	E	2	December 11, 2025

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26 05 05 Mounting Heights	E	2	December 11, 2025
26 05 21 Wires and Cables Under 2000 V	E	10	December 11, 2025
26 05 26 Grounding + Bonding	E	5	December 11, 2025
26 05 29 Hangers and Supports	E	2	December 11, 2025
26 05 31 Splitters, Junction, Pull Boxes and Cabinets	E	2	December 11, 2025
26 05 32 Outlet Boxes, Conduit Boxes and Fittings	E	3	December 11, 2025
26 05 34 Conduits, Conduit Fasteners and Fittings	E	5	December 11, 2025
26 05 36 Cable Trays	E	4	December 11, 2025
26 05 40 Poke-thru Devices	E	2	December 11, 2025
26 05 44 Installation of Cables in Trenches and in Ducts	E	2	December 11, 2025
26 05 53 Identification	E	5	December 11, 2025
26 05 63 Access Doors and Accessibility	E	2	December 11, 2025
26 05 73 Electrical Power System Studies	E	5	December 11, 2025
26 05 83 Sleeves	E	2	December 11, 2025
26 05 88 Cutting and Patching	E	2	December 11, 2025
26 08 00 Commissioning	E	5	December 11, 2025
26 09 13.01 Power Monitoring System – Web Based	E	5	December 11, 2025
26 09 24 Lighting Control Equipment – Addressable Low Voltage	E	15	December 11, 2025
26 12 17 Dry Type Transformers – 600V Primary	E	4	December 11, 2025
26 12 18 Harmonic Mitigating Dry Type Transformers	E	4	December 11, 2025
26 24 13 Switchboards	E	5	December 11, 2025
26 24 17 Panelboards – Breaker Type	E	3	December 11, 2025
26 27 02 Surge Protective Device	E	6	December 11, 2025
26 27 19 Multi-Outlet Assemblies	E	3	December 11, 2025
26 27 26 Wiring Devices	E	5	December 11, 2025
26 27 43 Electrical Vehicle (EV) Charging Stations	E	5	December 11, 2025
26 28 14 Fuses Low Voltage	E	2	December 11, 2025
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26 28 23 Disconnect Switches – Fused and Non-Fused	E	2	December 11, 2025
26 29 00 Motor Starters to 600 V	E	7	December 11, 2025
26 33 53 Uninterruptible Power Systems - Static	E	10	December 11, 2025
26 51 13 Lighting Equipment	E	9	December 11, 2025
26 51 14 Sports and Recreational Lighting	E	3	December 11, 2025
26 52 01 Unit Equipment for Emergency Lighting	E	3	December 11, 2025
26 52 01.01 Emergency Lighting - Inverter	E	14	December 11, 2025
26 52 01.02 Single Phase Inverters for Emergency Lighting	E	4	December 11, 2025
26 60 01 Elevator Services	E	3	December 11, 2025
26 60 20 Hand Dryers	E	1	December 11, 2025
28 05 00 Raceways for Security System	E	1	December 11, 2025

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28 31 03 Multiplex Fire Alarm and Voice Communication System	E	20	December 11, 2025
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27 00 05.10 General Instructions for Telecommunications Sections	E	14	December 11, 2025
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27 11 19 Telecommunications Termination Blocks and Patch Panels	E	3	December 11, 2025
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27 13 13 Telecommunications Copper Backbone Cabling	E	5	December 11, 2025
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27 15 00.19 Data Telecommunications Horizontal Cabling	E	5	December 11, 2025
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27 15 33 Telecommunications Coaxial Horizontal Cabling	E	2	December 11, 2025
27 15 43 Telecommunications Faceplates and Connectors	E	6	December 11, 2025
27 16 19 Telecommunications Patch Cords and Cross Connect Wire	E	3	December 11, 2025

DR - indicates entity responsible for preparation of listed documents (see Section 00 01 05)

<u>Document Identification</u>	<u>DR</u>	<u>Pgs</u>	<u>Issued</u>
DIVISION 28 - ELECTRONIC SAFETY AND SECURITY			
28 01 00 General Instructions for ESS Sections	E	2	December 11, 2025
28 05 05.20 Definitions and Abbreviations	E	9	December 11, 2025
28 00 05.30 Codes, Standards, and Regulations	E	15	December 11, 2025
28 00 05.60 Administrative Requirements	E	18	December 11, 2025
28 00 06 Fire Stopping and Water Proofing	E	21	December 11, 2025
28 01 01 Operation and Maintenance of Electronic Safety and Security	E	25	December 11, 2025
28 05 03 Record Drawings	E	28	December 11, 2025
28 05 04 Submittals – Shop Drawings	E	31	December 11, 2025
28 05 13 Conductors and Cables for Electronic Safety and Security	E	32	December 11, 2025
28 05 26 Grounding and Bonding for Electronic Safety and Security	E	34	December 11, 2025
28 05 28 Pathways for Electronic Safety and Security	E	38	December 11, 2025
28 05 53 Identification for Electronic Safety and Security	E	40	December 11, 2025
28 08 00 Commissioning of Electronic Safety and Security	E	42	December 11, 2025
28 13 00 Access Control	E	45	December 11, 2025
28 16 00 Intrusion Detection	E	72	December 11, 2025
28 23 00 Video Surveillance	E	83	December 11, 2025
28 26 00 Electronic Personal Protection System	E	94	December 11, 2025
28 40 00 Electronic Safety and Security Systems Integration	E	101	December 11, 2025
28 51 00 Intercom System	E	109	December 11, 2025

END OF SECTION

GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to the requirements of Division 1, The City of Winnipeg Tender Document (for Tender No. 63-2025B) and City of Winnipeg General Conditions for Construction (latest edition), which applies to and forms part of all sections of the work.
 - .1 Where conflict exists between the above noted documents and this specification, the above noted documents take precedence.
- .2 The Specification is divided into Sections which are not intended to identify contractual limits between Subcontractors nor between the Contractor and their Subcontractors. The requirements of any one Section apply to all Sections. Refer to other Divisions and Sections to ensure a complete and operational system.
- .3 Provide mechanical components and accessories which may not be specifically shown on the Drawings or stipulated in the Specifications, but are required to ensure complete and operational systems.

1.2 Intent

- .1 Mention in the Specifications or indication on the Drawings of equipment, materials, operation and methods, requires provision of the quality noted, the quantity required, and the systems complete in every respect.
- .2 The Specifications are an integral part of the accompanying Drawings. Consider any item or subject omitted from one or the other, but which is either mentioned or reasonably implied, as properly and sufficiently specified.
- .3 Be completely responsible for the acceptable condition and operation of all systems, equipment and components forming part of the installation or directly associated with it. Promptly replace defective material, equipment and part of equipment and repair related damages.

1.3 Sections Affected

- .1 These instructions apply to and form a part of all Division 20, 21, 22, and 23 Sections referred herein as Mechanical.

1.4 Definitions

- .1 Where used on the Drawings or in the Specifications, the following words are given the meanings below.
 - .1 Provide: means supply, install, connect and test.
 - .2 Demolish: detach existing items and legally dispose of them off site.
 - .3 Remove and Reinstall: Detach existing items, prepare them for reuse, and reinstall them where indicated.
 - .4 Existing to Remain: existing items that are not removed and that are not otherwise indicated as being removed, removed and salvaged (turned over to The City), or removed and reinstalled.
 - .5 Remove and Salvage: detach existing items and turn over to The City.

GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS

1.5 Scope

- .1 Provide all labour, materials, equipment and services to complete the work of the mechanical division as further specified and as shown on the drawings.
- .2 Should any discrepancy, omissions or errors appear between any parts of the specifications and/or the drawings to cause doubt as to the true meaning and intent of the drawings and specifications, a ruling shall be obtained from the Contract Administrator before submitting the tender. If this is not done the following will be assumed:
 - .1 Where a discrepancy occurs between the specification and the drawings, the more expensive/onerous alternative will be deemed as included in the contract.
 - .2 Where a discrepancy occurs in the drawings the more expensive/onerous alternative will be deemed as included in the contract.
- .3 Where a discrepancy occurs in the specifications the more expensive/onerous alternative will be deemed as included in the contract.

1.6 Regulations

- .1 Perform Work in accordance with codes, rules, regulations, by-laws and requirements of the authorities having jurisdiction.
- .2 Comply with all guidelines and standards issued by the authorities having jurisdiction.
- .3 Where names of codes and standards are referenced on the Contract Documents, comply with the latest in force edition in the jurisdiction of the Place of the Work.
- .4 Comply with regulations respecting plumbing made under the following legislation except as modified by rules, regulations and by-laws of authorities having jurisdiction:
 - .1 Manitoba Plumbing Code.
- .5 For natural gas systems, follow the requirements of:
 - .1 Gas Protection Act
 - .2 CAN/CSA B149.1 - Natural Gas and Propane Installation Code.
- .6 Provide materials and assemblies with flame-spread ratings and smoke developed classifications in conformance with CAN/ULC-S102 "Test for Surface Burning Characteristics of Building Materials and Assemblies." Compliance with ASTM E84 "Surface Burning Characteristics of Building Materials" in lieu of CAN/ULC-S102 is not acceptable.
- .7 These Specifications are supplementary to the requirements above.
- .8 Drawings and Specifications should not conflict with the above regulations but where there are apparent discrepancies, notify the Contract Administrator.
- .9 Where equipment utilizing refrigerants is provided, comply with regulatory refrigerant phase out requirements and dates applicable in the jurisdiction where the Project is taking place. Where equipment not meeting refrigerant phase out requirements or dates is supplied to site, provide revised unit(s) operating on a new refrigerant at no additional cost to The City; cover all costs of any electrical, structural, mechanical, architectural, etc. changes required to accommodate the new refrigerant.

GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS

- .10 Where equipment described in these Specifications utilizes refrigerants, provide refrigerants that have a global warming potential (GWP) of less than 700 and that are compatible with the equipment.

1.7 Permits, Fees and Inspections

- .1 Obtain all permits, make submissions, pay all fees and arrange for all inspections required for the Work of this Division.

1.8 Drawings, Changes and Installation

- .1 The Drawings show the general character and scope of the Work and not the exact details of the installation. Install all equipment and systems complete with all accessories required for a complete and operational installation.
- .2 The location, arrangement and connection of equipment and material as shown on the Drawings represents a close approximation to the intent and requirements of the Work. The right is reserved by the Contract Administrator to make reasonable changes required to accommodate conditions arising during the progress of the Work, at no additional cost.
- .3 In order to show more clearly the arrangement of the Work, plans and sections do not show every valve, thermometer, pressure gauge or other system accessory. Refer to the Mechanical Standard Details and to the Specifications to determine the requirements.
- .4 Install equipment in accordance with the manufacturer's written installation requirements. In the event of conflicts between the Drawings or Specifications and the manufacturer's written installation requirements, notify the Contract Administrator for resolution.
- .5 Certain Details indicated on the Drawings are general in nature and specific labelled detail references to each and every occurrence of use are not indicated, however, such details are applicable to every occurrence.
- .6 Conceal all piping and ductwork in finished areas in ceiling spaces and shafts or furred into walls. Do not install exposed piping or ductwork in such areas unless specifically reviewed and accepted by the Contract Administrator. Do not install piping in outside walls.
- .7 Do not install vent pipes, exhaust hoods or other mechanical equipment mounted on the roof, or housing for such equipment, closer to the edge of the roof than a distance equal to the height of the pipe, hood or equipment, unless specifically reviewed and accepted by the Contract Administrator.
- .8 The location and size of existing services shown on the Drawings are based on the best available information. Site verify the actual location of existing services before commencing Work. Pay particular attention to underground services.
- .9 Make changes and modifications necessary to ensure co-ordination and to avoid interference and conflicts with other Trades, or to accommodate existing conditions, at no additional cost.
- .10 Leave areas clear of piping and ducts where space is indicated as reserved for future equipment and equipment for other Trades.
- .11 Coordinate piping low point drain locations so that they are not above or adjacent to electrical equipment, including junction boxes.

GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS

- .12 Allow adequate space and provisions for the removal of coils and servicing of equipment, with minimum inconvenience to the operation of systems.
- .13 Where equipment is shown to be 'roughed-in only,' obtain accurate information from the Contract Administrator before proceeding with the Work.
- .14 Before fabricating ductwork or piping for installation, make certain that such items can be installed as shown on the Drawings without interfering with the structure or the Work of other Trades. Submit any problems that cannot be solved in agreement with the other Trades affected, for resolution. If ductwork or piping is prefabricated prior to the investigation and reaching of a solution to possible interference problems, make necessary changes in such prefabricated items at no additional cost.
- .1 Comply with 01 31 00 Coordination and Interference Drawings.
- .15 Location of diffusers, grilles, registers, thermostats, sprinklers and all other equipment shown on plans is diagrammatic. Layout of each device in finished areas is critical in terms of symmetry and location. Refer to Architectural Drawings and to Supplemental Instructions in all regards. Revise any Work not installed in the correct location (at the sole discretion of the Contract Administrator) at no additional cost. Mark-out fully co-ordinated Work with all other trades, in sufficient time for review by Contract Administrator prior to rough-in. Precisely locate all mechanical and sprinkler services.
- .16 Prepare dimensioned layouts of each room prior to rough-in for review by the Contract Administrator. Do not proceed with any Work until the Contract Administrator has reviewed the layout.

1.9 Installation, Interference and Setting Drawings

- .1 Submit installation, interference and setting drawings dimensioned and to scale, for review by the Contract Administrator, as may be required or requested by the Contract Administrator to make clear the Work intended or to show its relation to adjacent Work or to the Work of other trades. When an alternative piece of equipment is substituted for equipment shown, prepare drawings of the area involved. Submit drawings in pdf format as well as in the format the Tender Drawings are prepared.
- .2 Prepare installation working drawings to 1:50 scale (1/4 in. equal to 1 ft.) for mechanical rooms showing plan and sections of the plant, services, bases, curbs, drains, motor terminals, etc.
- .3 Prepare interference drawings for shafts, ceiling spaces, typical floors and wherever there is possible conflict with the positioning of mechanical equipment, piping or ductwork and architectural or structural features or the Work of other trades.
- .4 The design of the structural framing of the mechanical rooms and pipe spaces and major pipe run supports has been based on assumed loadings supplied during the design phase. Well ahead of the construction of the affected areas, prepare and submit drawings for review by the Contract Administrator showing the layout and weights of all finally selected mechanical equipment including details of concrete pads, concentrated pipe loads and point reactions of the equipment onto the structure.
- .5 Prepare sleeving drawings indicating the size and locations of openings required in concrete floor slabs, roof slabs/decks and walls for piping, ductwork and equipment. Bear the cost of all extra work necessary due to failure to provide information in time (i.e. before the concrete is poured).

GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS

- .6 Do not proceed with Work in areas involved until after final review of such drawings has been obtained.

1.10 Bid Form and Submissions of Bids

- .1 Submit with the bid, all information called for on the Bid Form. Bids not completed in full may, at the discretion of The City, be rejected.
- .2 Where only one name appears in the Specification, include the specified equipment in the Bid.
- .3 Where two or more names are shown in the Specifications as alternatives or equal to, this Division can select which manufacturer is to be carried, provided the choice is shown on the Bid Form. Where the choice is not indicated, supply the equipment described in the Specification or first named on the Bid Form.
- .4 The Contractor is to list substitute equipment as a price deduction to the Bid Price on the Tender Bid Form. Acceptance of substitute equipment shall be at the discretion of The City and/or Contract Administrator and has been provided in writing. Any substitutes not approved in writing will not be entertained.
- .5 Provide materials and Products specified by the name of the manufacturer, the brand or trade name, or catalogue reference, as the basis of the Bid price. Provide these Products under the Contract unless substitutions are proposed and accepted in accordance with the following procedures:
 - .1 Comply to Section 01 25 00 Substitution Procedures.
 - .2 Substitution may be proposed only when the phrase, "or other approved manufacturer" is included in the Specification.
 - .3 List the proposed substitution under Substitute Equipment on the Bid Form.
 - .4 Indicate the Product name and provide a complete Product description.
 - .5 Clearly indicate the change in the Bid price for this substitution.
- .6 Only propose alternative and/or substitute equipment that is equal in performance and quality to that specified. Include the cost of all changes required to accommodate alternative and/or substitute equipment, in the price shown on the Bid Form, including but not limited to space, power, structural or any other requirements that are different from the equipment specified.
- .7 The City reserves the right to accept or reject any substitution without question.

1.11 Materials

- .1 Make and quality of materials used in the construction of this Work are subject to the approval of the Contract Administrator.
- .2 Supply only new materials and equipment, free from defects and as specified by the manufacturer's name and catalogue reference.

GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS

- .3 Where a manufacturer's equipment has been specified by name and/or model number, ensure that the performance and quality of equipment provided by an acceptable manufacturer, meets the specified equipment performance, is inclusive of all standard and specified optional features, and can be installed in the planned location with access and maintenance clearances in accordance with the manufacturer's written installation recommendations. Provide all required piping, duct and electrical connections at no additional cost.

1.12 Co-Operation With Contract Administrator

- .1 To assist in the successful execution of the Project, the Contractor will receive an initial job report that summarizes the expectations of the Contract Administrator and the Contractor. This job report covers topics such as progress billings, shop drawing requirements, Change Order pricing, the commissioning process, installation drawings, the Specifications, as-built drawings and operations and maintenance manuals, along with a number of other items. This job report is intended to reiterate key items from the Contract Documents and is not intended to impose new requirements.
 - .1 Comply to section 01 31 00 Project Management and Coordination.
- .2 At the appropriate time during construction, submit the applicable documentation listed below. The Contract Administrator will review the information and identify when the information is complete. The Contract Administrator's general review letter (required for building occupancy) will only be issued when the information requested below is submitted by the Subcontractor and deemed to be complete by the Contract Administrator.
- .3 For mechanical systems occupancy, provide a PDF copy of the following documents to the Engineer's office for review:
 - .1 CAN/ULC-S1001 "Standard for Integrated Systems Testing of Fire Protection and Life Safety Systems" reports for mechanical systems
 - .2 Fire alarm verification certificate
 - .3 Sprinkler System Engineer's letters of assurance and occupancy, signed and sealed by P.Eng.
 - .4 Subcontractor's letter verifying that all fire fighting access routes have been provided and are accessible
 - .5 Subcontractor's letter confirming ventilation supply air and return air available for each room
 - .6 Report confirming sanitary systems operational
 - .7 Subcontractor's letter verifying fire stops and smoke seals installed in accordance with Mechanical Specification
 - .8 Subcontractor's letter verifying fire damper, smoke damper, and / or combination smoke / fire damper installations are in accordance with their listings and the Mechanical Specification, and fire damper test confirmation letter
 - .9 Subcontractor's letter verifying smoke control system is installed, operational and commissioned per Mechanical Contract Documents and Building Code requirements

GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS

- .10 Subcontractor's letter verifying carbon monoxide detection and exhaust system is installed, operational and commissioned per Mechanical Contract Documents and Building Code requirements
 - .11 Start up report(s) for heating systems, air handling unit(s), heating boiler(s), fan coil unit(s), heat pump(s), fan(s), etc.
 - .12 Start up report(s) for ventilation systems, air handling unit(s), fan coil unit(s), heat pump(s), fan(s), exhaust fan(s), etc.
 - .13 Start up report(s) for cooling systems including chillers, cooling towers, air handling unit(s), fan coil unit(s), heat pump(s), split a/c unit(s), etc.
 - .14 Plumbing system pressure testing, flushing, water quality test, and chlorination report(s)
 - .15 Final plumbing inspection certificate
 - .16 Pressure test report on all piping systems
 - .17 Subcontractor's letter verifying that all plumbing fixtures are installed and operational
 - .18 Test reports and certificates from local building inspection authority confirming that the following items are installed, pressure tested and operational: building drains, sanitary and storm building sewers, drainage system and venting system, pipes, fittings, fixtures, etc.
 - .19 Backflow preventer test reports
 - .1 All backflow preventer installations to be an approved licensed backflow installer with the City of Winnipeg Water and Waste Department
 - .20 Subcontractor's letter verifying grease interceptor(s) installed and tested in accordance with Mechanical Contract Documents and Building Code
 - .21 Subcontractor's verification of accessibility of the fire dampers, fixtures, cleanouts, valves, plumbing appliances, devices and equipment
 - .22 Cyber Security Report Letter
 - .23 Air balancing report
 - .24 Hydronic (Piping) balancing report
 - .25 Pressure testing of refrigerant systems report
 - .26 Where the The City has hired a third party commissioning agent, all documentation and completion of the commissioning process submitted up to the initial BAS commissioning stage where the system is ready for season performance testing, where relevant.
- .4 For mechanical systems closeout, provide the following additional documents to the Engineer's office for review:
- .1 Copies of as-built drawings
 - .2 Operating and maintenance manual
 - .3 Warranty letter

GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS

1.13 Substantial Performance

- .1 The City will not deem the Project “ready for use” as defined in the provincial or territorial lien legislation until the following minimum items are complete. :
 - .1 Comply to 01 77 00 Closeout Procedures.
 - .2 Everything required in the clauses above for occupancy.
 - .3 All mechanical items commissioned and accepted by Contract Administrator as noted in Specification Section 20 08 00 – COMMISSIONING.
 - .4 Submission of final, reviewed Operating and Maintenance Manuals including final reviewed Shop Drawings turned over to the Contract Administrator and The City as outlined in Section 20 08 03 – OPERATING AND MAINTENANCE INSTRUCTIONS.
 - .5 Submission of final, reviewed as-built documentation to the Contract Administrator and The City, as outlined in Specification Section 20 05 02 – AS-BUILT DRAWINGS. Note that this includes all final balancing reports.

1.14 Co-Operation With Other Divisions

- .1 Pay particular attention to the proximity of electrical conduit and cable to mechanical piping and equipment.
- .2 Maintain at least 150 mm (6 in.) separation between pipes transporting hot fluids and pipes carrying cold fluids, unless approval from the Contract Administrator is obtained.
- .3 Do not allow Electrical conduits to touch or be supported from piping or ductwork.
- .4 Install all materials in the spaces shown without encroaching upon space for materials installed under other Sections or Divisions. Where the space allocated to another Section or Division is encroached upon, relocate the materials to their proper space allocation in such a manner to complete the Work using space allocated to the various Sections and Divisions. Relocate materials and Work involved at no additional cost.
- .5 Supply all items to be built in ample time for rapid progress of the Work. Schedule and proceed with Work as required to satisfy the construction schedule.
- .6 Confirm the available voltage for all single phase and three phase motors or other similar electrically driven equipment with the Electrical Division prior to ordering the equipment. Report any discrepancy between the requirements identified within the Contract Documents and those of the Electrical Division to the Contract Administrator and supply equipment to suit the appropriate power requirements. Bear all costs associated with failure to perform this coordination prior to ordering of the motors or equipment.

1.15 Temporary Use of Equipment

- .1 Where systems, or a part thereof, are operated during construction, maintain the system and equipment in proper operating condition.

GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS

- .2 Prior to application for Substantial Performance of the Work as certified by the Contract Administrator, return the systems and/or equipment to new condition by replacing all consumables such as air or water filters, belts in belt driven equipment, etc. with new components. Clean the air side of all coils in the air handling systems, lubricate all bearings according to manufacturer's written factory standards and adjust the thermostatic control system according to Specifications. Clean all duct systems to NADCA Standards.

1.16 Interruption of Services

- .1 Schedule interruptions of the mechanical services to any part of the building at a time agreeable to the The City's Representative. Make all necessary arrangements with those concerned and include for any overtime required to ensure that the interruption is held to a minimum.
- .2 Obtain approval from the Contract Administrator for testing and operation of major equipment to avoid excessive utility charges. Such testing is to be generally carried out after normal working hours or on weekends.
- .3 Perform all such overtime Work at no additional cost.

1.17 Statement of Prices

- .1 Comply to 01 29 00 Payment Procedures.
- .2 For the purpose of progress applications, submit a summary statement of estimated prices for the various portions of the Work, including labour, materials and equipment shown separately. The total price of all portions of the Work must equal the total price of the Work covered under Divisions 20, 21, 22 and 23.
- .3 Submit the summary of Work for this Contract to the Contract Administrator for review and approval. Provide sufficient detail in the summary to enable the Contract Administrator to evaluate the progress of Work and identify all major equipment, components and subcontractor.

1.18 Metric Conversions

- .1 Take particular care with imperial versus SI metric conversions. This applies to all services including, but not limited to, equipment, pipes, ductwork and site services in both new and existing installations.
- .2 Conform to CAN/CSA-Z234.1 "Metric Practice Guide."

1.19 Schedule, Access, Protection and Clean-Up

- .1 There may be access restrictions to the site (location, time of day, days of week). Refer to Front End Specifications for more information and conform to all requirements stated within.
- .2 Refer to the security and protection requirements and conform to all requirements. In particular:
 - .1 No open flames without prior written approval of The City.
 - .2 No smoking.
 - .3 Keep the site clean at all times.

GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS

1.20 Housekeeping Pads, Curbs and Support Piers

- .1 Provide dimensioned drawings for final sizes and locations for housekeeping pads, support piers, and curbs around all floor penetrations for pipes and ducts. Submit for review by Division 3 and the Contract Administrator. Extend edge of equipment housekeeping pad 100 mm (4 in.) beyond equipment frame and hold down bolts. Refer to the Drawings and Details for additional information.
 - .1 Division 3 shall furnish and install curbs and housekeeping pads.
 - .2 Division 3 shall furnish and install equipment support piers.
- .2 Provide housekeeping pad and curb heights as follows:
 - .1 Air handling equipment with cooling coils: 150 mm (6 in.).
 - .2 Air handling equipment with heat wheels: 200 mm (8 in.).
 - .3 All other equipment: 100 mm (4 in.).
 - .4 Curbs around floor penetrations: 50 mm (2 in.).

1.21 ASHRAE 90.1

- .1 Provide mechanical equipment that complies with the minimum efficiency standards set out in ASHRAE 90.1 "Energy Standard for Buildings Except Low-rise Residential Buildings" and the National Energy Code of Canada for Buildings. Submit all necessary information to substantiate conformance.

1.22 Hoisting Facilities

- .1 Provide hoisting facilities for the Work of this Division.
- .2 Hoisting facilities provided by the Contractor may be available for Subcontractor's use. If the Contractor's hoisting facilities are inadequate, provide hoisting facilities for the Work of this Division. Coordinate requirements with the Contractor prior to submission of Bid.

1.23 Enclosures

- .1 Where VFDs, pump control panels, fan control panels, or disconnect switches supplied by Mechanical are installed in parking garages, bike storage spaces, or spaces accessible to the public or general building occupants, install the aforementioned items inside a secured, lockable, naturally ventilated, see through tamperproof cover. Ensure tamperproof cover is such that Electrical Code "working space around electrical equipment" with secure footing requirements are complied with.

1.24 LEED Requirements

- .1 This Project shall conform to the rating system referenced in the CaGBC Leadership in Energy and Environmental Design for New Construction (LEED v4). Information on the rating system and the reference guide can be found at www.cagbc.org.

GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS

.2 Summary

- .1 This section includes the mechanical requirements necessary to comply with the LEED v4 rating system including the prerequisites and credits needed for the Project to obtain a LEED Silver status.
- .2 To achieve LEED Silver status, 50-59 points are required.
- .3 Refer to the LEED v4 BD+C Reference Guide for details on credit requirements.
- .4 The LEED Project checklist provided in the Division 1 Specification indicates which points are targeted. The explanations in this Specification shall assist, and not limit, the Mechanical Subcontractor in determining their role in the process and the points that are being counted on to achieve the rating stated above.

.3 LEED is divided into 9 categories where prerequisites and credits are targeted. These categories are: Integrative Process, Location and Transportation, Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, Innovation, and Regional Priority.

.4 Definitions

- .1 Acronyms Used in LEED
- .2 IP - Integrative Process
- .3 LT - Location and Transportation
- .4 SS - Sustainable Sites
- .5 WE - Water Efficiency
- .6 EA - Energy and Atmosphere
- .7 MR - Materials and Resources
- .8 EQ - Indoor Environmental Quality
- .9 IN - Innovation
- .10 RP - Regional Priority
- .11 CaGBC - Canada Green Building Council

.5 Submittals

- .1 Identify items in shop drawing submittals which are required for obtaining mandated LEED credits.
- .2 Assist the Contractor in submitting information documenting the LEED process.

.6 Prerequisites (P) and credits (C)

- .1 Be responsible for understanding the prerequisites and credits included within the LEED rating system.
- .2 Undertake reasonable steps during the construction process to ensure that required prerequisites and credits are met. Be aware that prerequisites and credits refer to standards and adhere to these standards during the installation.

GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS

1.25 Intellectual Property

- .1 The Contractor acknowledges, represents, warrants and agrees that the The City, its Consultants, and the Contract Administrator are not responsible, and are hereby indemnified against any action as a result of patent infringement made through the review, acceptance, or receipt of materials, equipment, Work, etc. provided by the Contractor or any of their Suppliers or manufacturers in the execution of this Contract.

1.26 Materials and Equipment

- .1 Use new materials and equipment as specified or shown that are free from defects that impair strength, durability, or aesthetics.
- .2 Manufacture in Canada wherever possible.
- .3 Labelled and/or Listed as required by the Authority Having Jurisdiction or Code.
- .4 Mechanical systems are designed and coordinated based on the manufacturer and model number and/or parameters indicated on the Equipment Schedules. Accept all costs for differences in physical properties or performance between scheduled equipment and acceptable alternative equipment manufacturers or models identified in these Specifications. Differences may include, but are not limited to, size, layout, arrangement of components, connection sizes, maintenance access, locations and/or quantity of service connections, and performance differences such as noise, power consumption, flow rates, etc.
 - .1 Electrical coordination: accept all extra costs to revise the electrical provisions, including but not limited to feeder/wiring sizes, breaker sizes, fuse sizes, starters and equipment, to supply power to the non-basis of design piece of equipment.
- .5 Be responsible for all design costs associated with differences between scheduled equipment and alternate manufacturers or models identified in these Specifications.

1.27 Cyber Security

- .1 Coordinate with The City's Information Technology representatives, obtain a copy of The City's cyber security policy and provide all applicable cyber security configurations.
- .2 Definitions
 - .1 Cyber Assets: Systems (including hardware, software, and data) and communication networks (including hardware, software, and data).
 - .2 Critical Cyber Assets: Cyber assets that perform critical system functions. The loss or compromise of these cyber assets would adversely affect the operational reliability of the system.
 - .3 Cyber Attack: The use of electronic means to interrupt, manipulate, destroy, or gain unauthorized access to a computer system, network, or device.
 - .4 Cybercrime: Any crime where cyber – the internet and information technologies, such as software, firmware, computers, tablets, personal digital assistants or mobile devices – has a substantial role in the commission of a criminal offence.

GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS

- .5 Cyber Hygiene: Practices and steps that users of computers and other devices take to maintain system health and improve online security. These practices are often part of a routine to ensure the safety of identity and other details that could be stolen or corrupted.
- .6 Cyber Incident: Any unauthorized attempt, whether successful or not, to gain access to, modify, destroy, delete, or render unavailable any computer network or system resource.
- .7 Cyber Security: Technologies, processes, and practices designed to protect networks, devices, programs, and data from attack, damage, or unauthorized access.
- .8 Cyber Threat or Cyber Security Threat: Malicious act that seeks to damage data, steal data, or disrupt digital life in general. Cyber threats include computer viruses, data breaches, Denial of Service (DDoS / DoS) attacks and other attack vectors.
- .9 Cyber Threat Actors: Broad term for any states, groups, or individuals who, with malicious intent, aim to take advantage of vulnerabilities, low cyber Security awareness, and technological developments to gain unauthorized access to information systems in order to access or otherwise affect victims' data, devices, systems and networks.
- .10 IP Multicast: Technique for one-to-many and many-to-many real-time communication over an IP Infrastructure network.
- .11 Endpoint: Remote computing device that communicates back and forth with a network to which it is connected. Such as a server, desktop, or laptop.
- .12 Network Certificates: Also known as a Digital Certificates, which are an electronic "password" that allows a person or organization to exchange data securely over the internet using the public key infrastructure (PKI). Digital Certificates are also known as a public key certificate or identity certificate. There are 3 Main types of certificates:
 - .1 Secure Socket Layer Certificate (SSL) Digi-SSL
 - .2 Software Signing (Code Signing Certificate) Digi-Code
 - .3 Client Certificate (Digital ID) Digi-ID
- .13 Social Engineering: Exploitation methods that target human vulnerabilities, such as carelessness and trust.
- .14 Technical Vulnerabilities: Weaknesses or flaws in the design, implementation, operation, or management of an information technology system, device, or service.
- .3 Cyber Security Measures
 - .1 Implement at minimum the following multi-layered Cyber Security measures to limit and / or reduce The City's potential risk from a cyber threat event; such as a Cyber Security data breach or Cyber Security attack.

GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS

- .2 Password Management
 - .1 Employ password management best practices such as:
 - .1 Do not use default passwords.
 - .2 Use strong and unique passwords for all applications. Use a minimum of 8 characters where there is no password policy inherent in the software; use a mixture of uppercase and lowercase letters, numbers, and include at least one special character (! @ # ?]).
 - .3 Reset passwords at regular intervals.
 - .4 Configure two-factor authentication for all accounts where possible in the system software.
 - .5 Do not use System Admin logins for simple tasks; create separate User accounts with rights levels appropriate for the job function. Create and define user accounts as appropriate such as Role based, Individual logins or assigned roles.
 - .6 Use different passwords for every account.
 - .7 Enforce secure password policies within the business environment.
 - .8 Have interface lock after a predefined # of failed login attempts for a pre determined time interval.
- .3 Port and Interface Management
 - .1 Employ Port Management techniques such as:
 - .1 Restrict access on network switch ports to assigned devices addresses.
 - .2 Lock down all open, unused and unsecure ports on the networking devices such as switches, routers, and firewalls.
 - .3 Shut off all unused communication services and hardware interfaces.
 - .4 Advise The City on use of 3rd party port security monitoring.
- .4 Physical and Virtual Networks
 - .1 Provide a dedicated VLAN for network connected systems where a dedicated LAN has not been provided.
- .5 Encryption
 - .1 Use minimum TLS 1.2 for all network attached equipment and use TLS 1.3 where available.
- .6 Network Certificates
 - .1 Ensure Network Certificates are up to date and not expired for all equipment and systems.
- .7 Firmware & Software Update Management
 - .1 Use the latest stable Firmware / Software version on all devices / equipment as well as implement a Firmware / Software Update management process and procedure.
- .8 Manufacturer's System Hardening Guides

GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS

- .1 Provide the Manufacturer's System hardening guides for the equipment being installed and implement as many recommendations / features as possible.
- .9 External Memory
 - .1 Restrict the use of external memory. Restrict or eliminate the use of devices such as external USB Thumb drives unless expressly allowed by the The City's Information Technology representatives.
- .10 Log Off
 - .1 Enable auto-log off timer for all software, websites and logins. Set auto-log off timer on local Workstation(s) being used to access the equipment with a reasonable timer in the case that an employee leaves the workstation unattended.
- .11 Anti-Virus Software
 - .1 Enable and configure anti-virus software on PC endpoints in accordance with The City's Information Technology requirements, unless it is to be installed and configured by The City.
- .12 Filtering Techniques
 - .1 Apply filtering techniques including the types listed below where possible:
 - .1 Web Filtering: A Web filter adds another layer to anti-phishing defences by blocking the web based component of phishing and malware attacks.
 - .2 Multicast Message Filtering: Filters the packets sent to multicast groups users are not subscribed to.
 - .3 Content Filtering: Is the use of a program to screen and / or exclude access to web pages or email deemed objectionable. A content filter will then block access to this content.
- .13 Back up Regularly
 - 1. Provide backup schedule in the closeout submittals and configure system for automatic backups wherever possible.
 - 2. Identify files that require manual backup and the backup procedure. This helps to protect against many types of data loss, especially if a Cyber Threat Actor gains access.
- .4 IT Devices and Systems
 - .1 Apply the Cyber security measures listed in the clauses above in part or in full, as possible, to a wide range of Information Technology (IT) Devices including:
 - .1 Firewalls
 - .2 Routers
 - .3 Network switches (Core and Edge Devices)
 - .4 Servers and databases
 - .5 Workstation computers
 - .6 Network connected system devices and controllers
 - .7 Wireless Access Points and wireless controllers

GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS

- .8 Mobile phones and tablets
- .9 Any IT System or endpoint connected to the network
- .5 Operational Technology (OT) Devices and Systems
 - .1 Apply the Cyber security measures listed in the clauses above, in part or in full, as possible, to a wide range of OT Network devices including:
 - .1 Industrial Control Systems such as:
 - .1 (PLC's) Programmable Logic Controllers are an industrial digital computer which has been ruggedized and adapted for the control of manufacturing processes, such as assembly lines, or robotic devices.
 - .2 (SCADA) Supervisory Control and Data Acquisition is a control system architecture comprising of computers, networked data communications and graphical user interfaces (GUI) for high level process supervisory management.
 - .3 (DCS) Distributed Control System is a computerized control system for a process or plant usually with many control loops, in which autonomous controllers are distributed throughout the system.
 - .4 (CNC) Computer numerical Control is the automated control of machining tools (Drills, boring tools, lathes) and 3D printers by means of a computer.
 - .2 Building Management Systems (BMS) and Building Automation Systems (BAS)
 - .3 HVAC equipment
 - .4 Lighting controls for both internal and external applications
 - .5 Energy monitoring and metering equipment
 - .6 Transportation and parking systems
 - .7 Scientific equipment
 - .8 Any other OT System or endpoint that can be connected to the network
- .6 Report Cybercrime
 - .1 Advise The City and / or their representatives of any indication of a Cyber Incident of a criminal nature when performing any work on a network connected system.
- .7 Cyber Security Report Letter
 - .1 Provide a Cyber Security Report Letter in the closeout documents to the client stating which Cyber Security measures have been implemented, when implementing any and / or all of the Cyber Security Measures mentioned in this Specification.

1.28 Life Safety Integration Testing

- .1 Provide testing of the integration of all life safety and fire protection systems.

GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS

- .2 The Integrated Testing Coordinator (ITC) will complete an Integration Testing Plan (ITP). Carry out the testing as described by the ITC in the ITP, and in accordance with CAN/ULC-S1001 "Integrated Systems Testing of Fire Protection and Life Safety Systems" as it relates to any mechanical systems.
- .3 The ITC and development of the ITP are not the responsibility of this Contractor.
- .4 The testing of the integrated systems shall include, but not be limited to the following systems and all associated components:
 - .1 Fire Alarm (e.g. mechanical systems integrated with or controlled by fire alarm system – dampers, fan start up, fan shut down, make up air, pressurization, etc.)
 - .2 Elevators
 - .3 Emergency Generators and/or Inverters (e.g. combustion air, cooling air, cooling, dampers, fuel, alarms, etc.)
 - .4 Sprinkler Systems
 - .5 Standpipe Systems
 - .6 Fire Pumps
 - .7 Water Supplies
 - .8 Water Supply Control Valves
 - .9 Heat Tracing for Life Safety Systems
 - .10 Fixed Fire Suppression Systems
 - .11 Cooking Equipment Fire Suppression Systems
 - .12 Automatic Door Operators for Stair Relief
 - .13 Hold-Open Devices (e.g. smoke control system integration)
 - .14 Smoke Control Systems (Passive and / or Active)
 - .15 Venting to Aid Firefighting
 - .16 Hazardous Protection Monitoring
 - .17 Gas / CO Detection Systems
 - .18 Prevention of Smoke Recirculation (AHUs)
- .5 Coordinate with all other trades to carry out the appropriate testing.
- .6 Be responsible for carrying out and coordinating the testing Work associated with the ITP. Coordinate all Work with the ITC and include but not be limited to the following:
 - .1 Perform functional testing of the integration of all life safety and fire protection systems as a whole to ensure the proper operation and interconnection between the systems.
 - .2 Testing of the integrated life safety systems must be done as a complete installed assembly; individual component testing or partially installed assembly testing is not acceptable.
 - .3 Follow the testing methodology for verifying and documentation of operation as outlined in the ITP and in accordance with CAN/ULC-S1001.

GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS

- .4 Provide all other documentation requested by the ITC as it relates to the mechanical systems in conformance with CAN/ULC-S1001.

1.29 Valuation Of Changes

- .1 Further to Contract requirements, use the following method in determining the value of a change to the Work, by Change Order:
 - .1 Estimate and acceptance in a lump sum, unless the Contract Administrator otherwise determines that the method shall be unit prices set out in the Contract.
- .2 Provide the Contract Administrator with a detailed cost analysis of the proposed change including:
 - .1 Quantity of each material.
 - .2 Unit cost of each material.
 - .3 Labour units based on s Association of America (MCAA) Labour Estimating Manual.
 - .4 Labour (hours) involved.
 - .5 Suppliers' quotation or credit memo for equipment noted in proposed change, with detailed breakdown.
 - .6 Sub-trade quotations including a complete cost breakdown of the proposed change meeting the requirements of this section.
 - .7 Sub-trade's suppliers' quotation or credit memo for equipment noted in proposed change, with detailed breakdown.
 - .8 Mark-ups, if applicable.
 - .9 Value of GST or HST, as applicable.
 - .10 Proposed change in contract time, if any.
 - .11 Proposed change number in every quotation to facilitate record keeping.
- .3 Comply with requirements of Contract Documents for all materials included in quotations for proposed changes.
- .4 List material and labour separately for each item/clause of the proposed change, on the detailed cost breakdown.
- .5 Not be entitled to any additional compensation arising out of changes to the Work other than the amounts determined and agreed to under the Contract.
- .6 Charge special equipment rental rates at cost. Provide an official quotation of the equipment rental with the proposed change quotation as backup, otherwise special equipment rentals will not be accepted by The City/Contract Administrator
- .7 .
- .8 The maximum percentage fee for mark-ups is as stated in the City of Winnipeg General Conditions.
- .9 All changes, change notices, proposed changes, revisions to contract, Supplemental Instructions, any additional costs or deletes to the stipulated lump sum Contract Price are subject to review and scrutiny by a qualified third party or individual.

GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS

- .10 Use material costs based on a discount to nationally available pricing guides (i.e. Trade Service, Allpricer, etc.) to reflect a value with a fair and reasonable markup to the actual cost of the materials purchased from distributors. The City and/or Contract Administrator reserve the right to negotiate material pricing to a value that is fair and reasonable to The City. Indicate on the Bid Form or Supplementary Bid Form: which pricing guide is proposed to be used and discount rate compared to list price.
- .11 Base the hourly labour rate for all changes on a Journeyperson rate as listed on the Bid Form. The City and/or Contract Administrator reserve the right to renegotiate the labour rate. The hourly labour rate will be inclusive of overhead, markup and profit.
- .12 At the request of The City or the Contract Administrator, submit a detailed labour cost breakdown showing a breakdown of all adders to the base wage rate to show how the Contractor has come to the proposed hourly rate. The City and the Contract Administrator reserve the right to negotiate the hourly labour rate with the Contractor.
- .13 When pricing additional work for proposed changes, only price new materials that are required for the proposed change. Where existing materials and/or infrastructure can be re-used for the proposed change, utilize these items in the valuation of the change at no extra cost.
- .14 Where a proposed change includes both credits and extras, overhead and permitted mark-ups apply to the net extra or credits, if any, of the entire change.
- .15 When pricing proposed changes containing both additions and credits, and where no work and/or materials have been installed on site, only price the net new materials and net new labour that are required for the proposed change. Utilize equal per unit labour and material costs for credits and additions.
- .16 Utilize equal per unit labour and material costs for credits and additions.

1.30 Schedule of Values

- .1 Comply to 01 29 00 Payment Procedures and City of Winnipeg General Conditions for Construction Contracts.
- .2 Refer to Mechanical Schedule of Values to be provided prior to Proper Invoice to meet Contract Administrator's approval.
 - .1 Present line items from Section 20 08 00 – COMMISSIONING as shown below.
 - .2 List and track each of the approved changes on separate lines on the progress draw.
- .3 Amortize costs of temporary facilities and utilities over the duration of the Work. Claims for 'mobilization,' 'bidding costs,' or similar lump sums at or before start of Work are not acceptable.

GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS

EXAMPLE SCHEDULE OF MECHANICAL VALUES

Mechanical Subcontractor Name

Billing Application Mechanical Division

Project Name

Application Number – xx

Date – xxxx to xxxx

Description	Contract Value	%	Billed To Date	%	Prev. Billed	%	This Billing	Balance to Complete
Permits	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Demolition & removals	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Plumbing piping – Materials	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Plumbing piping – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Plumbing fixtures – Materials	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Plumbing fixtures – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Plumbing equipment – Materials	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Plumbing equipment – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Drainage piping – Materials	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Drainage piping – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Drainage pumps – Materials	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Drainage pumps – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Fire protection piping – Materials	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Fire protection piping – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Fire protection valves / equipment – Materials	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Fire protection valves / equipment – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
HVAC piping – Materials	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
HVAC piping – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
HVAC ductwork – Materials	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
HVAC ductwork – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
HVAC equipment – Materials	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
HVAC equipment – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Building Automation System raceways and wiring – Materials	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Building Automation System raceways and wiring – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Building Automation System equipment – Materials	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Building Automation System equipment – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Heat tracing – Materials	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Heat tracing – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Gas service – Materials	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Gas service – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx

Gas piping – Materials	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Gas piping – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Water service – Materials	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Water service – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Fuel oil system – Materials	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Fuel oil system – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Excavation and backfill – Materials	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Excavation and backfill – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Balancing Contractor walk-through of site with Mechanical Contractor to confirm that all valves, appurtenances, dampers, and balancing devices to fully balance and test the systems are available and accessible	x,xxx.xx	xxx	x,xxx.xx	xxx	x,xxx.xx	xxx	x,xxx.xx	x,xxx.xx
Shop Drawings (0.5 % of contract value)	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Installation review and equipment verification (0.5 % of contract value)	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Plumbing and drainage system testing (0.5 % of contract value)	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Testing of piping systems (0.5 % of contract value)	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Assistance with Independent Contractor balancing of piping systems (0.25 % of contract value)	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Testing of air systems (0.5 % of contract value)	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Assistance with Independent Contractor balancing of air systems (0.25 % of contract value)	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
System start-up (0.5 % of contract value)	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Commissioning / Testing (3% of contract value)	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Operating & Maintenance Manuals (0.5 % of contract value)	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Training (0.5 % of contract value)	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
As-Built Drawings (0.5 % of contract value)	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Demobilization / Clean-up	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	Xxx	xxx,xxx.xx	xxx,xxx.xx
Subtotal	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Additions to Contract								
CO # / PC # / CCN #	xx,xxx.xx	xxx	xx,xxx.xx	xxx	xx,xxx.xx	xxx	xx,xxx.xx	xx,xxx.xx
Cash Allowance #	xx,xxx.xx	xxx	xx,xxx.xx	xxx	xx,xxx.xx	xxx	xx,xxx.xx	xx,xxx.xx

GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS

Subtotal	xx,xxx.xx	xxx	xx,xxx.xx	xxx	xx,xxx.xx	xxx	xx,xxx.xx	xx,xxx.xx
	-----		-----		-----		-----	-----
	-----		-----		-----		-----	-----
Total Contract	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Less Holdback			xxx,xxx.xx		xxx,xxx.xx		xxx,xxx.xx	
			-----		-----		-----	
Total			xxx,xxx.xx		xxx,xxx.xx		xxx,xxx.xx	

PART 2 - PRODUCTS

2.1 Not Used

PART 3 - EXECUTION

3.1 Not Used

END OF SECTION

ABBREVIATIONS

PART 1 - GENERAL

1.1 Abbreviations

- .1 The following list of common abbreviations and acronyms may be utilized in the Contract Documents or in the execution of the Work. The list is considered general in nature and all abbreviations or acronyms identified may not apply to the specific Work required to be completed. The list is not exhaustive and some abbreviations or acronyms may be the same however represent different denotation (e.g. BHP - Boiler Horsepower and BHP - Brake Horsepower) and must be read in the context of the Section the abbreviation or acronym is written in. A Section may define alternative abbreviations or acronyms that take precedence in the execution of the Work of that Section.

AABC	- Associated Air Balance Council
AAP	- Alarm Annunciator Panel
ABMA	- American Boiler Manufacturers Association
ABSA	Alberta Boilers Safety Association
AC	- Alternating Current
ACO	- Acid Resistant Cleanout
AD	- Acid Resistant Drains
AFD	- Acid Resistant Floor Drain
AFF	- Above Finished Floor
AGA	- American Gas Association
AMCA	- Air Movement and Control Association
ANSI	- American National Standards Institute
AHRI	- Air-Conditioning, Heating and Refrigeration Institute
ASCE	- American Society of Civil Engineers
ASHRAE	- American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	- American Society of Mechanical Engineers
ASTM	- American Society for Testing and Materials
AV	- Acid Resistant Vent
AWG	- American Wire Gauge
AWS	- American Welding Society
AWWA	- American Water Works Association
BHP	- Boiler Horsepower or Brake Horsepower
Btu/hr	- British Thermal Units per Hour
BWG	- British Wire Gauge
CAD	- Computer Aided Drafting
CAFV	- Controllable Air Flow Venturis
CAP	- College of American Pathologists
CBC	- California Building Code
CCA	- Chromated Copper Arsenate
CEMA	- Canadian Electrical Manufacturer's Association

ABBREVIATIONS

CEMS	- Central Energy Management System
CCF	- Central Computer Facility
CCMC	- Canadian Construction Materials Centre
cfm	- Cubic Feet per Minute
CGA	- Canadian Gas Association
CGSB	- Canadian General Standards Board
CI	- Cast Iron
CIMJ	- Cast Iron Mechanical Joint
CPU	- Central Processing Unit
CRN	- Canadian Registration Number
CSA	- Canadian Standards Association
cu.ft.	- Cubic Feet
cu.m.	- Cubic Meter
c/w	- Complete with
db	- Dry Bulb
dB	- Decibel
dBA	- A-weighted Decibel
DC	- Direct Current
DDC	- Direct Digital Control
DegC	- Degrees Celsius
DegF	- Degree Fahrenheit
dia.	- Diameter
DPDT	- Double Pull Double Throw
DPTX	- Differential Pressure Transmitters
EAP	- Excess Exhaust Alarm Panel
EDR	- Equivalent Direct Radiation
EF	- Exhaust Fan
EEMAC	- Electrical Equipment Manufacturers Association of Canada
EEPROM	- Electrically Erasable Programmable Read-Only Memory
EMT	- Electrical Metallic Tubing
EP	- Electric Pneumatic
EPDM	- Ethylene Propylene Diene-Rubber
EPROM	- Electrically Programmable Read Only Memory
ERW	- Electric Resistance Welded
FACP	- Fire Alarm Control Panel
FDA	- Food and Drug Administration
FHC	- Fume Hood Controller or Firehose Cabinet
FLA	- Full Load Amps
fpm	- Feet per Minute
fps	- Feet per Second
FM	- Factory Mutual

ABBREVIATIONS

ft.	-	Foot or Feet
ga	-	Gauge
gal	-	Gallons
GFD	-	Gallons per Square Feet per Day
GPD	-	Gallons per Day
GPH	-	Gallons per Hour
GPM	-	Gallons per Minute
GS	-	Galvanized Steel
GSG	-	Galvanized Sheet Gauge
GSS	-	Galvanized Sheet Steel
h-cu.ft.	-	Hour-cubic footHCFCs - Hydrochlorofluorocarbons
HEPA	-	High Efficiency Particulate Air
HOA	-	Hand/Off/Auto
HOT	-	Hand Held Operator Terminal
HSS	-	Hollow Steel Sections or Hollow Structural Sections
HTK	-	Hood Termination Kit
hp	-	High Pressure or Motor Horsepower
Hz	-	Hertz
IAO	-	Insurers' Advisory Organization
IAOC	-	Insurers' Advisory Organization of Canada
IBC	-	International Building Code
ICU	-	Intensive Care Unit
(I)GPH	-	(Imperial) Gallons per Hour
(I)GPM	-	(Imperial) Gallons per Minute
in.	-	Inch or Inches
in. WG	-	Inches of Water Gauge
IRMA	-	Inverted Roof Membrane Assembly
kg	-	Kilogram
kg/cu.m.	-	Kilogram per cubic meter
kPa	-	Kilopascals
kVa	-	Kilovolt-amps
kW	-	Kilowatts
lbs/cu.ft.	-	Pounds per cubic foot
lbs/hr.	-	Pounds per Hour
L	-	Litre
L/s	-	Litres per Second
LFC	-	Laminar Flow Cabinets
LEDs	-	Light Emitting Diodes
LCP	-	Laboratory Control Panel
LTF	-	Linear foot
LM	-	Linear meter

ABBREVIATIONS

mA	- Milliamps
MAC	- Make-up Air Controller
mADC	- Milliamps Direct Circuit
MBH	- 1000 British Thermal Units per Hour
MCC	- Motor Control Centre
mm	- Millimetre
m	- Metre
m/s	- Metres per Second
mL	- Millilitre
MCP	- Motor Control Panel
MJ	- Mechanical Joint
MOV	- Motor Overvoltage
mPa	- Millipascals
MSC	- Master Summing Controller
MSG	- Manufacturers' Standard Gauge
NADCA	- National Air Duct Cleaners Association
NBS	- National Bureau of Standards
NC	- Noise Criterion as Defined by Graph in ASHRAE
NCCLS	- National Committee for Clinical Laboratory Standard
NEMA	- National Electrical Manufacturers Association
NFPA	- National Fire Protection Association
NIM	- Network Interface Module
NIST	- National Institute of Standards and Technology
NIOSH	- National Institute of Occupancy Safety and Health
NPS	- American National Standard Straight Pipe Thread
NPSH	- Net Positive Suction Head
NPT	- American National Standard Taper Pipe Thread
No.	- Number
NST	- National Standard Thread
NVLAP	- National Voluntary Laboratory Accreditation Program
OAT	- Outside Air Temperature
OC	- On Centre
OCP	- Operator Control Panel
OPSS	- Ontario Provincial Standard Specification
OS&Y	- Outside Screw and Yoke
OWRA	- Ontario Water Resources Act
oz.	- Ounce or Ounces
PCU	- Personal Computer Unit
PE	- Pneumatic Electric
PIT	- Portable Interface Terminal
ph	- Hydrogen Ion Concentration

ABBREVIATIONS

ppm	- Part per Million
psf	- Pounds per Square Foot
psi	- Pounds per Square Inch
psia	- Pounds per Square Inch Absolute
psig	- Pounds per Square Inch Gauge
PWM	- Pulse Width Modulation
PVC	- Polyvinyl Chloride
qt.	- Quart
RAH	- Return Air Humidity
RH	- Relative Humidity
RO	- Reverse Osmosis
rpm	- Revolutions per Minute
RPU	- Remote Processing Unit
RPU-TU	- Remote Processing Unit for Terminal Units
SCFH	- Standard Cubic Feet per Hour
SCMH	- Standard Cubic Meters per Hour
SCR	- Silicone Controlled Rectifier
SI	- International System of Units
SMACNA	- Sheet Metal and Air Conditioning Contractors' National Association
sp. in. wg.	- Static Pressure, Inches Water Gauge
SPDT	- Single Pull Double Throw
SPS	- Sash Position Sensor
SS	- Stainless Steel
SF	- Supply Fan
SPWM	- Sine-Coded Pulse Width Modulated
SSPC	- Steel Structures Painting Council (The Society of Protective Coatings)
sq.m.	- Square Meter
STC	- Supply/Exhaust Tracking Controller or Sound Transmission Class
SWS	- Sidewall Velocity Sensors
TDS	- Totally Dissolved Solids
TEFC	- Totally Enclosed Fan Cooled
TIG	- Tungsten Inert Gas
TKV-TWA	- Threshold Limit Value - Time Weighted Average
UACU	- Unitary Air Conditioning Units
UL	- Underwriter's Laboratories
ULC	- Underwriter's Laboratories of Canada
Ohm	- Ohm
USP	- United States Pharmacopeia
USG	- United States Gallons
USGPH	- United States Gallons per Hour
USGPM	- United States Gallons per Minute

ABBREVIATIONS

UV	- Ultraviolet
VAC	- Volts Alternating Current
VDC	- Volts Direct Current
VFD	- Variable Frequency Drive
VSC	- Variable Speed Controllers
VSCFH	- Closed Loop Variable Frequency Drives For Dedicated Exhaust Hoods
VSD	- Variable Speed Drives
W	- Watt
W/cu.m.	- Watts per Cubic Meter
W/ft.	- Watts per Foot
W/m	- Watts per Meter
W/sq.in.	- Watts per Square Inch
W/sq.m.	- Watts per Square Meter
WC	- Water Closet
wb	- Wet Bulb
wg	- Water Gauge
WHMIS	- Workplace Hazardous Material Information System
WSP	- Working Steam Pressure
WOG	- Water, Oil, Gas

PART 2 - PRODUCTS

2.1 Not Used

PART 3 - EXECUTION

3.1 Not Used

END OF SECTION

AS-BUILT DRAWINGS

PART 1 - GENERAL

1.1 Work Included

- .1 Comply to 01 32 00 Construction Progress Documentation
- .2 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Related Work Specified Elsewhere

- .1 Refer to as-built drawings in Section 01 70 00 (01 78 00) - CLOSEOUT SUBMITTALS.

1.3 Record of Revisions On Site

- .1 Maintain an updated copy of plans and schematics in the digital format for which the Project is provided (i.e. AutoCAD or Autodesk Revit MEP) and be capable to produce documents in Adobe PDF upon request.

1.4 Submittals

- .1 Comply with 01 33 00 Submittal Requirements
- .2 Submit as-built drawings in CAD format and PDF format for underground services for review prior to slab pour.
- .3 Submit as-built drawings in CAD format and PDF format for all other areas of the building prior to request for occupancy.
- .4 Comply with Section 20 05 03 - SHOP DRAWINGS for all submittals.

PART 2 - PRODUCTS

2.1 Not Used

PART 3 - EXECUTION

3.1 Documentation Requirements

- .1 As the Project progresses record all changes and deviations.
- .2 Maintain an accurate dimensional record of revisions. Specifically record:
 - .1 Underground piping invert elevations and pipe locations dimensioned to column lines after review and acceptance by the Authority Having Jurisdiction.
 - .2 Inverts of underground piping at building exit and entry, below floor slab at each branch connection, riser base, and change in direction as well as a least 3 points on long straight runs.
 - .3 Above ground piping revisions.
 - .4 Duct revisions.
 - .5 Equipment revisions.
 - .6 Locations of access doors and panels. Identify the equipment and components they serve.

AS-BUILT DRAWINGS

- .7 Locations of valves.
- .8 Locations of water hammer arrestors.
- .9 Locations of all backflow preventers.
- .10 Vent pipe routing.
- .11 Locations of all expansion loops on all piping systems.
- .3 Keep revisions up-to-date during construction including Change Orders and Supplemental Instructions. Make documentation available for review at all times.
- .4 Final as-built documents shall not contain markings or corrections electronically or by hand (i.e. marker, pen, pencil, etc.). Drawings submitted that contain mark-ups will not be accepted.
- .5 Final as-built drawings to include all revisions made to the drawings during construction, including all approved changes.

3.2 Submission Requirements

- .1 On completion of the Work, submit the draft documentation indicating all such changes and deviations for review by the Contract Administrator. Submit all documents in PDF format.
- .2 Upon return of the "Reviewed" draft submittal, transfer "as-built" information and any additional submittal comments to the final software submission requirement (Autodesk AutoCAD latest version) for all building systems and components.
 - .1 Request the acceptable version(s) of the software that may be used. The City shall confirm the acceptable software version upon receipt of request. If The City has no preference, the latest published version shall apply.
 - .2 Conform to The City and the Contract Administrator's standards.
 - .3 The Mechanical Subcontractor may request from the Contract Administrator the most current electronic documentation (Mechanical Drawings) in Autodesk Revit MEP. Documents to be forwarded via a secure file transfer. The Contract Administrator will provide the Drawings one time at no charge. Where the Drawings are requested more than one time throughout the course of the project, a nominal charge of \$500.00 will apply to the second and subsequent requests.
 - .4 Clearly label electronic files with Contract Administrator and The City, Contract number, file names and the Drawing number.
- .3 Submit the documents in PDF along with the submission of the completed electronic source software documentation on an approved electronic storage device for review by the Contract Administrator. The PDF is to be signed and dated by the Engineer of Record.
- .4 If required, the Contract Administrator will provide a quotation to this Contractor to transfer "as-built" information from the mark-up documentation to the acceptable software.

AS-BUILT DRAWINGS

- .5 The contractor is to identify the cost of As-Built Drawings and the Operation and Maintenance Manuals as a separate line item on their progress draw. The following values are to be broken out:

\$5,000	For Mechanical Contracts up to \$250,000
2% of Mechanical Contract	For Mechanical Contracts from \$250,000 to \$1,500,000
\$30,000	For Mechanical Contracts over \$1,500,000

- .6 The project will remain incomplete and monies retained until a satisfactory as-built submission and the final versions, both hard and electronic, of the drawings and manuals are received.

3.3 Autodesk Revit MEP Specific Submission Requirements

- .1 Submit a complete list of layer names and brief description of each layer's use with all files.
- .2 Submit a complete list of symbol (block) names with a description of each symbol.
- .3 Make special effort to ensure that drafting is accurate, i.e. appropriate lines are indeed horizontal and vertical; lines that should intersect do but not over-intersect and that entities are placed on correct layers.
- .4 Use the standard fonts available in the software. Do not use custom fonts, shape files, etc.
- .5 Provide all drawings in the same scale of measurement and units as issued on Bid Documents.

END OF SECTION

SHOP DRAWINGS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Related Work Specified Elsewhere

- .1 Comply with Section 01 33 00 (01 33 23) for Submittals except as amended below.

PART 2 - PRODUCTS

2.1 Shop Drawings

- .1 Submit Shop Drawings organized by Specification Section. Ensure shop drawing package for a given Specification Section is complete, including all equipment, products, materials, and systems to be used as part of that Specification Section, and submit as a single shop drawing package. Do not submit numerous separate Shop Drawings for the same Specification Section. Do not combine more than one Specification Section into one submission. Incorrect submissions will be returned without review.
- .2 Submit Shop Drawings electronically, by email, in PDF format. Submissions that are not electronic without prior approval from the Contract Administrator shall be returned as not reviewed. Provide the following information in the email submission:
 - .1 S+A Project number and Contractor Shop Drawing Identifier in Subject Line
 - .2 Attachments shall be limited to 20 MB
 - .3 Provide FTP hyperlink for all attachments in excess of 20 MB with appropriate information for downloading the file (as required)
 - .4 Shop Drawing Submission to the following email address:
ContractAdmin.Winnipeg@smithandandersen.com
 - .5 Shop drawings submitted directly to Smith + Andersen personnel (and not copied to the email address provided above) without advanced permission will not be processed nor considered as received.
- .3 Shop Drawings shall indicate clearly the materials and/or equipment actually being supplied, all details of construction, accurate dimensions, capacity, operating characteristics and performance. Each Shop Drawing shall give the identifying number as noted in the documents of the specific pump, fan, etc. for which it was prepared.
- .4 Each Shop Drawing for non-catalogue items shall be prepared specifically for this Project. Shop Drawings and brochures for catalogue items shall be marked clearly to show the items being supplied.
- .5 When requested, Shop Drawings shall be supplemented by data explaining the theory of operation. The Contract Administrator may also request that this information be added to the maintenance and operating manual.
- .6 Provide a cover sheet with the Project name, issue date, issue number, Specification section number, title of section and with space for Shop Drawing review stamps for the Contractor and Contract Administrator.

SHOP DRAWINGS

2.2 Environmental Product Declarations (EPD)

- .1 Where EPDs are available for Products, submit them for review.
- .2 Follow Product Category Rules (PCRs) for Life Cycle Assessment (LCA) presented on EPDs.
- .3 Where multiple EPDs are available for the same Product, the order of preference is as follows:
 - .1 Product Specific, Facility Specific EPD: a Product and manufacturer specific EPD, where the environmental impacts are unique to the specific manufacturing facility.
 - .2 Product Specific EPD: a Product and manufacturer specific EPD where the environmental impacts are considered across multiple manufacturing facilities (i.e. an average of the different facilities in which the Product is manufactured).
 - .3 Industry Average EPD: an EPD for a type of Product, representing the typical environmental impacts averaged across a number of different manufacturers.

PART 3 - EXECUTION

3.1 Submissions

- .1 Each Shop Drawing or catalogue sheet shall be in original PDF format stamped and signed by the Contractor to indicate that they have checked the submission for conformance with all requirements of the Drawings and Specifications, that they have co-ordinated this equipment with other equipment to which it is attached and/or connected and that they have verified all dimensions to ensure the proper installation of equipment within the available space and without interference with the Work of other trades. Ensure that electrical co-ordination is complete before submitting Shop Drawings for review.
- .2 Scanned PDF versions are not acceptable.
- .3 Manufacturing of equipment, installation of equipment or connecting services shall not start until after final review of Shop Drawings by the Contract Administrator has been completed.
- .4 Should equipment or materials that arrive on site differ from those shown on the Shop Drawings, bear all costs for:
 - .1 Revising the equipment and materials.
 - .2 Revising the Work of other Contractors impacted.

END OF SECTION

ELECTRIC MOTORS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 Provide electric motors for all driven equipment supplied by this Division.

1.2 Submittals

- .1 Provide Shop Drawings for all electrical motors in accordance with Section 20 05 03 - SHOP DRAWINGS and incorporate the following information:
 - .1 Horsepower
 - .2 Voltage
 - .3 Frequency
 - .4 Speed
 - .5 Starting current and torque characteristics
 - .6 Full load current
 - .7 Class of insulation
 - .8 Enclosure type
 - .9 Service factor
 - .10 Ambient temperature reference
 - .11 Type of bearings
 - .12 Locations of connection box
 - .13 Manufacturer
 - .14 Motor starting times

PART 2 - PRODUCTS

2.1 Materials

- .1 Motors:
 - .1 Efficiency:
 - .1 Meet or exceed requirements of ASHRAE 90.1 "Energy Standard for Sites and Buildings Except Low-Rise Residential Buildings," CSA C390 "Test method, marking requirements, and energy efficiency levels for three-phase induction motors," and Government of Canada Electric Motors Energy Efficiency Regulations.
 - .2 High efficiency motors: T frame, AC, three phase, meeting or exceeding the CSA C390 "Test Methods, Marking Requirements, and Energy Efficiency Levels for Three-phase Induction Motors" Table 3 Premium Efficiency levels and approved under the Canadian Electrical Code:
 - .1 Provide high efficiency motors for all fans and pumps having motors 0.75 kW (1 hp) or larger.
 - .2 Squirrel cage induction type with standard drip proof enclosure.

ELECTRIC MOTORS

- .3 Conform to NEMA and CSA standards for electrical motors.
- .4 Canadian manufacturer where possible.
- .5 1750 nominal rpm unless specified otherwise.
- .6 Class B Insulation.
- .7 For motors controlled by variable speed drives, provide class H windings and class F insulation and comply with NEMA MG 1 "Motors and Generators" Part 31 "Definite Purpose Inverter-fed Polyphase Motors."
- .8 Starting current-torque characteristics in accordance with NEMA, Design B unless otherwise specified or unless load characteristics dictate otherwise.
- .9 Starting times: start and accelerate to full speed within 10 seconds.
- .10 Motor horsepower indicated in the Specifications, Schedules, or Drawings are minimums.
- .11 Designed for continuous operation at 40 deg. C. (104 deg. F.).
- .2 Motors controlled from Variable Speed Drives:
 - .1 Maintenance free, conductive microfiber, shaft grounding ring.
 - .1 AEGIS SGR for low voltage motors up to 500 hp.
 - .2 AEGIS Pro Series for medium and low voltage motors over 500 hp.
 - .3 Where explosion proof motors are required, locate shaft grounding rings within explosion proof enclosure in accordance with IEEE Standard 303 "IEEE Recommended Practice for Auxiliary Devices for Rotating Electrical Machines in Class I, Division 2 and Zone 2 Locations" or inside the explosion proof motor. Install in accordance with manufacturer's recommendations.
- .3 Locate motor connection boxes on side of motor most easily accessible for maintenance and remote from belts, gears or driven equipment. If boxes are factory installed on wrong side of motor, relocate as required.
- .4 Motor characteristics unless noted otherwise in equipment schedules:
 - .1 For 0.375 kW (1/2 hp) and larger 575 volt, 3 phase, 60 cycle.
 - .2 For 0.25 kW (1/3 hp) and smaller 120 volt, 1 phase, 60 cycle.
- .5 Single phase motors 0.25 kW (1/3 hp) and smaller: capacitor start.
- .6 Provide motors 22.4 kW (30 hp) and larger with heat detector protection embedded in the windings for connection into the motor control circuit.
- .7 Motors 74.6 kW (100 hp) and larger: suitable for reduced voltage starting, delta-wye.
- .8 Motor enclosures as follows:
 - .1 If protected from the weather and entraining moisture, use open drip-proof, service factor 1.15.
 - .2 Motors located in air streams: suitable for satisfactory operation at maximum temperature and moisture levels of surrounding air.
 - .3 For all other locations, use totally-enclosed fan-cooled (TEFC), service factor 1.0.
 - .4 Use explosion proof motors where scheduled.

ELECTRIC MOTORS

- .9 Nameplate: minimum of 2 mm (3/32 in.) thick laminated phenolic plastic 100 mm (4 in.) long x 50 mm (2 in.) wide with black face and white centre, 5 mm (7/32 in.) high letters engraved through to the white lamination, securely fastened in a conspicuous place on the motor. Include the following information on the nameplate:
 - .1 Motor No.
 - .2 Mechanical Equipment Driven
 - .3 Circuit No.
 - .4 Panel No.
 - .5 Panel Location
- .10 Manufacturer nameplate: include the nominal full load motor efficiency.
- .11 Manufacturers:
 - .1 Canadian General Electric
 - .2 TECO Westinghouse
 - .3 Lincoln
 - .4 US Motors
 - .5 Weg
 - .6 ABB Baldor

PART 3 - EXECUTION

3.1 Installation

- .1 Install protective guards over all moving parts. Include tachometer holes for each shaft.

END OF SECTION

WIRING AND STARTERS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 All power and control wiring from starters and fused and non-fused disconnect switches, whether mounted in MCCs or individually, to all mechanical devices and equipment shall be provided by this Division except where shown and specified under the Electrical Division.
- .3 All starters for devices supplied by this Division shall be provided by this Division except where shown and specified under the Electrical Division.

1.2 Related Work Specified Elsewhere

- .1 All power wiring and starters for devices supplied by this Division shall be provided by the Electrical Division except where shown and specified under this Division. All control wiring shall be provided by this Division.
- .2 Where starters for skid mounted, packaged equipment are provided by this division they shall meet the requirements of the Electrical Division.

PART 2 - PRODUCTS

2.1 By Electrical.

PART 3 - EXECUTION

3.1 Installation

- .1 All wiring and starters provided by this Division shall comply with the requirements of the Electrical Division of the Specifications.
- .2 This Division shall review the Shop Drawings for the motor starters submitted by the Electrical Division to ensure that all field connections are shown, the motor horsepower's are correct and that the motor control schematics reflect all requirements.
- .3 Ensure slack is provided in control wiring connections to control valves, dampers, differential pressure sensors, or other equipment with moving parts.

END OF SECTION

VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to the Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Quality Assurance

- .1 The Variable Frequency Drive (VFD) manufacturing facility shall be ISO 9001 "Quality Management Systems - Requirements" certified. The VFD shall be UL listed, Canadian UL listed and CSA listed.
- .2 Provide a minimum 100,000 hours mean time between failure (MTBF).
- .3 The term Variable Frequency Drive (VFD) shall be synonymous with Variable Speed Drives (VSD) and Adjustable Frequency Drives (AFD).
- .4 All Variable Frequency Drives for this Project shall be of a single manufacturer for all fan and pump systems, including all components that require VFDs for air handling equipment, cooling towers, fluid coolers, pumps, etc. except where specifically identified as part of a packaged system in these Specifications.

1.3 Related Work

- .1 For motors connected to Variable Frequency Drives, refer to requirements of Section 20 05 13 - ELECTRIC MOTORS.

1.4 Submittals

- .1 Submit Shop Drawings of all items supplied in accordance with requirements of Section 20 05 03 - SHOP DRAWINGS.
- .2 Ensure Shop Drawings include VFD Short Circuit Current Rating (SCCR).

PART 2 - PRODUCTS

2.1 General Requirements

- .1 Variable Frequency Drives (VFD) shall be Danfoss VLT HVAC Drive FC102, Rockwell Automation Allen-Bradley PowerFlex 700, and ABB ACH580 as specified herein for the fans, pumps, heat recovery wheels, and cooling tower fans designated on the schedules or in the respective sections to be variable speed.
- .2 All standard and optional features shall be included within the VFD enclosure, unless otherwise specified. The VFD's UL listing shall allow it to be mounted in a plenum or other air handling compartments.
- .3 For indoor applications, the VFD shall be housed in a CSA Type 1 with drip hood, sprinkler proof enclosure.
- .4 For outdoor and humid (>70% relative humidity) applications, the VFD shall be housed in a CSA Type 3R enclosure.
- .5 The VFD shall be a digitally controlled drive, using Pulse Width Modulation (PWM) technology with sensorless vector control. It shall utilize IGBTs in its inverter section.

VARIABLE FREQUENCY DRIVES

- .6 The VFD shall allow the motor to produce full rated power at rated amps, RMS fundamental volts, and speed without using the motor's service factor when the motor's rated voltage is applied to the VFD input.
- .7 The VFD shall include an integral disconnect switch on the line side of the drive.
- .8 VFDs for pumps shall bear a minimum Short Circuit Current Rating (SCCR) listed by a Nationally Recognized Testing Lab, acceptable to the local Authority Having Jurisdiction, and shall be 35,000 A Lower SCCR listed units implying the use of current limiting fuses ahead of them in the field, in lieu of an actual appropriate SCCR rating, are not acceptable.
- .9 The VFD including all specified options shall be assembled by the ANSI/UL Standard 508 "Industrial Control Equipment" certified manufacturer for the building and assembly of option panels and the complete unit shall be tested to ANSI/UL Standard 508. Assembly of the option panels by a third-party panel shop shall not be acceptable. Where the components are separate, the appropriate CSA or C-UL stickers shall be applied to both the VFD and option panel. Both the VFD and option panel shall be manufactured in ISO 9001 "Quality Management Systems - Requirements" certified facilities.
- .10 The VFD shall have a 5% THD input current harmonic filter, designed such that no individual current harmonic will be greater than 4% at full load operation. The supply of line reactors (such as 3% DC reactors or 5% AC reactors), without filters, is NOT acceptable. Filters shall be by Matrix or Mirus (The Lineator) or similar.
 - .1 Filter must never introduce a capacitive reactive power (kVAR) which is greater than 15% of its kVA rating for sizes ≥ 100 HP and 20% for sizes ≤ 75 HP.
 - .2 Provide the harmonic filter with a built-in "automatic control" capacitor switching system with the following features / functionality:
 - .1 Factory install and wire capacitor switching system components and accessories within the harmonic filter enclosure.
 - .2 Include current switch (current transformer and relay combination device) or equivalent, as part of capacitor switching system.
 - .3 Provide current switch that switches harmonic filter capacitors into the filter circuit only when the load current downstream of the filter reaches a field adjustable current threshold.
 - .4 Factory set current threshold at 30 % of the full load current of the downstream mechanical equipment.
 - .5 Provide current switch that allows one harmonic filter output wire to be routed through its current transformer window to allow monitoring of the current of the downstream mechanical load.
 - .6 Provide current switch with built-in adjustable time delay, adjustable between 0 and 15 seconds and factory set at 15 seconds.
 - .7 Provide current switch with field adjustable current threshold, adjustable in at least 10% increments from 0% to 100%.

VARIABLE FREQUENCY DRIVES

- .11 The VFD's full load amp rating shall meet or exceed Canadian Electrical Code Table 44 "Three-phase ac motors." The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 160% of rated current for up to 0.5 second while starting.
- .12 The VFD shall be able to provide full torque at any selected frequency from 28 Hz to base speed to allow driving direct drive fans without derating.
- .13 Input and output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD. Switching rate may be up to 1 time per minute on the input and unlimited on the output. Disconnect switches located between the drive and the motor shall be interlocked into the VFD's safety circuitry.
- .14 An automatic motor adaptation test algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or de-couple the motor from the load to run the test.
- .15 VFD power components shall be designed for 600 V AC where intended for 575/600 V service. Components designed for 480 V AC installed on 575/600 V service shall not be acceptable.
- .16 VFD shall minimize the audible motor noise through the use of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD efficiencies while reducing motor noise.
- .17 VFD's output switching shall be maintained within the requirements of NEMA Standard MG 1 "Motors and Generators" Part 30. VFD's with output exceeding 1000 V shall employ dV/dT output filters.

2.2 Protective Features

- .1 A minimum of Class 20 I²t electronic motor overload protection for single motor applications and thermal-mechanical overloads for multiple motor applications shall be provided.
- .2 Protection against input transients, loss of AC line phase, output short circuit, output ground fault, over-voltage, under-voltage, VFD over-temperature and motor over-temperature. The VFD shall display all faults in plain English. Codes shall not be acceptable.
- .3 Where the Electrical Drawings indicate that the VFDs are to be used on a high resistance grounded (HRG) power distribution system, as is common in hospitals, data centres, and industrial facilities, ensure that VFD surge protection devices are of the delta connected type, and ensure that metal oxide varistor (MOV) maximum continuous operating voltage (MCOV) is selected for a HRG power distribution system of the voltage shown on the Electrical Drawings. Ensure that MOVs will not fail when a sustained line-to-ground fault occurs on the HRG system and the two unfaulted phases see their line-to-ground voltage rise to the line-to-line voltage until The City undertakes a scheduled shutdown at a later time. Ensure that the remainder of the VFD components are selected for proper application on a HRG system.
- .4 Protect the VFD from sustained power or phase loss. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal.
- .5 The VFD assembly including all required options shall be rated for 100,000 A interrupting capacity (AIC).

VARIABLE FREQUENCY DRIVES

- .6 The VFD shall have built-in or externally mounted EMI electromagnetic filters to limit the EMI and RFI output from the VFD, designed to meet standard EN/IEC 61800-3 "Adjustable speed electrical power drive systems - Part 3: EMC requirements and specific test methods."
- .7 The VFD shall have a wide operating supply power range and shall continue to operate without faulting or tripping until the input voltage reaches at least 701 V AC on 600 V systems and 300 V AC on 208/230 V systems and 539 V AC on 460 V systems.

2.3 Interface Features

- .1 Each VFD shall have the same operator's keypad, including digital display with Hand/Start, Off/Stop, Auto/Start, and Help selector switches or buttons that shall be provided to start and stop the VFD and determine the speed reference. The keypad shall be removable, capable of remote mounting and allow for uploading and downloading of parameter settings. The keypad shall include a built-in real time clock with date function. Speed Transfer between Hand and Auto shall be "bumpless."
- .2 Each VFD shall include an open system communication protocol interface, BACnet as defined by ANSI/ASHRAE Standard 135 "BACnet™--A Data Communication Protocol for Building Automation and Control Networks" for seamless integration with Section 23 09 00 - BUILDING AUTOMATION SYSTEM (BAS).
- .3 Run permissive circuit shall be provided to accept a "system ready" signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation. The run permissive circuit shall also be capable of sending an output signal as a start command to actuate external equipment before allowing the VFD to start.
- .4 The VFD shall be able to be programmed to sense the loss of load and signal a no load/broken belt warning or fault.
- .5 If the temperature of the VFD's heat sink rises to 80 Deg. C. (176 Deg. C.), the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature. If the temperature of the heat sink continues to rise the VFD shall automatically reduce its output frequency to the motor. As the VFD's heat sink temperature returns to normal, the VFD shall automatically increase the output frequency to the motor and return the carrier frequency to its normal switching speed.
- .6 At least six programmable digital inputs shall be provided for interfacing with the system's control and safety interlock circuitry.
- .7 As a minimum, the following hardware points shall be available for direct connection to Section 23 09 00 - BUILDING AUTOMATION SYSTEM (BAS):
 - .1 VFD Start/Stop
 - .2 VFD Speed Control
 - .3 VFD Speed Feedback
- .8 Under smoke control or special fire mode conditions, the VFD shall be able to be programmed to automatically default to a pre-set speed or bypass.

VARIABLE FREQUENCY DRIVES

2.4 Service Conditions

- .1 Ambient temperature, -10 Deg. C. to 40 Deg. C. (14 Deg. F. to 104 Deg. F.) without derating.
- .2 0 to 95% relative humidity, non-condensing.
- .3 Elevation to 1005 m (3300 ft.) without derating.
- .4 AC line voltage variation, -10 to +10% of nominal with full output.
- .5 No side clearance shall be required for cooling of any units. All power and control wiring shall be done from the bottom.

PART 3 - EXECUTION

3.1 Installation

- .1 Comply with manufacturer's installation instructions.
- .2 Provide a disconnect switch at the motor where required by the authorities having jurisdiction. Where such a disconnect switch is installed, provide an auxiliary contact or switch at the disconnect switch, mounted to open when the disconnect switch is opened and wired to a terminal strip in the VFD such that opening the disconnect switch initiates a drive shut down and prevents the drive from starting in either Line or Drive positions.
- .3 Locate and mount VFD panels in Mechanical Rooms and/or where shown on the Drawings.
- .4 Where VFDs and or small harmonic filters are shown on the Drawings in locations away from building walls or need to be installed away from building walls, install them in accordance with the Execution requirements of Section 20 05 29 – HANGERS AND SUPPORTS.
- .5 Where harmonic filters are floor mounted, provide concrete housekeeping pads in accordance with the requirements of Section 20 05 48 – VIBRATION AND NOISE CONTROL and Section 20 05 00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .6 Arrange for manufacturer's technical representative or local qualified representative to:
 - .1 Inspect the installation of the drives and to start-up.
 - .2 Test and commission the drives. The VFD shall operate a dynamometer at full load and speed and shall be cycled during the test.
 - .3 Be present during testing and commissioning performed under Section 23 09 00 - BUILDING AUTOMATION SYSTEM (BAS).
- .7 Measure the distortion of each phase at the load terminals of the branch breaker and report the results to the Contract Administrator. Any deficiency shall be corrected and re-evaluated.
- .8 Implement a communication protocol for remote interface to match the communication protocol under Section 23 09 00 - BUILDING AUTOMATION SYSTEM (BAS).
- .9 BAS connection to drives provided under Section 23 09 00 - BUILDING AUTOMATION SYSTEM (BAS).

VARIABLE FREQUENCY DRIVES

- .10 Where harmonic filters require capacitor switching system per requirements of Part 2 of this Specification section, ensure the following:
 - .1 One harmonic filter output wire is routed through current switch current transformer window to allow monitoring of downstream load. Comply with manufacturer's written instructions. Coordinate with Electrical.
 - .2 Current switch current threshold is set at 30 % of the full load current of the mechanical equipment downstream of each individual harmonic filter.

3.2 Warranty

- .1 Warranty shall be 24 months from the date of Substantial Performance of the Work. Warranty shall be on-site parts and labour inclusive.

END OF SECTION

INDICATING INSTRUMENTS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Submittals

- .1 Shop Drawings: Further to requirements of Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS and Section 20 05 03 - SHOP DRAWINGS, submit working ranges of thermometers and gauges with Shop Drawings.

PART 2 - PRODUCTS

2.1 Materials

- .1 Pipeline thermometers shall be complete with:
 - .1 Dust-tight stainless case and stem with 127 mm (5 in.) dial.
 - .2 Bi-metal type.
 - .3 White face with black lettering.
 - .4 Range normally 0 to 115 deg. C. (32 to 240 deg. F.) for hot water and -17 to 49 deg. C. (0 to 120 deg. F.) for chilled water but range shall suit maximum and minimum temperatures of location and be shown on Shop Drawings.
 - .5 Temperature marking in 1 deg. C. (2 deg. F.) increments in both imperial and metric scales.
 - .6 External recalibration adjustment.
 - .7 Separable socket with extension neck as required for insulated pipe.
 - .8 Universal adjustable hinge.
 - .9 Wells shall be registered with the provincial Boiler and Pressure Vessel Safety Branch and have a CRN.
- .2 Thermometers for remote reading shall be similar to duct thermometers specified above but with armoured extension capillary and bulb with separable well for pipelines or flanged duct connection for averaging bulb, as required.
- .3 Pressure gauges shall be complete with:
 - .1 Dust-tight nominal 115 mm (4½ in.) dia. case, solid front complete with back blow-out to ASME B40.100 "Pressure Gauges and Gauge Attachments", ASME B40.1 "Gauges: Pressure Indicating Dial Type — Elastic Element" Grade 2A Level Standards.
 - .2 Back-flanged where required.
 - .3 Black pointer.
 - .4 White dial with black markings.
 - .5 Dial range to cover twice the average working pressure of the equipment and shall be compound gauges on pump suction for all open systems.

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- .6 Clear lens.
- .7 Phosphor bronze bourdon tube, silver soldered.
- .8 Brass or stainless steel movement, bronze or nylon brushed, scale and movement mounted independent of the case.
- .9 Brass socket.
- .10 kPa and psi scales.
- .11 Provincial Boiler and Pressure Vessel Safety Branches registration number.
- .12 All wetted parts in contact with potable water systems shall be lead free.
- .4 Pressure and temperature test port:
 - .1 Continuous operating temperature range of -40 Deg. C. (-40 Deg. F.) to 65.6 Deg. C. (150 Deg. F.).
 - .2 Dual self closing Nordel valves for 135 Deg. C (275 Deg. F.) intermittent maximum operating temperature.
 - .3 2758 kPa (400 psig) maximum operating pressure.
 - .4 Threaded brass or 316 stainless steel body to suit service material.
 - .5 Screwed cap and gasket with retaining strap.
 - .6 Temperature and pressure test kit in protective carrying case with 2 thermometers, 1 pressure gauge and 2 adaptors for full range of service temperatures and pressures.
- .5 Manometers shall be Magnehelic gauge type in dust free case with black pointer. Gauge range shall be 2½ times the maximum filter resistance. Case shall be suitable for duct or plenum mounting. Provide bracket for mounting gauge on insulated ducts or plenums.
- .6 Pressure and temperature test ports shall be Pete's Plug II.
- .7 Thermometers shall be Trerice, Taylor, Weksler, Winters or Ashcroft.
- .8 Pressure gauges shall be Trerice, Ashcroft, Morrison, Winters or Weksler.

PART 3 - EXECUTION

3.1 Installation

- .1 Locate all thermometers and pressure gauges so as to assure easy reading from the floor or platform.
- .2 Where direct reading instruments cannot be satisfactorily located use a remote instrument.
- .3 Locate remote instruments next to the point of the reading, on wall or structure.
- .4 Each remote or panel mounted instrument shall have an engraved lamaroid nameplate identifying the system and service.
- .5 Insert pipeline thermometer and/or pressure gauges into tanks, equipment tappings or in pipeline using screwed tees or forged steel couplings, welded into the pipe.
- .6 Provide thermometers in the following locations in pipelines:

INDICATING INSTRUMENTS

- .1 In and out of each water coil or other coil, handling liquid, except individual reheat coils in ductwork
- .2 On each branch of 3 port control valves, excluding valves on fan coil, induction units, or individual reheat coils in ductwork
- .3 In and out of each heat exchanger, condenser, cooler or type of other heat exchanger
- .4 Each heating water return and each heating water supply for each main system
- .5 Each hot or cold water storage tank
- .6 and where specifically shown
- .7 When a common supply header provides the same temperature water to more than one coil or zone, provide a thermometer on the common header only.
- .8 For control valves with by-pass, locate thermometer in common pipe to allow for manual temperature control.
- .9 Provide test wells for thermometers where shown. Test wells shall be compatible with the thermometers used. Wells shall be registered with the applicable Provincial Authority Having Jurisdiction and have a CRN.
- .10 Provide a ball valve on the inlet to each gauge. Install a pressure snubber on any gauge installed near a pump or in any location where damping is required to prevent rapid oscillation of the pointer. When the equipment is subject to vibration, mount the gauge on adjacent wall or on a mounting plate, supported from the floor.
- .11 Provide pressure gauges in the following areas (not permitted to be pressure and temperature test ports):
 - .1 City (potable) water line where it enters the building
 - .2 In and out of each pump
 - .3 In and out of all pressure reducing valves
 - .4 Each fire standpipe at highest fire hose cabinet
 - .5 and where specifically shown
- .12 Provide pressure gauges or pressure and temperature test ports in the following areas:
 - .1 On each hot water supply and hot water return header
 - .2 Air cushion tank or expansion tank
 - .3 City (potable) water make-up line
 - .4 In and out of each heat exchanger, condenser, cooler or type of other heat exchanger
 - .5 and where specifically shown
- .13 Provide valved and capped connections for pressure gauges on each side of coils where pressure and temperature test ports are not provided.

INDICATING INSTRUMENTS

- .14 Install manometer at each bank of filters to show the resistance to air flow through the filters. Where prefilters and final filters are mounted in a common frame it is only necessary to provide a single manometer to show the resistance across the total filter assembly. Where filters are separately mounted in individual frames provide a manometer for each set of filters.

END OF SECTION

HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 For piping and equipment provided under the Mechanical Division, provide complete with all necessary supports and hangers required for a safe and professional installation.
- .3 Hangers, supports, anchors, guides, and restraints shall be selected to withstand all static and dynamic loading conditions which act upon the piping system and associated equipment.

1.2 Submittals

- .1 Submit Shop Drawings in accordance with Section 20 05 03 – SHOP DRAWINGS.
- .2 The Mechanical Division shall prepare detailed Shop Drawings showing all anchors and guides for all systems with the potential for thermal expansion/contraction and/or loads due to weight or thrust. The drawings shall bear the signed seal of a Professional Engineer licensed to practice in the appropriate discipline and Place of the Work. The drawings shall include all details of construction, static and dynamic forces at points of attachment, etc. necessary for review and acceptance by the Project Structural Contract Administrator. Make adjustments as necessary to satisfy the requirements of the Structural Division. No anchor points shall be permitted without reviewed Shop Drawings and, where installed prior to review, shall be removed and replaced to the satisfaction of the Contract Administrator.

PART 2 - PRODUCTS

2.1 Materials

- .1 Provide hangers and supports manufactured by Anvil ASC Engineered Solutions, Taylor Pipe Supports, or E. Myatt & Co.
- .2 All pipe hangers and supports shall be manufactured to the latest requirements of ANSI MSS-SP-58 "Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation." Where applicable, design and manufacture of hangers and supports shall also conform to ANSI/ASME B31 "Code for Pressure Piping."
- .3 Pipe rolls shall have cast iron rollers, shaped to accept the outside diameter of the insulated pipe. Roll shall either rotate on a steel shaft mounted on a cast iron stand or shall roll on a cast iron bed plate.
- .4 Pipe slide assembly shall be manufactured to the latest requirements of ANSI MSS-SP-58. Assembly shall be complete with Carbon steel structural or fabricated tee, 100% virgin PTFE bonded slide plates and carbon steel base.
 - .1 For cold services such as cooling systems (e.g. chilled water, chilled glycol, brine, refrigerant, etc.), domestic cold water, and dual temperature systems (cooling systems and heating systems (e.g. heating glycol, heating, etc.)) to maintain the integrity of the insulation and vapour barrier and where slides cannot be directly welded to the pipe, provide a plain carbon steel pipe clamp to be welded to the tee support. Clamp shall be full length of tee support and shall

HANGERS AND SUPPORTS

- be minimum 150 mm (6 in.) or as recommended by manufacturer for the specific pipe size.
- .2 For hot services such as heating systems (e.g. steam, steam condensate, heating glycol, heating, etc.), domestic hot water, etc. where the piping is 50 mm (2 in.) and larger, use a standard catalogue protection saddle tack welded to the pipe, which provides a space between the pipe and tee equal to the thickness of the insulation. Weld the tee to the protection saddle.
 - .3 For longitudinal movement only provide hold down lugs.
 - .4 For free movement in all directions width of slide plate base shall be sufficient for full travel.
 - .5 As an alternative to the above, for compact installations, tees may be welded to the pipe directly provided that the temperature is suitable, extended structural or fabricated tees are used, and the tee is vapour sealed at the insulation and completely insulated to prevent condensation for cold services. Provide details and obtain approval from the Contract Administrator prior to proceeding with this arrangement.
- .5 For pipe and duct runs on the roof of the building, anchor pipes and ducts to the building structure using supports by Thaler Roof Specialties or equal.
 - .6 As an alternative to pipe and duct runs on the roof of the building being anchored to the building structure, provide support system design taking into account wind load review, stamped and signed by a Professional Engineer registered in the location of the Project. Provide roof supports by Trikon Systems, MIRO Industries (Unistrut), Advanced Support Products Inc., or Portable Pipe Hangers Inc.
 - .7 All hangers, supports, brackets and other devices installed exterior to the building or in corrosive environments (pool mechanical rooms, pools, pool change rooms, etc.) shall be galvanized to prevent failure from environmental corrosion. If galvanized components cannot be used submit samples of proposed substitute for review prior to installation.
 - .8 Provide supplemental support to minimize the risk of joint separation under high thrust conditions for large diameter no-hub cast iron fittings over 102 mm (4 in.) in accordance with the Standard Details and manufacturer's recommended installation instructions.
 - .1 As an alternative to the above field devised methods and materials, provide engineered pipe and fitting restraints designed and manufactured for the specific purpose of restraining no hub cast iron pipe and fittings against separation under thrust forces equivalent to 145 kPa (50 ft) head pressure. Equal to Holdrite #117.

PART 3 - EXECUTION

3.1 Installation

- .1 Pipe hangers shall be capable of supporting the pipe in all conditions of operation. They shall allow free expansion and contraction of the piping, and prevent undue stress to building structural components.

HANGERS AND SUPPORTS

- .2 Piping shall be supported from walls, beams, columns, and slabs using approved structural attachments. In situations where approved attachments cannot be used, alternative attachments or substructure assemblies shall receive approval prior to installation. Prior approval shall be given for any cutting or drilling of building structural steel. Damage or modification to the structure through welding, cutting, or drilling shall not be permitted if it reduces the integrity of the building structure as deemed by the Structural Contract Administrator. It shall be the responsibility of the Mechanical Division to supply anchor bolts and base diagrams for equipment and pipe supports showing exact location of attachments.
- .3 All drilling for hangers, rod inserts and Work of similar nature shall be done by this Division.
- .4 Auxiliary structural members shall be provided under the Mechanical Section concerned where piping, ducts or equipment must be suspended between the joists or beams of the structure, or where required to replace individual hanger to allow for installation on new services. Auxiliary structural members shall be the same material and finish as the primary structure (i.e. prime painted, galvanized, etc.). Submit details for review as requested.
- .5 Depending on the type of structure, hangers shall be either clamped to steel beams or joists, or attached to approved concrete inserts. Submit proposed hanger details for review and acceptance by the Structural Contract Administrator. Make adjustments as necessary to satisfy the requirements of the Structural Division.
- .6 Approved type expansion shields and bolts may be used for pipe up to 100 mm (4 in.) diameter where the pre-setting of concrete inserts is not practical. Submit proposed hanger details for review and acceptance by the Structural Contract Administrator. Make adjustments as necessary to satisfy the requirements of the Structural Division.
- .7 Suspension from metal deck shall not be allowed unless specifically accepted by the Contract Administrator. Drawings of the proposed method of suspension must be submitted for review.
- .8 Hanger rods shall be subject to tensile loading only. Suspended piping shall be supported by adjustable hanger rods sized as follows:

Pipe Size	Hanger Rod Diameter
50 mm (2 in.) and under	9 mm (3/8 in.)
65 mm (2-1/2 in.) and 75 mm (3 in.)	12 mm (1/2 in.)
100 mm (4 in.) and 125 mm (5 in.)	16 mm (5/8 in.)
150 mm (6 in.) to 200 mm (8 in.)	19 mm (3/4 in.)
250 mm (8 in.) to 300 mm (12 in.)	22 mm (7/8 in.)

- .9 Unless otherwise specified or shown, hanger spacing for all services shall be as follows:

Nominal Pipe Diameter	Maximum Span
Up to and including 38 mm (1-1/2 in.)	2.1 m (7 ft.)
50 mm (2 in.) to 125 mm (5 in.)	3 m (10 ft.)
150 mm (6 in.) and larger	4.6 m (15 ft.)
- .1 For all steel piping connected to the geothermal field including all piping from the field to the heat exchangers in the Energy Transfer Stations:

HANGERS AND SUPPORTS

Nominal Pipe Diameter	Maximum Span
Up to and including 38 mm (1-1/2 in.)	2.1 m (7 ft.)
50 mm (2 in.) to 125 mm (5 in.)	3 m (10 ft.)
150 mm (6 in.) and larger	3.5 m (11.5 ft.)

- .10 In addition, provide a hanger within 600 mm (2 ft.) on each side of valves, fitting or tees on pipes 38 mm (1½ in.) diameter and larger.
- .11 Hanger spacing for plumbing and drainage services shall be in accordance with the plumbing code or municipal by-laws as applicable.
- .12 Hanger spacing for fire protection services shall be in accordance with the NFPA codes.
- .13 All horizontal piping 50 mm (2 in.) diameter and larger shall be supported by adjustable wrought iron clevis type hangers. Smaller piping shall be supported by adjustable split ring hangers or clevis type hangers.
- .14 Suspending one hanger from another shall not be permitted.
- .15 For all heating systems piping (e.g. steam, steam condensate, heating glycol, heating, etc.) and domestic hot water piping, 50 mm (2 in.) and larger, use a standard catalogue protection saddle tack welded to the pipe, which provides a space between the pipe and hanger equal to the thickness of the insulation.
- .16 For all heating systems piping (e.g. steam, steam condensate, heating glycol, heating, etc.) and domestic hot water piping, 38 mm (1-1/2 in.) and smaller, use line size hangers.
- .17 For all cooling systems (e.g. chilled water, chilled glycol, brine, refrigerant, etc.) piping, domestic cold water piping, or dual cooling systems and heating systems (heating glycol, heating, etc.) piping, 25 mm (1 in.) and smaller, install a section of high density insulation complete with continuous vapour barrier between the pipe and the hanger. Refer to Section 20 07 00 - INSULATION.
- .18 For all cooling systems (e.g. chilled water, chilled glycol, brine, refrigerant, etc.) piping, domestic cold water piping, or dual cooling systems and heating systems (heating glycol, heating, etc.) piping, larger than 25 mm (1 in.), use a galvanized steel shield between the insulation and the hanger. Between the shield and the pipe, install a section of high density insulation complete with continuous vapour barrier. Refer to Section 20 07 00 - INSULATION.
- .19 For insulated ducts, ensure supports are on the outside of the insulation so as to not be directly connected to the duct creating a vapour barrier issue. Provide high density insulation in the area of the supports and spread the load.
- .20 The shield width shall be minimum 1/4 of the pipe circumference. The length and gauge shall be as follows:
 - .1 150 mm (6 in.) long and 14 US gauge for pipe larger than 25 mm (1 in.) up to 50 mm (2 in.) diameter
 - .2 250 mm (10 in.) long and 12 US gauge for pipes 65 mm (2-1/2 in.) to 300 mm (12 in.) diameter
 - .3 300 mm (12 in.) long and 10 US gauge for pipes 350 mm (14 in.) to 400 mm (16 in.) diameter
- .21 Hangers and riser clamps in contact with copper pipe shall be copper coated construction or plastic coated. Taped hangers and riser clamps shall not be accepted.

HANGERS AND SUPPORTS

- .22 Unless otherwise specified or shown, all pipes supported from below shall be mounted on pipe rolls or pipe slides.
- .23 Provide constant support hangers where shown for horizontal or vertical pipes which require vertical movement for expansion. Vertical movement shown for these hangers shall be movement either up or down. Provide hangers to allow for movement in both directions.
- .24 Unless otherwise specified or shown, vertical pipes shall be supported at least every fourth floor or every 12 m (40 ft.) maximum.
- .25 Pipe slides shall be pre-engineered type. Structural or fabricated tees shall be welded to the pipe or to the protection saddle.
- .26 Install resilient hangers in accordance with Section 20 05 48 - VIBRATION AND NOISE CONTROL.
- .27 Other means of support shall be as shown or as specified hereunder.
- .28 Provide minimum clear height of 203 mm (8 in.) under roof-mounted piping, with insulation in place, to facilitate proper roof drainage and access to roof membrane.
- .29 Provide minimum clear height under roof-mounted ductwork, with insulation in place, in compliance with SMACNA "HVAC Duct Construction Standards Metal and Flexible" Rooftop Equipment Installation section figures and Smith + Andersen Mechanical Standard Details, to facilitate proper roof drainage and access to roof membrane.
- .30 For special equipment supports refer to equipment sections. Where no support method is identified, secure wall mounted equipment to metal framing or masonry, with steel toggle or expansion fasteners, machine screws or sheet metal screws as applicable. Plastic, fibre or soft metal inserts shall not be acceptable. Wall mounted equipment shall not exceed 45.5 kg (100 lbs) in weight or 250 mm (10 in.) in depth unless reviewed or detailed by the Contract Administrator. Where framing does not permit direct attachment, provide metal strut sub-framing or minimum 19 mm (3/4 in.) fire retardant treated plywood backboards, unpainted, attached to the framing. Provide attachments for backboards at 600 mm (24 in.) on centres with no less than 4 attachments.
- .31 Where equipment control panels, VFDs, and similar equipment are shown on the Drawings in locations away from building walls or need to be installed away from building walls, provide suitably sized, galvanized, strut channel, frame walls, securely fixed to the floor, for mounting the equipment.

END OF SECTION

ELECTRIC TRACING

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 Conform to Section 26 05 01 - GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.2 submittals

- .1 Submit detailed Shop Drawings for all Products being supplied and include electric tracing cable layouts, calculations, power requirements, connection quantities and locations, and control information. Demonstrate compliance with Specification.
- .2 Submit Shop Drawings in accordance with Section 20 05 03 - SHOP DRAWINGS.

PART 2 - PRODUCTS

2.1 Materials

- .1 Electric tracing cable shall be nVent Raychem or Thermon, for 208 volt, 1 phase supply.
- .2 Tracing cable shall be self-regulating type to CSA Standard C22.2 No. 130 "Requirements for electrical resistance trace heating and heating device sets."
- .3 Thermostat shall be minimum 20 amp rating with adjustable control from 0 deg. C. (32 deg. F.) to 49 deg. C. (120 deg. F.) with remote bulb, 3 m (10 ft.) of copper capillary. Where thermostat is mounted in conditioned areas, enclosure shall be dust and moisture resistant and where mounted in non-conditioned areas, enclosure shall be weather-proof. Thermostat shall have CSA Type 4X enclosure.
- .4 Provide electronic controller with an alarm contact for any fire protection or life safety systems to monitor cables and de-energize cables fully during periods when ambient temperatures exceed set point. Controllers for single circuit with features as follows:
 - .1 LED window digital display of measured temperature, set points, and alarm conditions;
 - .2 LED status indicators;
 - .3 integral 30 mA ground fault protection;
 - .4 programmable temperature settings;
 - .5 current rating up to 30 A;
 - .6 alarm contacts and LED indicator;
 - .7 CSA Type 4X enclosure; and
 - .8 thermistor sensor.

ELECTRIC TRACING

- .5 Provide electronic controller with an alarm contact for any gutter tracing, drip pan/condensate pipe tracing, or rain water leader applications to monitor cables and de-energize cables fully during periods when ambient temperatures exceed set point or when no precipitation is occurring. Controllers for single circuit with features as follows:
 - .1 LED window digital display of measured temperature, set points, and alarm conditions;
 - .2 LED status indicators;
 - .3 integral 30 mA ground fault protection;
 - .4 programmable temperature settings;
 - .5 remote precipitation sensor(s);
 - .6 programmable time delay to control how long heating cable remains energized after end of precipitation event;
 - .7 current rating up to 30 A;
 - .8 alarm contacts and LED indicator;
 - .9 CSA Type 4X enclosure; and
 - .10 thermistor sensor.
- .6 Contactors, where required, shall be with 120 V coil and pilot light in cover. Provide control transformer as required.
- .7 The following minimum watts/linear foot shall be maintained for pipe freeze protection applications. The table below is based on a -29 Deg. C. (-20 Deg. F.) minimum ambient temperature.

Up to and including 75 mm (3 in.) pipe	=	5 watts/ft. nominal
100 - 150 mm (4-6 in.) pipe	=	8 watts/ft. nominal
200 mm (8 in.) and larger	=	12 watts/ft. nominal
- .8 For soffit and slab heating systems, provide isometric drawings for every circuit for a complete heat tracing system.
- .9 Provide thermal insulation for pipes as specified in Section 20 07 00 – INSULATION.
- .10 On non-metallic (plastic) pipes the cable shall be installed using aluminum tape (AT180/AL-20L). The cable shall have an outer braid of tinned copper and an outer jacket of modified polyolefin.
- .11 Electric tracing cable for sprinkler systems shall be listed for this use. Where electric tracing cable protects branch lines, it shall be specifically listed for use on branch lines.
- .12 Include the following accessories:
 - .1 power connection and end seal kits
 - .2 splice, and tee kits
 - .3 "Electric Traced" caution labels
 - .4 aluminum tape for plastic pipe (where required)
 - .5 glass cloth adhesive tape

ELECTRIC TRACING

- .6 contactors, relays, power distribution components
- .7 mounting clips/hardware for installation of the cables on the bottom of the slab

PART 3 - EXECUTION

3.1 Installation

- .1 Completely cover the pipe with cable for the full length shown, and without gaps. Ensure that valve body and bonnet are completely protected.
- .2 Install heating cables after pipe installation and testing is complete. Attach cable as recommended by the manufacturer with pipe straps, ensuring cables do not touch or cross.
- .3 Strap thermostat bulb to pipe clear of cable, and mount thermostat on wall or roof with brackets. Hang capillary on straps.
- .4 Retain the services of the manufacturer to inspect and approve the entire installation before the pipe or slab/soffit is concealed and/or insulated. Check for breaks with a 2500 volt DC megger. Provide report for inclusion in the operating manuals. The cost of inspection shall be included in the Contract Price. This Contractor shall provide pre-commissioning and final commissioning.
- .5 The installation by this Section shall be complete requiring power supply only by the Electrical Division. Provide all wiring between the electric tracing and the electrical junction box and make final connections.

END OF SECTION

VIBRATION AND NOISE CONTROL

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Related Work Specified Elsewhere

- .1 Concrete Work on grade or cast integrally with a floor is provided under Division 3.
- .2 Sound isolated concrete floors – under Division 13.

1.3 Submittals

- .1 Shop Drawings: Supply Shop Drawings of the vibration and noise control equipment being supplied in accordance with Section 20 05 03 - SHOP DRAWINGS. Provide Shop Drawings showing completely the various acoustic assemblies. Include on the Shop Drawings the equipment weight at each isolator and the isolator proposed to be used complete with its weight rating. Submit Shop Drawings after all major equipment (e.g. chillers, cooling towers, etc.) has been reviewed and isolators have been coordinated.

1.4 Performance Requirements

- .1 Adequately isolate all equipment to maintain acceptable noise levels in the occupied area of the building as specified below. Take noise measurements over the complete audible frequency range in each of the occupied zones under, above and beside Mechanical Equipment Rooms, and where indicated by the Contract Administrator. Noise levels due to mechanical equipment, ductwork, grilles, registers, terminal devices, diffusers, etc., shall not exceed sound pressure levels in all 8 octave bands corresponding to the NC levels per ASHRAE handbook as indicated.

.2 AREAS	NC LEVELS
Residential Suites	30 NC
General offices	35 NC
Meeting Rooms	35 NC
Corridor and Lobbies	35 NC
Storage Rooms	40 NC
Entrance Halls	40 NC
Amenity Space	35 NC
Fitness	40 NC
Pool	40 NC
Outdoors	45 dBA

PART 2 - PRODUCTS

2.1 Materials

- .1 All equipment provided for vibration isolation or noise control shall be new and manufactured specifically for the purpose intended.

VIBRATION AND NOISE CONTROL

- .2 All vibration isolation devices shall be Vibro-Acoustics, Kinetics Noise Control, VMC Amber Booth, Isotech, or Mason Industries and shall be one manufacturer throughout the Project.
- .3 All factory built silencers and acoustic plenums shall be Vibro-Acoustics, Kinetics Noise Control/Vibron, VAW Systems or EH Price and shall be one manufacturer throughout the Project.
- .4 Provide vibration isolation devices for all motorized or electrical equipment. Static deflection of isolators shall be as given in the Vibration Isolation Schedule and/or as specified below. The Vibration Isolation Schedule shall take precedence.
- .5 Provide silencers in accordance with the Silencer Schedule and/or as shown on Drawings to maintain acceptable noise levels.

2.2 Vibration Isolation

- .1 Type EP (Elastomeric Pad) - Vibro-Acoustics Model N, Kinetics Model NPD, Mason Industries Model W or Super W, or ISOTECH Model IR or ISOPAD.
 - .1 Type EP shall be 8 mm thick ribbed or waffle neoprene pads. Isolator pads shall be selected for less than 80% maximum rated load.
 - .2 If the isolator is bolted to the structure, a neoprene vibration isolation washer and sleeve (Uniroyal Type 602/660 or as approved) shall be installed under the bolt head between the steel washer and the base plate.
- .2 Type MEP (Metal and Elastomeric Sandwich Pad) - Vibro-Acoustics Model NSN, Kinetics Model RSP, Mason Industries Model WSW, or ISOTECH Model IRMR or IPMP.
 - .1 Type MEP shall consist of two 8 mm thick ribbed or waffle neoprene pads bonded to each side of a 16-gauge stainless or galvanized steel shim plate. Isolator pads shall be selected for less than 80% maximum rated load.
 - .2 If the isolator is bolted to the structure, a neoprene vibration isolation washer and sleeve (Uniroyal Type 602/660 or as approved) shall be installed under the bolt head between the steel washer and the base plate.
- .3 Type DDNM (Double Deflection Neoprene Mounts) - Vibro-Acoustics Model RDM, Kinetics Model RD, Mason Industries Model ND, or ISOTECH Model IDR.
 - .1 Type DDNM shall be laterally stable, double deflecting, molded neoprene isolators. All metal surfaces shall be covered with neoprene. The top and bottom surfaces shall be ribbed and bolt holes shall be provided in the base. The mounts shall have leveling bolts rigidly secured to the equipment.
 - .2 DDNM mounts shall be selected for a static deflection of 9.5 mm unless specified otherwise.
- .4 Type DDNH (Double Deflection Neoprene Hangers) - Vibro-Acoustics Model RHD, Kinetics Model RH, Mason Industries Model HD, or ISOTECH Model IHND.
 - .1 Type DDNH shall consist of a molded neoprene isolating element in a steel hanger box. A neoprene sleeve shall be provided where the lower hanger rod passes through the steel hanger box, such that the hanger rod cannot contact the steel. The diameter of the clear hole in the hanger box shall be at least 19 mm larger than the diameter of the hanger rod and permit the hanger rod to swing through a 30 degree arc. When installed the hanger box shall be allowed to rotate through a full 360 degrees without encountering an obstruction.
 - .2 Unless otherwise specified the static deflection of DDNH hangers shall be 8 mm.

VIBRATION AND NOISE CONTROL

- .5 Type SPNM (Spring and Neoprene Mounts) - Vibro-Acoustics Model FS, Kinetics Model FDS, Mason Industries Model SLFSW, or ISOTECH Model IOSB.
 - .1 Type SPNM shall have a free standing and laterally stable steel spring without any housing, and two type WP isolation pads sandwiching a 16 gauge stainless or galvanized steel separator plate shall be bonded to the isolator base plate. Springs shall be designed so that the ratio of the horizontal to vertical spring constant is between one and two. The spring diameter shall not be less than 80% of the compressed height of the spring at rated load. Loaded springs shall have a minimum additional travel to solid equal to 50 % of the specified static deflection.
 - .2 Unless otherwise specified the minimum static deflection of SPNM isolators under actual load conditions for equipment mounted on grade slabs shall be 25 mm (1 in.), and 50 mm (2 in.) for equipment mounted elsewhere.
 - .3 Unless otherwise specified, isolators need not be bolted to the floor for indoor installations. If base plates are bolted to the structure, a neoprene vibration isolation washer and sleeve (Uniroyal Type 602/660 or as approved) shall be installed under the bolt head between the steel washer and the base plate.
- .6 Type SPH (Spring Hangers) - Vibro-Acoustics Model SH, Kinetics Model SH, Mason Industries Model 30, or ISOTECH Model IHS, IHA or IHB.
 - .1 Type SPH shall consist of a steel spring and welded steel housing. Spring diameter and hanger box hole shall be large enough to permit the hanger rod to swing through a 30 degree arc. A neoprene sleeve shall be provided where the lower hanger rod passes through the steel hanger box, such that the hanger rod cannot contact the steel hanger. The diameter of the clear hole in the hanger box shall be at least 19 mm (3/4 in.) larger than the diameter of the hanger rod. When installed, the spring element shall not be cocked, and the hanger box shall be allowed to rotate through a full 360 degree arc without encountering any obstructions.
 - .2 Unless otherwise specified, the static deflection of SPH hangers under actual load conditions shall be 50 mm (2 in.).
- .7 Type SPNH (Spring and Neoprene Hangers) - Vibro-Acoustics Model SHR, Kinetics Model SRH, Mason Industries Model 30N, or ISOTECH Model IHSE, IHAЕ or IHBE.
 - .1 Type SPNH shall consist of a steel spring and welded steel housing. Spring diameter and hanger box hole shall be large enough to permit the hanger rod to swing through a 30 degree arc. A neoprene sleeve shall be provided where the lower hanger rod passes through the steel hanger box, such that the hanger rod cannot contact the steel hanger. The diameter of the clear hole in the hanger box shall be at least 19 mm (3/4 in.) larger than the diameter of the hanger rod. When installed, the spring element shall not be cocked, and the hanger box shall be allowed to rotate through a full 360 degree arc without encountering any obstructions.
 - .2 Type SPNH shall include the addition of a neoprene element in series with the spring. The neoprene element shall have a deflection of not less than 9 mm with a strain not exceeding 15 %. Unless otherwise specified, the static deflection of SPNH hangers under actual load conditions shall be 50 mm (2 in.).
- .8 Type CSNM (Constrained Spring and Neoprene Mounts) - Vibro-Acoustics Model CSR, Kinetics Model FLS, Mason Industries Model SLR, or ISOTECH Model ICSA.

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- .1 Type CSNM shall be a spring and neoprene mount that incorporates a housing which contains unrestrained stable springs with built-in leveling device and resilient vertical limit stops to prevent spring elongation when partial load is removed and limits the movement of equipment when it is subjected to wind loading.
- .2 A minimum clearance of 25 mm (1 in.) shall be maintained around the restraining bolts and between the housing and the spring so as not to interfere with the spring operation. Limit stops shall provide minimum 6 mm (1/4 in.) clearance under normal operation, and a neoprene washer shall be installed beneath the bolt head/washer used to restrain the isolator.
- .3 For installations subject to wind load, provide tapped hole in top and bottom plates for bolting to equipment and the roof or supporting structure with a neoprene sleeve.
- .4 Provide minimum 6 mm thick neoprene acoustical base pad on the underside of the mount unless designated otherwise.
- .5 Mount shall be capable of supporting equipment at a fixed elevation during equipment erection. Installed and operating heights shall be identical.
- .6 Unless specified otherwise, the minimum static deflection for Type CSNM mounts under actual load conditions shall be 50 mm (2 in.).
- .9 Type SB (Steel Base) - Vibro-Acoustics Model S, Kinetics Model SFB, Mason Industries Type MSLFSW, or ISOTECH Model ISB.
 - .1 Type SB base which shall be a structural steel base frame with clearance holes located to correspond to the mounting bolt holes of the equipment mounted on the base. Fan bases shall have built-in motor slide rails, and shall be reinforced as necessary to withstand belt pull without drive misalignment or base distortion.
 - .2 The bases shall be constructed with deep angle steel sections with a minimum vertical angle leg of 100 mm (4 in.) for motors of 7.5 hp or less, 125 mm (5 in.) for motors between 7.5 hp and 20 hp, and 150 mm (6 in.) for motors over 20 hp.
 - .3 Structural steel base frames shall be prime painted.
- .10 Type CB (Concrete Base) - Vibro-Acoustics Model C, Kinetics Model CIB-L, Mason Industries Type KSLFSW, or ISOTECH Model ICIB
 - .1 Type CB inertia base shall have an integral rectangular structural steel form to which concrete is poured.
 - .2 Perimeter members shall be beams of depth equal to 10% of the longest span of the base, but not more than 300 mm (12 in.) or less than 150 mm (6 in.) deep. Forms shall include motor slide base and all reinforcing steel. Where anchor bolt locations fall in concrete, the reinforcing steel shall include drilled members with sleeves welded below the steel to accept the anchor bolts. Height saving steel brackets shall be used in all mounting locations.
 - .3 When the concrete base is T-shaped, isolators shall be located under the projections as well as under the main body in order to prevent cantilever distortion.
 - .4 Inertia bases for pumps shall be of sufficient size to accommodate supports for pipe elbows at pump suction and discharge connections.

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- .5 Height saving brackets or welded steel pockets shall be incorporated in ensure a 50 mm (2 in.) minimum clearance under each inertia base.
- .6 The weight of each inertia base shall be sufficient to lower the centre of gravity to or below the isolator support plane.
- .7 The structural perimeter frame, mounting templates, height saving brackets, and spring system shall be provided as an assembly by the vibration control vendor.
- .8 Structural perimeter frames shall be prime painted.
- .11 All spring mounts shall be complete with levelling devices 6 mm (1/4 in.) thick ribbed neoprene sound pads and completely colour coded stable springs.
- .12 Where steel spring isolation systems are described in the Specifications, the mounting assemblies shall utilize bare springs with the spring diameter not less than 80 % of the loaded operating height of the spring. Each spring isolator shall be designed and installed so that the ends of the spring remain parallel during and after spring installation.
- .13 All isolators shall operate in the linear portion of their load versus deflection curve. Load versus deflection curves shall be furnished by the manufacturer, and must be linear over a deflection range of not less than 50 % above the design deflection.
- .14 All vibration isolators shall have either known undeflected heights of calibration markings to that, after adjustment, verified, thus determining that the load is within the proper range of the device and that the correct degree of vibration isolation is being provided according to design.
- .15 All mounts installed outdoors or exposed to high humidity conditions shall have two coats of rust resisting paint and springs shall be cadmium plated and neoprene coated. Nuts and bolts shall be cadmium plated. All metal parts of mountings (except springs and hardware) shall be hot dip galvanized.
- .16 Flexible spherical expansion joints shall be constructed of EPDM in the covers, liners and with Kevlar tire cord frictioning.
 - .1 Solid steel rings shall be used within the raised face rubber flanged ends to prevent pullout. Flexible cable bead wire is not permitted.
 - .2 19 mm (3/4 in.) to 38 mm (1-1/2 in.) shall have threaded two piece bolted flange assemblies, one sphere and cable retention.
 - .3 50 mm (2 in.) and larger shall have two spheres reinforced with a ductile iron external ring between spheres.
 - .4 400 mm (16 in.) to 600 mm (24 in.) shall be single sphere.
 - .5 Flanges shall be split ductile iron or steel with hooked or similar interlocks.

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- .6 Connectors shall be rated at 1.72 MPa (250 psi) up to 77 Deg. C. (170 Deg. F.) with a uniform drop in allowable pressure to 1.48 MPa (215 psi) at 121 Deg. C. (250 Deg. F.) in sizes through 350 mm (14 in.). 400 mm (16 in.) through 600 mm (24 in.) single sphere minimum ratings shall be 1.24 MPa (180 psi) at 77 Deg. C. (170 Deg. F.) and 1.03 MPa (150 psi) at 121 Deg. C. (250 Deg. F.).
- .7 Higher rated connectors shall be used to accommodate service conditions where required.
- .8 Factory test all expansion joints to 150 % of the rated pressure. Safety factors to burst and flange pullout shall be a minimum of 3/1.
- .17 Neoprene mounting sleeves for hold down applications of equipment with vibration isolators shall be Uniroyal Type 620/660 or as approved.
- .18 Grout: Non-shrink, self-levelling grout having ability to withstand thermal, vibratory and impact stresses.
- .19 Acoustic Sealant: Non-hardening, non-skinning permanently flexible, to CAN/CGSB-19.21 "Sealing and Bedding Compound, Acoustical." Tremco, CGC Acoustic Sealant or approved equivalent.

2.3 Internal Acoustic Duct lining

- .1 Fiberglass duct lining manufacturer: Certainteed, Owens-Corning, Knauf Insulation, or Johns Manville.
- .2 Natural fibre duct lining manufacturer: Bonded Logic.
- .3 Provide acoustic duct lining with a minimum density of 24 kg/m³ (1.5 lbs/ft³).
- .4 Provide acoustic duct lining that complies with the requirements of NFPA 90A "Standard for the Installation of Air-Conditioning and Ventilation Systems" and the "Duct Liner Materials Standard" of the Thermal Insulation Manufacturer's Association.
- .5 Provide internal acoustic duct lining that incorporates means to prevent fiber entrainment in the air stream, such as airstream surface and long edges complete with acrylic polymer surface coating.

2.4 Acoustical Duct and Pipe Lagging

- .1 Acoustical duct and pipe lagging shall be Kinetics Model KNM-100ALQ.
- .2 The barrier shall be constructed of a 2 mm (1/16 in.) thick barium sulphate loaded limp vinyl sheet bonded to a thin layer of reinforced aluminum foil on one side. The barrier shall have a nominal density of 4.8 kg/m² (1 lbs/ft²) and shall have a minimum STC rating of 28.
- .3 The barrier shall have a minimum thermal conductivity "K" value of 0.29 and a rated service temperature range of -40 Deg. C. (-40 Deg. F.) to 105 Deg. C. (220 Deg. F.).
- .4 The barrier shall have a Flame Spread Index of no more than 25 and a Smoke Development Index of no more than 50 when tested for Surface Burning Characteristics per ASTM E84 "Standard Test Method for Surface Burning Characteristics of Building Materials."

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- .5 The decoupling layer shall be a combination of 25 mm (1 in.) or 50 mm (2 in.) as shown, fibreglass batting, non woven porous scrim-coated glass cloth, quilted together in a matrix of diamond stitch pattern which encapsulates the glass fibres. The composite material shall be fabricated to include a nominal 152 mm (6 in.) wide barrier overlap tab extending beyond the quilted fibreglass to facilitate a leak-tight seal around field joints.

2.5 Silencers

- .1 Provide factory-built silencers completely pre-fabricated of incombustible materials and bearing a minimum insertion loss and a maximum air pressure drop as shown in Silencer Schedule. Include all system effects in the installed position shown on the Drawings in the silencer performance. Conform to ASTM E477 "Standard Test Method for Laboratory Measurements of Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers" for submitted silencer performance.
- .2 Media filled silencers shall contain acoustic media type as indicated on the Silencer Schedule, either acoustic quality, shot free glass fibre insulation with long, resilient fibres bonded with a thermosetting resin, or 100% natural cotton fibres treated with an EPA registered, non-toxic borate solution, "flash dried" to provide resistance to mould, mildew and fungi. Media shall not cause or accelerate corrosion of aluminum or steel. Glass fibre, and rockwool will not be permitted as a substitute for cotton fibre media.
- .3 Acoustic media in media filled silencers shall have density as required to provide specified performance, packed under 15 percent compression and protected from air erosion by perforated sheet metal, gauge as specified below.
- .4 Acoustic media filled silencers with internal air velocities above 22.9 m/s (4500 fpm) shall have acoustic media wrapped with glass fibre cloth for additional erosion protection.
- .5 Silencers shall have acoustic media wrapped in Tedlar film liner to help prevent shedding, erosion and impregnation of the acoustic media in the following areas:
 - .1 Where indicated on Silencer Schedules
- .6 No-media silencers shall contain no absorptive media of any kind. Attenuation shall be achieved with controlled impedance membranes and broadly tuned resonators.
- .7 Silencer materials, including acoustic media and Tedlar film, shall have the following combustion ratings when tested in accordance with ASTM E84 "Standard Test Method for Surface Burning Characteristics of Building Materials": maximum Flamespread Classification 25, maximum Smoke Development Rating 50.
- .8 Rectangular type silencers for duct systems operating less than 4 in. WG and designated as Class 1 on the Silencer Schedule shall be constructed with a minimum 22 gauge (0.78 mm) lock formed galvanized steel outer casing and 26 gauge (0.47 mm) galvanized perforated steel liner.
- .9 Rectangular type silencers for duct systems operating greater than 4 in. WG and less than 8 in. WG and/or designated as Class 2 on the Silencer Schedule shall be constructed with a minimum 18 gauge (1.18 mm) Pittsburgh lock formed galvanized steel outer casing and 22 gauge (0.78 mm) galvanized perforated steel liner.

VIBRATION AND NOISE CONTROL

- .10 Rectangular type silencers for duct systems operating under more than 8 in. WG and/or designated as Class 3 on the Silencer Schedule shall be constructed with a minimum 16 gauge (1.46 mm) continuously welded galvanized or hot rolled steel painted with one anti-rust prime coat of paint casing and 22 gauge (0.78 mm) galvanized perforated steel liner.
- .11 Rectangular type elbow silencers shall have minimum Class 2 construction, 18 gauge (1.18 mm) Pittsburgh lock formed galvanized steel outer casing and 22 gauge (0.78 mm) galvanized perforated steel liner, unless indicated as Class 3 on the Silencer Schedule. All acoustical splitters shall be internally radiused and aerodynamically designed for efficient turning of the air. Half and full splitters are required as necessary to achieve the scheduled insertion loss. All elbow silencers with a turning cross-section dimension greater than 1200 mm (48 in.) shall have at least two half splitters and one full splitter.
- .12 Circular media filled silencers, unless noted on the Silencer Schedule as Class 3, 16 gauge (1.46 mm) construction shall have gauges and construction as follows: under 750 mm (30 in.) casing diameter, 20 gauge (0.91mm) lockformed galvanized steel outer casing, under 1350 mm (54 in.) casing diameter, 18 gauge (1.18 mm) lockformed galvanized steel outer casing, otherwise 16 gauge (1.46 mm) stitch welded galvanized steel outer casing. Galvanized steel perforated inner liner shall be 22 gauge (0.78 mm) for all diameters.
- .13 Circular no-media silencers, unless noted on the Silencer Schedule as Class 3, 16 gauge (1.46 mm) construction shall have gauges and construction as follows: under 450 mm (18 in.) duct diameter, 22 gauge (0.78 mm) lockformed galvanized steel outer casing, under 750 mm (30 in.) duct diameter, 20 gauge (0.91 mm) lockformed galvanized steel outer casing, under 1350 mm (54 in.) duct diameter, 18 gauge (1.18 mm) lockformed galvanized steel casing, otherwise 16 gauge (1.46 mm) stitch welded galvanized steel outer casing. Galvanized steel perforated inner liner shall be 26 gauge (0.47 mm) for all diameters.
- .14 Silencers shall be complete with high transmission loss (HTL) casing where indicated on the silencer schedule. HTL walls shall consist of media, airspace, mass and outer protective metal skin as required to obtain specified room noise criteria. Standard acoustic panels will not be accepted as HTL walls. Where requested by the Contract Administrator, provide breakout noise calculations for each air handling and fan system with silencer submittal to ensure compliance with the room noise criteria. Breakout noise calculations shall be based on the sound power levels of the specified equipment and calculation methods in accordance with ASHRAE HVAC Applications handbook.

PART 3 - EXECUTION

3.1 Installation

- .1 Obtain one copy of all Shop Drawings of equipment to be isolated showing weights, shaft centres and all dimensions.
- .2 On system start-up, inspect the complete installation and provide a report in writing.
- .3 Furnish concrete bases, including concrete fill, on springs or other vibration isolation materials for mechanical isolation.

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- .4 All floor mounted equipment shall be erected on concrete housekeeping pads, with thickness as identified, over the complete floor area of the equipment, unless shown or specified otherwise. Wherever vibration eliminating devices and/or concrete inertia pads are specified, these items shall be mounted on concrete housekeeping pads.
- .5 Furnish and install neoprene mounting sleeves for hold-down bolts to prevent any metal to metal contact.
- .6 All equipment shall be provided with lateral restraining isolators as required to limit horizontal motion to 6 mm maximum, under all operating conditions. Lateral restraining isolators shall have the same static deflection as equipment being isolated.
- .7 Unless otherwise indicated, all equipment mounted on vibration isolators shall have a minimum operating clearance of 50 mm (2 in.) between the bottom of the equipment or inertia base (and height-saving bracket) and the concrete housekeeping pad (or bolt heads) beneath the equipment. The clearance shall be checked by the Contractor to ensure that no material has been left to short-circuit the vibration isolators. There shall be a minimum 100 mm (4 in.) clearance between isolated equipment and the walls, ceiling, floors, columns and any other equipment not installed on vibration isolators.
- .8 Piping, ductwork, conduit or mechanical equipment shall be supported from building structure, not hung from or supported on other equipment, pipes, or ductwork.
- .9 Equipment connected to water or other fluid piping shall be erected on isolators or isolated foundations at correct operating heights prior to connection of piping, and blocked-up with temporary shims to final operating height. When the system is assembled and fluid is added, the isolators shall be adjusted to allow removal of the shims.
- .10 All mechanical equipment not specifically identified in this Section that contains rotating or vibrating elements, and any associated electrical apparatus installed by this Division that contains transformers or inductors shall be installed on Type DDNM, MEP, or EP isolators as appropriate.
- .11 All wiring connections to mechanical equipment on isolators shall be made with a flexible conduit installed in a slack "U" shape.
- .12 Elastomeric isolators that will be exposed to temperatures below 0 deg. C. (32 deg. F.) shall be fabricated from natural rubber instead of neoprene.
- .13 Springs shall be designed and installed so that ends of springs remain parallel and all springs installed with adjustment bolts.
- .14 Springs shall be sized to be non-resonant with equipment forcing frequencies or support structure natural frequencies.
- .15 Fans and air handling units shall be levelled with fans operating before the flexible connectors are attached.
- .16 All fan bases and isolators shall be sized so that thrust restraints (which would act against turning moment caused by static pressure) are not required.

3.2 Equipment Isolation

- .1 Floor Mounted Centrifugal Fans and axial flow fans less than 0.87 kPa (3-1/2 in. WG) static pressure and/or under 29.8 kW (40 hp), shall be mounted on a Type SB base with Type SPNM isolators and shall have static deflection not less than 50 mm under actual load conditions unless shown otherwise in the Vibration Isolation Schedule.

VIBRATION AND NOISE CONTROL

- .2 Floor Mounted Centrifugal Fans and axial fans 0.87 kPa (3-1/2 in. WG) static pressure and over and/or 29.8 kW (40 hp) and larger, shall be mounted on Type CB with Type SPNM isolators and shall have static deflection not less than 50 mm (2 in.) under actual load conditions unless stated otherwise on the Vibration Isolation Schedule.
- .3 Ceiling Suspended Centrifugal Fans, and axial flow fans shall be mounted on Type SPNH spring isolators. Static deflection of the isolators shall be 50 mm (2 in.) unless shown otherwise on the Vibration and Isolation Schedule. Fans shall be suspended from above only if expressly noted as such on the Drawings and Schedules. Thrust restraint shall be by pre-compressed springs.
 - .1 If the fan to be suspended is not furnished with integral structural frame and external mounting lugs of suitable strength and rigidity, install approved structural base with lugs in the field.
 - .2 Fans in packaged or custom air handling units shall be mounted on a Type SB base with Type SPNM isolators. The static deflection shall not be less than 50 mm (2 in.) under actual load conditions.
 - .3 Structural steel floor supports shall be located beneath the spring isolators and shall be equivalent to the structural perimeter frame of the air handling unit.
 - .4 Roof mounted air conditioning units without internal fan isolation shall be mounted on RTIC isolator. Static deflection shall be as shown in the Schedules.
- .4 Floor mounted air handling units
 - .1 Install Type MEP isolation under floor mounted air handling units located above occupied areas. Where hold down fasteners are used, include neoprene vibration isolation washers and sleeves.
- .5 Base mounted pumps 3.73 kW (5 hp) and larger except where located on slab-on-grade. Mount each pump with motor on a Type CB inertia base. Minimum base thickness shall be:

Pumps 3.73 kW (5 hp) to 5.52 kW (7.5 hp)	150 mm (6 in.)
Pumps 5.6 kW (7-1/2 hp) to 18.7 kW (25 hp)	200 mm (8 in.)
Pumps 22.4 kW (30 hp) to 74.6 kW (100 hp)	250 mm (10 in.)
Pumps 93.3 kW (125 hp) and larger	300 mm (12 in.)
- .6 Vertical in-line pumps floor mounted 7.5 kW (10 hp) and larger except where located on slab-on-grade bolt and grout each elbow support to a Type CB inertia base. The minimum base thickness shall be:

Pumps 5.6 kW (7-1/2 hp) to 18.7 kW (25 hp)	200 mm (8 in.)
Pumps 22.4 kW (30 hp) to 74.6 kW (100 hp)	250 mm (10 in.)
Pumps 93.3 kW (125 hp) and larger	300 mm (12 in.)

 - .1 Mount the base on Type SPNM isolators.
 - .2 Pour bases on roofing felt and elevate a minimum of 50 mm (2 in.) with mounting adjustment bolts after the pump elbows are grouted to the base.
 - .3 No damping or snubbing materials shall be used. Spring deflection shall be as specified in the Vibration Isolation Schedule, but in no case less than 25 mm

VIBRATION AND NOISE CONTROL

(1 in.) and all mountings shall have 6 mm (1/4 in.) thick neoprene vibration isolation pads at the bottom.

- .7 Vertical in-line pumps floor mounted 5.6 kW (7-1/2 hp) and smaller and 7.5 kW (10 hp) and larger where located on slab-on-grade, shall be supported on Type MEP isolation. Refer to Mechanical Standard Details.
- .8 Vertical in-line pumps ceiling hung shall be supported by Type SPNH spring isolators. Refer to Mechanical Standard Details.
- .9 Refrigeration machines and boilers shall be mounted on a Type SB base with CSNM isolators. Spring deflection shall be 50 mm (2 in.) minimum. If the equipment is suitable and an additional steel base is not required, the equipment can be mounted directly on the isolators.
- .10 Mount air source heat pumps on a Type SB base supported by CSNM isolators. Spring deflection shall be 50 mm (2 in.) minimum. If the equipment is suitable and an additional steel base is not required, the equipment can be mounted directly on the isolators.
- .11 Suspend all piping in Mechanical Rooms on Type SPH or SPNH isolators as required. Where piping is supported from the floor, weld brackets to the piping and support on Type SPNM isolators. Isolators do not replace constant support hangers or mounts.
- .12 The first isolator both upstream and downstream of equipment on springs shall have a static deflection of 1.5 times the deflection of the vibration isolated equipment to a maximum of 50 mm (2 in.). All other piping supports shall have a static deflection of 25 mm (1 in.) minimum.
- .13 Where a pipe connects to multiple pieces of equipment in the Mechanical Room the pipe isolators for the entire run shall be chosen to suit the connected equipment of the greatest static deflection.
- .14 Piping that is connected only to equipment installed on neoprene isolators shall be either supported from the floor by Type DDNM isolators or suspended from the structure on Type DDNH isolators within the Mechanical Equipment Rooms.
- .15 Install double sphere EPDM type flexible piping connectors with: control rods with grommets to limit vibration transfer; stabilizing ring; and floating flanges, to connect piping of diameter 50 mm (2 in.) or greater to reciprocating or rotating equipment.
- .16 Piping attached to either coil sections separated from the fan sections of air handling units by flexible connections, or to air handling units with internal isolators meeting the requirements of these Specifications is exempt from these requirements and is not considered connected to vibrating equipment.
- .17 No rigid connections between equipment and the building structure shall be made that degrades the specified noise and vibration control system.
- .18 Any conflicts with other trades which result in rigid contact with the equipment or piping due to inadequate space or other unforeseen conditions shall be brought to the Contract Administrator's attention prior to installation. If not brought to the attention of the Contract Administrator prior to installation corrective Work necessitated by conflicts shall be at the Contractor's expense.
- .19 Locate isolation hangers with the housing a minimum of 50 mm (2 in.) below but as close as possible to the structure. Where isolator hangers would be concealed by a non-accessible acoustical sub-ceiling, install the hangers immediately below the sub-ceiling for access.

VIBRATION AND NOISE CONTROL

- .20 Ducts shall be connected to fans, fan casings and fan plenums by means of flexible connectors. Flexible connectors shall be installed to prevent metal-to-metal contact across flexible connection.
 - .1 Flexible connections are not permitted on NFPA 96 "Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations" kitchen exhaust systems.
 - .2 Flexible connectors shall be in accordance with Section 23 31 13 - DUCTWORK AND SPECIALTIES.

3.3 Silencers

- .1 Where silencers are to be installed in stainless steel or aluminum ductwork, the silencer shall be all stainless steel or aluminum construction to match the ductwork.
- .2 Silencers for all variable air volume boxes, and fan powered variable volume boxes shall be as scheduled in the Silencer Schedule. Refer to Drawings for specific number required. The Silencer Schedule only indicates type. Receive from VAV box manufacturer dimension and sound data. Adjust silencers as required to match box discharge size. Adjust silencer as required to ensure insertion loss necessary to meet the room noise criteria.
- .3 Silencers shall have outside dimensions that match the connecting duct size unless indicated otherwise.
- .4 Submittals shall include certified test data on dynamic insertion loss, self-noise power levels, and pressure drop for reverse or forward flow. Silencer performance must have been substantiated by laboratory testing according to ASTM E477 "Standard Test Method for Laboratory Measurements of Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers" and so certified when submitted for approval. The laboratory must be NVLAP accredited for the ASTM E477 test standard. Provide a copy of the accreditation certificate with the submittals upon request by the Contract Administrator. Data from non-NVLAP accredited test facilities will not be accepted.
- .5 The certification of the pressure drop, insertion loss and generated noise data shall be based upon tests of the same silencer for all measurements.
- .6 For specific silencers indicated on the Silencer Schedule, the manufacturer shall provide acoustic analysis for approval showing that this silencer will reduce mechanical fan noise to acceptable levels in the occupied space. Use sound power levels of actual equipment to be installed on Project. Analysis shall include breakout noise calculations.

3.4 Acoustical Lining of Ducts

- .1 Acoustically line ductwork where shown on the Drawings and as Specified.
- .2 Provide a minimum of 25 mm (1 in.) thick acoustical duct lining in all internally lined sheet metal ducts, unless otherwise specified or shown on the Drawings.
- .3 In addition, internally line all low or medium pressure supply air ductwork in mechanical rooms, fan rooms, or equipment rooms.

VIBRATION AND NOISE CONTROL

- .4 Install acoustic lining using both pins and a minimum of 50 % coverage of a fire-resistant adhesive. Install pins on maximum 450 mm (18 in.) centres on all sides and tack weld to the duct or plenum. Mechanical fasteners that pierce the duct are unacceptable. Seal all edges of acoustic lining to prevent air erosion with sheet metal nosing that overlaps the insulation by 19 mm (3/4 in.) minimum. Coat all ends of the liner with a fire resistant cementing material to prevent delamination, leakage or erosion. Firmly butt all joints and coat ends with an adhesive to ensure that the lining is smooth across all joints.
- .5 For acoustic lining downstream of VAV boxes refer to Section 23 36 16 - VARIABLE VOLUME BOXES.
- .6 Where acoustical duct lining is installed, increase the dimensions of the sheet metal to include the thickness of the lining material. Dimensions shown on the Mechanical Drawings are the clear internal dimensions after the liner has been installed.
- .7 Internally insulate the following ductwork:
 - .1 All return air transfer ductwork.
 - .2 All ductwork specifically identified in Specifications and/or on the Drawings.
 - .3 All supply and return air ductwork in the amenity spaces, lobbies, and common areas that serve that space.

3.5 ACOUSTICAL DUCT AND PIPE LAGGING

- .1 Install Acoustical Duct and Pipe Lagging where indicated on Drawings.

END OF SECTION

PIPE AND DUCTWORK IDENTIFICATION

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Related Work Specified Elsewhere

- .1 Field painting of non-colour coded piping and ductwork - under Division 9, Section 09 90 00 - PAINTING AND COATING.

1.3 Submittals

- .1 Submit designations and abbreviations for review in accordance with Section 20 05 03 – SHOP DRAWINGS. Submit digital samples of identification for review.

PART 2 - PRODUCTS

2.1 Materials

- .1 Paint shall be compatible with the surface material to be painted.
- .2 Colour code shall conform to CAN/CGSB 24.3-92 "Identification of Piping Systems" and ANSI/ASME A13.1 "Scheme For The Identification Of Piping Systems."
- .3 Pipe covering shall be SMS, Brady, Primark Manufacturing Inc. and Seton equal to SMS Coil-Mark system pipe markers.
- .4 All identification shall incorporate direction of flow arrows, and the specified system designations and abbreviations. Designations and abbreviations shall be submitted for review prior to installation.
- .5 All reclaimed rainwater distribution systems shall be purple in colour and conform to requirements of NSF-RW and NSF/ANSI Standard 14 "Plastics Piping System Components and Related Materials." All other non-potable water piping shall conform to the requirements of CAN/CSA B128.1 "Design and Installation of Non-potable Water Systems," CAN/CSA B128.2 "Maintenance and Field Testing of Non-potable Water Systems," and CAN/CSA B128.3 "Performance of Non-Potable Water Treatment Systems."
- .6 Colour code shall conform to the requirements under the by-laws of the Authority Having Jurisdiction.

PART 3 - EXECUTION

3.1 Installation

- .1 After completion of insulation and/or painting, all piping and ductwork shall be marked to show the service and direction of flow.
- .2 Marking shall be placed at each side of any wall, partition or floor, at 9.1 m (30 ft.) intervals (maximum) on all exposed piping and ductwork and at each access panel or door. Marking shall be located so as to be in full view and visible from the floor.
- .3 All pipe identification shall be installed in accordance with the manufacturer's recommendations.

PIPE AND DUCTWORK IDENTIFICATION

- .4 For insulated or non-insulated pipe sizes less than 150 mm (6 in.) outer diameter, provide pre-coiled pipe identification markers, cover the pipe in its entirety, and join using adhesive along the longitudinal joint. In addition to the adhesive, provide banded marking system with clear plastic tie-wraps on each end.
- .5 For insulated or non-insulated pipe sizes equal to and greater than 150 mm (6 in.) outer diameter, strap markers on with recommended tie-wraps.
- .6 Adhesive labels are not acceptable.
- .7 Gas piping shall be painted yellow for the entire length and identified with pipe identification markers. Banding is not permitted.
- .8 All electric traced piping shall have additional identification to show it is traced.
- .9 Identify ductwork with 50 mm (2 in.) stencils using black or white ink to contrast the surface being identified.
- .10 Identification location for ductwork shall conform to the guidelines for pipe and shall indicate flow medium, function, and direction.
- .11 Contractor shall ensure stenciling is performed in a neat, quality manner.

END OF SECTION

NAMEPLATES

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 Nameplates for systems include the designated equipment name, model number and main design parameters.
- .3 Every piece of equipment shall have a nameplate.

1.2 Submittals

- .1 Submit samples of nameplates before installation in accordance with Section 20 05 03 – SHOP DRAWINGS.

PART 2 - PRODUCTS

2.1 Materials

- .1 The nameplates must be a minimum 2 mm (3/32 in.) thick micro-surface impact acrylic suitable for a service temperature up to -29 Deg. C. through 80 Deg. C. (-20 Deg. F. through 175 Deg. F.). Minimum size shall be 100 mm (4 in.) long x 50 mm (2 in.) wide with maximum size to suit nomenclature required. Nameplate shall be with black face and white centre and with 5 mm (7/32 in.) high lettering engraved through to the white lamination.
- .2 The nameplates shall have the equipment type and name as indicated in the Equipment Schedules.
- .3 The nameplates shall have the service and area of the building served (e.g. Chilled Water - South Zone).

PART 3 - EXECUTION

3.1 Installation

- .1 Nameplates shall be securely fastened with screws or brass chains in a conspicuous place on the equipment.

END OF SECTION

VALVE TAGS AND CHARTS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Submittals

- .1 Submit samples of charts and numbering system before installation in accordance with Section 20 05 03 – SHOP DRAWINGS.

PART 2 - PRODUCTS

2.1 Materials

- .1 Tags must be a minimum 2 mm (3/32 in.) thick Micro Surface Impact Acrylic suitable for a service temperature up of -29°C through 80°C (-20°F through 175°F), with engraved numbers and/or letters as required. Tags shall be a minimum of 25 mm (1 in.) square and maximum to suit numbering system. Numbers shall be nominally 9 mm (3/8 in.) high. Letters shall be nominally 6 mm (1/4 in.) high.
- .2 Number and nameplates for standpipe and sprinkler system supervisory and main operating valves shall be minimum 2 mm (3/32 in.) thick laminated phenolic plastic and a minimum 125 mm (5 in.) long x 100 mm (4 in.) wide with red face and white centre. Lettering shall be a minimum 9 mm (3/8 in.) high with maximum to suit local authorities and shall be engraved through to the white lamination. Each nameplate shall contain the system name, service and valve number.
- .3 For all other valves on standpipe and sprinkler system not required to have laminated number and nameplates, provide plastic tags as specified above.
- .4 Abbreviations and colour code shall be as shown on Standard Details.

PART 3 - EXECUTION

3.1 Installation

- .1 Tags and nameplates shall be attached to the valve body or handle with brass hooks or chains.
- .2 All valves shall be provided with tags, other than valves on convectors, induction units or other space heating, cooling units and valves on plumbing fixtures. Provide a chart or charts, indicating location, service and zone of each valve. This Work shall be co-ordinated between the various Mechanical Sections to prevent overlapping of numbering systems.
- .3 Provide separate charts for all fire system nameplates and tags.
- .4 For extension and/or alterations to existing systems, provide new charts conforming in appearance to the existing charts.
- .5 Co-ordinate valve identification with pipe and ductwork identification.
- .6 Electronically submit charts as PDF files along with as-built drawings. Provide charts set in metal picture frames with a clear acrylic front and fastened securely where directed by Contract Administrator.

VALVE TAGS AND CHARTS

- .7 All valve tag numbers for all systems shall be shown on the as-built drawings.

END OF SECTION

ACCESS DOORS AND ACCESSIBILITY

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Submittals

- .1 Submit Shop Drawings showing size, type and location of all access doors, for review, before installation in accordance with Section 20 05 03 – SHOP DRAWINGS.
- .2 Have Balancing Contractor review proposed access door sizes and locations to ensure that sufficient access is available. Confirm in writing that this review has occurred.

PART 2 - PRODUCTS

2.1 Materials

- .1 Provide access doors that comply with Section 08 31 00 - ACCESS DOORS AND PANELS from the Architectural Specification. Where the Architectural Specification section is silent on a required access door type, comply with the Part 2 clauses in this section.
- .2 Provide access doors by Acudor, Bauco or Mifab Manufacturing Inc. Steel thickness (US Gauge) indicated as minimum acceptable.
- .3 For doors in solid walls, provide a 16 US gauge, prime painted steel door panel, rust resistant concealed hinges, flanged frame, and screwdriver operated lock. Acudor Model UF-5000 or Mifab Model UA.
- .4 For doors in drywall partitions or ceilings, provide a minimum 22 US gauge, prime painted steel recessed door panel for the acceptance of a drywall insert, concealed hinges, drywall bead frame, and screwdriver operated lock. Bauco Plus II, Acudor model DW-5015 or Mifab Model CAD-DW.
- .5 For doors in drywall partitions or ceilings, provide prime painted steel flush door panel, concealed hinges, drywall bead frame, and screwdriver operated lock. Acudor model DW-5040 or Mifab Model MDW.
- .6 For access doors in fire rated walls or ceilings, provide ULC labeled with insulated door panel, concealed hinge, self-closing, self-latching, flanged frame, and prime painted. Provide master key operated catch in areas accessible to the public. Acudor Model FW-5050 or Mifab MPFR.
- .7 For doors in tiled walls or ceilings, provide 16 US gauge, stainless steel, type 304 with #4 satin finish, concealed hinges, wall frame and screw driver operated lock. Acudor Model UF-5000 or Mifab Model UA-SS.
- .8 For doors in tiled walls or ceilings, provide 16 US gauge, prime painted steel recessed door panel for the acceptance of tile finish, concealed hinges, flush frame and screw driver operated lock. Acudor Model AT-5020 or Mifab Model CAD.

ACCESS DOORS AND ACCESSIBILITY

PART 3 - EXECUTION

3.1 Installation

- .1 Provide access doors of minimum 600 mm x 600 mm (24 in. x 24 in.) size. Custom size access doors may be required to allow combining access doors in close proximity and to ensure maintenance and accessibility of all parts requiring periodic maintenance.
- .2 Ensure all parts of the installation requiring periodic maintenance are accessible. Wherever valves, dampers and other appurtenances are concealed by building construction, provide access doors and install under the respective Trade Sections (i.e. masonry, plaster, drywall, tile, etc.). Be responsible for the proper location of the access doors.
- .3 For all mechanical equipment located above drywall and other inaccessible ceilings, provide access doors that will allow for full removal and replacement.
- .4 For wall mounted plumbing fixtures with back water connection, provide an adjacent access door.
- .5 Where access doors are required in ductwork requiring a fire rating, install them in accordance with the fire rating system manufacturer's written installation instructions, to ensure that the Product listing is not compromised.
- .6 Wherever possible, locate items requiring access in easily accessible areas (i.e. exposed or T-bar ceilings).
- .7 Group items in order to minimize the number of access doors required.
- .8 Install each access door to provide complete access to equipment for maintenance and servicing.
- .9 Make any changes to locations of access doors as directed by the Contract Administrator.
- .10 Show the final installed locations of all access doors on the as-built drawings.

END OF SECTION

EXCAVATION AND BACKFILL FOR MECHANICAL WORK

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 This Section governs requirements for all Work required for the installation of underground storm drains, sanitary sewers, gas lines, pressurized water lines, and appurtenances associated with such services.
 - .1 Excavation and backfill Work includes all Work within the building footprint (plan), and extends to a point 1500 mm (5 ft. 0 in.) beyond face of building foundation line. Services underground within interior courtyards are included in this Section.
- .3 Assume that material to be excavated is earth. When rock is encountered during construction, payment will be made on unit price basis to the extent of net difference in cost between dry earth excavation and solid rock excavation, all as indicated in Contract Documents.

1.2 Related Work Specified Elsewhere

- .1 Removing subgrade materials for service trenches inside and outside building perimeter, for general grade adjustments, and backfilling of trenches from top of bedding up to bottom of slab-on-grade - under Division 31.
- .2 Dewatering of Site - under Division 31.
- .3 Rock excavating and spreading - under Division 31.
- .4 Finish grading and spreading of topsoil - under Division 31.
- .5 Weeping tile drainage lines and filter media - under Division 31.

1.3 Submittals

- .1 Provide Shop Drawings indicating proposed method of bedding and backfilling in accordance with Section 20 05 03 – SHOP DRAWINGS.

PART 2 - PRODUCTS

2.1 Soils

- .1 Provide Granulars "A", "B" (Type 1), "M" and "Select Subgrade Material";
 - .1 CAN/CSA A23.1 "Concrete materials and methods of concrete construction" and CAN/CSA A23.2 "Test methods and standard practices for concrete."
- .2 Requirements for Pea Gravel: Granular, well-graded clean rounded pea gravel or stone with not more the 2% material that will pass 75 um (No. 200) sieve, maximum 6 mm (¼ in.), containing not other deleterious material, and subject to testing that specified density can be achieved without compaction.

EXCAVATION AND BACKFILL FOR MECHANICAL WORK

- .3 Requirements for Sand Fill: Uniform quality and unwashed river sand or any clean sand containing less than 5% organic materials, clay or silt (passing 125 um sieve) is acceptable. It can contain a limited amount of small stones or rocks as it comes from the pit. Sharp, clean, coarse sand, water washed, free from clay, salts and organic matter, and in accordance with CAN/CSA A179 "Mortar and Grout for Unit Masonry" for masonry sand is also acceptable.

PART 3 - EXECUTION

3.1 Installation

- .1 All excavation and backfilling for all services shall be in accordance with Division 31.
- .2 Refer to Division 31 for rough excavation, removal of excavated material and backfill.
- .3 Protection:
 - .1 Provide protection to existing structures and services. Be responsible for rectifying any damage to existing structures and services resulting from this operation.
- .4 Excavation in Soil:
 - .1 Where rough excavation is carried out by Division 31, perform all layout Work for trenches required under this Division, including verification of trench depths and slopes. Work in close cooperation with excavating trades that remove subgrade to within 6 in. (150 mm) of the correct and final trench depth.
 - .2 Perform the final excavation to the correct trench invert to permit proper bedding as detailed in the Standard Drawings. Excavation carried below the correct inverts shall be backfilled with 2000 psi (13.5 MPa) concrete to the underside of the pipe lines, unless otherwise directed in writing.
- .5 Excavation in Rock:
 - .1 All excavation in rock is included under a separate Section, and is taken to a minimum of 150 mm (6 in.) below the correct pipe invert. This Division shall use a bedding material as detailed in the Standard Details to the correct trench invert.
- .6 Backfilling
 - .1 Backfill with sand from the bottom of the trench or excavation up to a point 300 mm (12 in.) above the top of service line or appurtenance. Backfill pipe trenches with sand to a depth 300 mm (12 in.) above the pipe. The sand shall be thoroughly tamped around and over the pipes in 150 mm (6 in.) layers.
 - .2 Backfill up to top of subgrade.
 - .3 Backfill the remainder of trench or excavation up to top of subgrade or bottom of floor slabs on grade.

END OF SECTION

SLEEVES AND ESCUTCHEONS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Related Work Specified Elsewhere

- .1 Firestopping and smoke seals within mechanical assemblies (i.e. inside ducts, dampers, etc.) with the exception of sleeves shown for future use installed in fire or smoke rated partitions shall be the responsibility of Mechanical Division. All other firestopping and smoke seals of mechanical services are part of Mechanical Division.

PART 2 - PRODUCTS

2.1 Materials

- .1 Sleeves passing through stud partitions shall be 0.75 mm (0.0299 in. - 22 GSG) steel.
- .2 Sleeves passing through concrete or masonry partitions and floors shall be Schedule 40 steel pipe.
- .3 Sleeves passing through floors in finished areas and concealed spaces may be sheet metal where additional protection is provided to prevent water from passing freely (i.e. housekeeping pad).
- .4 Sleeves for pipes passing through exterior foundation walls shall be pre-manufactured molded non-metallic HDPE equal to GPT Industries/Garlock Century-Line. Each sleeve assembly shall have end caps manufactured of the same material as the sleeve and installed at each end to prevent deformation during the concrete pour.
 - .1 The annular space between the service pipe and the sleeve shall be a modular EPDM seal element, reinforced nylon polymer pressure plates, joined with ASTM B633 "Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel" carbon steel bolts with zinc dichromate and corrosion inhibiting coating equal to GPT Industries/Garlock Link-Seal Model C wall seal.
 - .2 A reinforced concrete bridge shall be installed between the wall and the adjacent undisturbed soil.
- .5 Escutcheons shall be satin finish stainless steel or satin finish chrome or nickel plated brass, with non-ferrous set screws. Do not use stamped steel split plates. Split cast plates with screw locks may be used. For escutcheons for plumbing fixtures refer to Section 22 42 00 - FIXTURES AND TRIM.
- .6 Provide adequate bracing for support of sleeves during concrete and masonry Work. For floors and walls with a fire resistance rating, build fire damper assemblies into structure to attain fire rated construction, in a manner acceptable to the governing authorities.
- .7 Cover exposed duct sleeves in finished areas with 1.42 mm (0.0561 in. - 18 GSG) galvanized sheet steel in the form of duct collars. Fix in position with non-ferrous metal screws.

SLEEVES AND ESCUTCHEONS

- .8 Counter flashing for roof penetrations shall be commercial quality galvanized sheet steel to ASTM A653/A653M "Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process," 0.70 mm (0.0276 in. - 24 GSG) minimum thickness, Z275 275 zinc coated by hot dip process.

PART 3 - EXECUTION

3.1 Installation

- .1 Arrange for all chases and formed openings in walls and floors as required by the Mechanical Division for the mechanical services. These chases and openings shall not be larger than necessary to accommodate the equipment and services. Advise on these requirements well in advance, before the concrete is poured and the walls are built. All necessary sleeves and inserts shall be supplied by this Division.
- .2 Chases and openings not located in accordance with the above provisions shall be made at the expense of this Division. Cutting of structural members shall not be permitted without specified written acceptance of the Contract Administrator.
- .3 Provide sleeves for all service penetrations through walls, partitions, floor slabs, plenums and similar barriers.
- .4 Sleeves shall be sized to maintain insulation and vapour barrier around all pipes and ducts for all service penetrations. Coordinate thickness requirements with Section 20 07 00 - INSULATION.
- .5 For sleeves through barriers without a fire resistance rating, for non-insulated pipe, fill the annular space between the service and the sleeve with insulation as specified in Section 20 07 00 - INSULATION and caulk around the edges with sealant.
- .6 Where holes are core drilled in existing structures, sleeves shall be provided as specified complete with a combination puddle/anchor flange bolted to the floor. Seal watertight between the flange and the floor.
- .7 Provide escutcheons at all penetrations of piping into finished areas, and at insulated pipes, make the escutcheons large enough to fit around the insulation.
- .8 Counter flash vertical duct penetrations through roof at intersection of roof curb and duct.
- .9 Extend sleeves a minimum of 50 mm (2 in) above floor and seal water tight to prevent seeping to the floor below. Sleeves passing through housekeeping pads are permitted to be flush with the top of the housekeeping pad.

END OF SECTION

CUTTING AND PATCHING

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 Openings required for mechanical services for new construction shall be in accordance with Section 20 05 83 - SLEEVES AND ESCUTCHEONS. This Section shall apply for openings required in existing construction or where sleeves for mechanical services have been omitted in new construction in error.
- .3 Include for all cutting and patching for all mechanical services for holes and openings with dimensions up to 200 mm (8 in.) in size and related patching. Perform cutting and patching Work in accordance with requirements of Section 01 60 00 - PROJECT FORMS.
- .4 Cutting and Patching shall be in accordance with Section 01 60 00 - PROJECT FORMS.

PART 2 - PRODUCTS

2.1 Materials

- .1 All services and materials used for the cutting and patching shall meet all requirements specified in Section 01 60 00 - PROJECT FORMS, and shall be carried out by professional workers experienced in the cutting and patching Work to be done.

PART 3 - EXECUTION

3.1 Installation

- .1 Locate all openings in non-structural elements requiring cutting and patching in cooperation with the applicable Trades in a timely manner to avoid unnecessary cutting. All openings shall be shown on drawings and submitted to the Contract Administrator for review. No holes through structure shall be permitted prior to review by the Structural Contract Administrator.
- .2 Core drilling for individual services shall be by this Division. Cut all openings no larger than is required for the services.
- .3 Locate all openings in structural elements requiring cutting and patching (concrete walls or floors) and x-ray the structure to obtain Structural Contract Administrator's approval prior to cutting or core drilling of structure. Make adjustments to location of openings as required to minimize cutting of rebar and completely avoid electrical conduit.
 - .1 Cut holes through slabs or walls only.
 - .2 Do not cut holes through beams.
 - .3 Holes to be cut are 200 mm (8 in.) diameter or smaller only.
 - .4 Maintain at least 100 mm (4 in.) clear from all beam faces. Space at least 3 hole diameters on Centre.
 - .5 For holes that are required closer than 25% of slab span from the supporting beam face, use cover meter above the slab to clear slab top bars.

CUTTING AND PATCHING

- .6 For holes that are required within 50% of slab span, use cover meter underside of slab to clear slab bottom bars.
- .7 X-rays shall be performed by a qualified technician, in a safe manner and in accordance with all applicable regulations governing this activity.
- .4 Obtain written approval from the Structural Contract Administrator before cutting or core drilling openings or holes.
- .5 Patch all openings after services have been installed to match the surrounding finishes.

END OF SECTION

INSULATION

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Submittals

- .1 Provide Shop Drawings with technical data on all types of insulation to be installed, in accordance with Section 20 05 03 – SHOP DRAWINGS.
- .2 Provide two samples of each type of insulation indicating where each is to be used, and a sample of a typical vapour barrier dam, where vapour barrier dams are called for: in Part 3 or on the Drawings. Samples shall be mounted on boards. One shall be kept at the Contractor's site office and the other shall be turned over to the Contract Administrator.

PART 2 - PRODUCTS

2.1 general

- .1 Provide insulation and jacket systems that are fire retardant, with a flame-spread rating not to exceed 25 and a smoke developed classification not to exceed 50, when tested in accordance with CAN/ULC S102 "Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies."
- .2 For indoor applications, provide insulation systems (insulation, jackets, adhesives, coatings, etc.) that are Certified under the UL GREENGUARD Certification Program for low chemical and particle (volatile organic compounds (VOC)) emissions.

2.2 Pipe insulation

- .1 Type P1 - Inorganic mineral fibre: glass wool, rock wool, or slag wool.
 - .1 To ASTM C547 "Standard Specification for Mineral Fiber Pipe Insulation."
 - .2 Rigid, pre-formed, with pressure sensitive longitudinal adhesion strip.
 - .3 Reinforced all service jacket (ASJ) vapour retarder.
 - .4 Suitable for temperature range of pipe application in question.
 - .5 Acceptable manufacturers:
 - .1 Johns Manville
 - .2 Knauf
 - .3 Manson
 - .4 Owens-Corning
- .2 Type P2 - Inorganic mineral fibre: rock wool, or slag wool.
 - .1 To ASTM C547 "Standard Specification for Mineral Fiber Pipe Insulation."
 - .2 Rigid, pre-formed, with pressure sensitive longitudinal adhesion strip. Chopped fibre moulded is not acceptable.

INSULATION

- .3 Reinforced all service jacket (ASJ) vapour retarder.
- .4 Suitable for temperature range of pipe application in question.
- .5 Acceptable manufacturers:
 - .1 Knauf
 - .2 Rockwool
- .3 Type P3 - Closed cell flexible elastomeric:
 - .1 To ASTM C534 "Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form."
 - .2 Preformed, with self closing adhesion strips.
 - .3 Suitable for temperature range of pipe application in question.
 - .4 UV resistant with protective jacket/cladding where used outdoors.
 - .5 Adhesive for both surfaces to be joined.
 - .6 Acceptable manufacturers:
 - .1 Armacell
- .4 Type P4 - Inorganic rock wool mineral fibre pipe wrap:
 - .1 To ASTM C553 "Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications."
 - .2 Flexible blanket, with foil scrim kraft (FSK) facing or reinforced all service jacket (ASJ) vapour barrier.
 - .3 Suitable for temperature range of pipe application in question.
 - .4 Acceptable manufacturers:
 - .1 Johns Manville
 - .2 Rockwool
- .5 Type P5 - Closed cell cellular glass:
 - .1 To ASTM C552 "Standard Specification for Cellular Glass Thermal Insulation" and ASTM C1639 "Standard Specification for Fabrication Of Cellular Glass Pipe And Tubing Insulation."
 - .2 Acceptable manufacturer:
 - .1 Owens-Corning - Foamglas
- .6 Type P6 - Fire resistant pipe insulation:
 - .1 Except where other methods of fire rating are shown on the Drawings and provided that the local authority having jurisdiction is in agreement, provide CL4Fire fire wrap system for natural gas piping, fuel oil piping, standpipes, or other pipes requiring a fire rating and employ a fire wrap system listed for the specific piping application and fire rating in question. Provide fire wrap complete with CCMC Canadian code compliance evaluation approval.

INSULATION

- .7 Type P7 - Hydrous calcium silicate high temperature insulation:
 - .1 To ASTM C533 "Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation."
 - .2 Rigid, split formed, moulded insulation.
 - .3 Asbestos free, non-combustible.
 - .4 Abuse-resistant, 230 kg/cu.m. (14 lbs/cu.ft.) density.
 - .5 Suitable for temperature range up to 538 Deg. C (1000 Deg. F).
 - .6 Acceptable manufacturer:
 - .1 Johns Manville – Thermo-12 Gold

2.3 Duct insulation

- .1 Type D1 - Inorganic mineral fibre blanket - glass wool, rock wool, or slag wool:
 - .1 To ASTM C553 "Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications."
 - .2 Flexible blanket, with foil scrim kraft (FSK) facing jacket vapour barrier.
 - .3 Density: 24 kg/cu.m. (1.5 lbs/cu.ft.).
 - .4 Suitable for temperature range of duct application in question.
 - .5 Acceptable manufacturers:
 - .1 Johns Manville
 - .2 Knauf
 - .3 Rockwool
- .2 Type D2 - Inorganic mineral fibre board - glass wool, rock wool, or slag wool:
 - .1 To ASTM C612 "Standard Specification for Mineral Fiber Block and Board Thermal Insulation."
 - .2 Semi-rigid board, with factory applied foil scrim kraft (FSK) facing jacket vapour barrier.
 - .3 Suitable for temperature range of duct application in question.
 - .4 Density: 48 kg/cu.m. (3 lbs/cu.ft.).
 - .5 Acceptable manufacturers:
 - .1 Johns Manville
 - .2 Knauf
 - .3 Owens-Corning
 - .4 Rockwool

INSULATION

- .3 Type D3 - Closed cell flexible elastomeric:
 - .1 To ASTM C534 "Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form."
 - .2 Preformed.
 - .3 Suitable for temperature range of duct application in question.
 - .4 UV resistant with protective jacket/cladding where used outdoors.
 - .5 Adhesive for both surfaces to be joined.
 - .6 Acceptable manufacturers:
 - .1 Armacell
- .4 Type D4 - Extruded polystyrene (XPS):
 - .1 To ASTM C578 "Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation" and CAN/ULC S701.1 "Thermal Insulation, Polystyrene Boards."
 - .2 Rigid, formed into board insulation.
 - .3 Suitable for temperature range of duct application in question.
 - .4 Acceptable manufacturers:
 - .1 Dupont
 - .2 Owens-Corning
- .5 Type D5 - Fire resistant duct insulation:
 - .1 To meet the requirements of NFPA 96 "Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations."
 - .2 To meet the fire resistance rating indicated on the Drawings or 2 hours.
 - .3 Complete with all manufacturer's standard fastenings, including (where applicable) aluminum foil tape, filament tape, banding materials, pins, cup-head weld pins, and speed clips for a ULC listed installation.
 - .4 Acceptable manufacturers:
 - .1 3M - Fire Barrier Duct Wrap
 - .2 CL4Fire
 - .3 Unifrax Corporation – FyreWrap

2.4 Equipment insulation

- .1 Type E1 - Inorganic mineral fibre blanket - glass wool, rock wool, or slag wool:
 - .1 To ASTM C553 "Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications."
 - .2 Blanket, foil faced.
 - .3 Suitable for temperature range of equipment application in question.
 - .4 Density: Minimum 12 kg/cu.m. (0.75 lbs/cu.ft.).

INSULATION

- .5 Acceptable manufacturers:
 - .1 Johns Manville
 - .2 Knauf
 - .3 Manson
 - .4 Owens-Corning
- .2 Type E2 - Inorganic mineral fibre blanket - glass wool, rock wool, or slag wool:
 - .1 To ASTM C553 "Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications."
 - .2 Blanket, with foil scrim kraft (FSK) facing jacket or all service jacket (ASJ), vapour barrier.
 - .3 Suitable for temperature range of equipment application in question.
 - .4 Density: Minimum 24 kg/cu.m. (1.5 lbs/cu.ft.).
 - .5 Acceptable manufacturers:
 - .1 Johns Manville
 - .2 Knauf
 - .3 Manson
 - .4 Owens-Corning
- .3 Type E3 - Inorganic mineral fibre blanket - glass wool, rock wool, or slag wool:
 - .1 To ASTM C553 "Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications."
 - .2 Flexible blanket, with foil scrim kraft (FSK) facing jacket or all service jacket (ASJ), vapour barrier.
 - .3 Density: minimum 48 kg/cu.m. (3 lbs/cu.ft.).
 - .4 Suitable for temperature range of equipment application in question.
 - .5 Acceptable manufacturers:
 - .1 Johns Manville
 - .2 Knauf
 - .3 Owens-Corning
 - .4 Rockwool
- .4 Type E4 - Inorganic mineral fibre board - glass wool, rock wool, or slag wool:
 - .1 To ASTM C612 "Standard Specification for Mineral Fiber Block and Board Thermal Insulation."
 - .2 Semi-rigid board, with factory applied foil scrim kraft (FSK) facing jacket vapour barrier.
 - .3 Suitable for temperature range of equipment application in question.
 - .4 Density: minimum 48 kg/cu.m. (3 lbs/cu.ft.).
 - .5 Acceptable manufacturers:

INSULATION

- .1 Johns Manville
- .2 Knauf
- .3 Owens-Corning
- .4 Rockwool
- .5 Type E5 - Inorganic mineral fibre board - glass wool, rock wool, or slag wool:
 - .1 To ASTM C612 "Standard Specification for Mineral Fiber Block and Board Thermal Insulation."
 - .2 Semi-rigid board, with factory applied foil scrim kraft (FSK) facing jacket vapour barrier.
 - .3 Suitable for temperature range of equipment application in question.
 - .4 Density: minimum 128 kg/cu.m. (8 lbs/cu.ft.).
 - .5 Acceptable manufacturers:
 - .1 Johns Manville
 - .2 Owens-Corning
 - .3 Rockwool
- .6 Type E6 - Closed cell flexible elastomeric:
 - .1 To ASTM C534 "Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form."
 - .2 Self adhering roll sheets.
 - .3 Suitable for temperature range of equipment application in question.
 - .4 UV resistant with protective jacket/cladding where used outdoors.
 - .5 Acceptable manufacturers:
 - .1 Armacell
- .7 Type E7 - Stone wool high temperature insulation:
 - .1 To ASTM C547 "Standard Specification for Mineral Fiber Pipe Insulation."
 - .2 Moulded stone wool, non-combustible.
 - .3 Suitable for operating temperatures up to 760 Deg. C.(1400 Deg. F).
 - .4 Acceptable manufacturer:
 - .1 Rockwool – ProRox PS 980
- .8 Type E8 - Spun ceramic fibre blanket high temperature insulation:
 - .1 To ASTM C892 "Standard Specification for High-Temperature Fiber Blanket Thermal Insulation."
 - .2 Suitable for applications with temperatures from 538 Deg. C (1000 Deg. F) to 1345 Deg. C (2450 Deg. F).
 - .3 Nominal density:128 kg/cu.m. (8 lbs/cu.ft.).
 - .4 Acceptable manufacturers:

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- .1 Nutec - MaxWool spun ceramic fibre blanket.
- .9 Type E9 - Spun low bio-persistent (LBP) fibre blanket high temperature insulation:
 - .1 To ASTM C892 "Standard Specification for High-Temperature Fiber Blanket Thermal Insulation."
 - .2 Suitable for applications with temperatures up to 1100 Deg. C (2000 Deg. F).
 - .3 Nominal density: 128 kg/cu.m. (8 lbs/cu.ft.).
 - .4 Acceptable manufacturer:
 - .1 Nutec – Supermag HI low-bio-persistence spun blanket.
- .10 Type E10 - Hydrous calcium silicate high temperature insulation:
 - .1 To ASTM C533 "Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation."
 - .2 Rigid, split formed, moulded insulation.
 - .3 Asbestos free, non-combustible.
 - .4 Abuse-resistant, 230 kg/cu.m. (14 lbs/cu.ft.) density.
 - .5 Suitable for temperature range up to 538 Deg. C (1000 Deg. F).
 - .6 Acceptable manufacturer:
 - .1 Johns Manville – Thermo-12 Gold

2.5 Jackets

- .1 All service jacket (ASJ)
 - .1 As indicated in insulation types above.
- .2 Foil skim kraft (FSK)
 - .1 As indicated in insulation types above.
- .3 Insulation Jacketing System:
 - .1 Multi-layered, reinforced laminate jacketing tape with acrylic pressure sensitive adhesive.
 - .2 Zero permeability; self-adhesive; UV and weather resistant.
 - .3 Colour: Natural aluminum or white, as chosen at Shop Drawing stage.
 - .4 Finish: flat or embossed, as chosen at Shop Drawing stage.
 - .5 Acceptable manufacturers:
 - .1 3M – VentureClad Insulation Jacketing System 1577 Series
 - .2 3M – VentureClad Heavy Duty Jacketing System 1579 Series
- .4 Canvas jacket:
 - .1 ULC listed plain weave cotton fabric insulation jacket.
 - .2 Weight of canvas: 220 g/sq.m (6 oz/sq.yd.).
 - .3 Complete with two coats of fire retardant lagging finish.
- .5 Polyvinyl Chloride (PVC) jacket:
 - .1 Pre-moulded PVC covers.

INSULATION

- .2 Pre-moulded PVC elbows and fittings.
- .3 Minimum thickness: 20 mil.
- .4 Colour: white or coloured as chosen at Shop Drawing stage.
- .5 Tape: vinyl, pressure sensitive, colour matched.
- .6 Sealed with adhesive.
- .6 Aluminum jacket:
 - .1 Finish: smooth.
 - .2 Minimum thickness: 0.41 mm (0.016 in.).
 - .3 Factory applied poly-surlyn moisture barrier laminated to inside surface of jacket.
 - .4 Longitudinal and circumferential slip joints.
- .7 Stainless Steel (SS) jacket:
 - .1 Grade: 316.
 - .2 Finish: smooth.
 - .3 Minimum thickness: 0.25 mm (0.01 in.).
 - .4 Factory applied poly-surlyn moisture barrier laminated to inside surface of jacket.
 - .5 Longitudinal and circumferential slip joints.

2.6 Securement

- .1 Banding
 - .1 Aluminum or Stainless steel.
- .2 Tie Wire
 - .1 Stainless steel.
 - .2 Minimum 1.3 mm (16 gauge).
 - .3 Twisted ends.
- .3 Corner beads and channels at floor line:
 - .1 Minimum 0.4 mm (28 gauge) galvanized sheet metal.
- .4 As per insulation / jacket manufacturer's written installation instructions.

2.7 Cements And Adhesives

- .1 Where cements or adhesives are required, provide those that are compatible with insulation and jacket, per insulation and jacket manufacturer's written recommendations / instructions.
- .2 Fire retardant lagging coating:
 - .1 Chil Seal CP-50A by Childers Products Company or Henry equivalent.
- .3 Vapour barrier dam:
 - .1 CHIL-PERM CP-30 with fibreglass cloth reinforcing.

INSULATION

PART 3 - EXECUTION

3.1 Installation

- .1 Install insulation in accordance with the manufacturer's written installation instructions unless noted otherwise.
- .2 Insulation thicknesses and conductivities shall meet or exceed the minimum standards set out in ASHRAE 90.1 "Energy Standard for Buildings except Low-rise Residential Buildings" and in National Energy Code of Canada for Buildings (NECB), (refer to Table 2 below), and as specified herein for the services covered.
- .3 Apply insulation to clean, dry surfaces only while ambient temperature is at least 10 Deg. C. (50 Deg. F.).
- .4 Commence application of insulation following required testing of piping, ductwork, and apparatus where such items are to be covered. Do not commence insulation installation until testing report is submitted to Contract Administrator and is reviewed by Contract Administrator without requesting a resubmit.
- .5 Where pipes and ducts are specified to be insulated, insulate complete piping system and duct system with no gaps in insulation.
- .6 Protect insulation and pipe from moisture ingress where insulation is installed exterior to the building.
- .7 Utilize oversized hangers and pipe supports where pipes are installed exterior to the building and are to be insulated. Hangers and supports to support assembly on the outside of the insulation, so as to protect insulation and pipe from water damage due to ambient conditions.
- .8 Where vapour barrier dams are called for, terminate the insulation and seal the vapour barrier to the pipe or ductwork using a mesh embedded in a vapour barrier mastic. Provide dams at valves, fittings used for servicing, groups of other types of fittings, irregular shaped objects at floor and wall penetrations, and at 15 m (50 ft.) intervals of straight pipe or straight ductwork for the following services: water piping that is less than 26.7 deg. C. (80 deg. F.), including but not limited to the following:
 - .1 Domestic cold water piping
 - .2 Chilled drinking water piping
 - .3 Chilled water piping
 - .4 Glycol piping
 - .5 Spray coil piping
 - .6 Dual temperature piping
 - .7 Condenser water pipe piping and
 - .8 Exterior ductwork
- .9 Terminate insulation on pipes passing through fire rated walls or floors, and fit tight to the fire stop material.

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- .10 Irregular shaped objects such as strainers, pipe system filters, cyclone separators, blowdown valves and other accessories requiring servicing, on insulated piping, shall be insulated with removable caps or sections. All edges shall be sealed between pipe and vapour barrier and held in place with stainless steel straps. Finish all insulation smooth, making the outline of pipe insulation a true circular and concentric shape. Shape the outline of fitted insulation to blend with adjacent covering.
- .11 On piping systems specified to be insulated, include insulation on valves, flanges, couplings and unions.
- .12 Do not use staples to secure joints of insulation jackets.
- .13 Where tie wires are used, install on maximum 305 mm (12 in.) centres.
- .14 Install insulation jackets with minimum 50 mm (2 in.) laps.
- .15 Provide insulation and jacket systems in accordance with Table 1 below:

TABLE 1: INSULATION AND JACKET SYSTEMS

Pipe Application	Insulation	Thickness	Jacket
Piping services that will be painted	See table contents below	See table contents below	Do not use PVC.
Pipe insulation exposed to view / not concealed, where being painted	See table contents below	See table contents below	Canvas pasted on
Pipe insulation exposed to view / not concealed, where NOT being painted	See table contents below	See table contents below	Canvas pasted on or PVC
Pipes that are electrically heat traced	Do not use Type P3	See table contents below	See table contents below
Where pipes are installed outdoors, provide pipe coatings in accordance with Section 23 21 13.23 – Piping, Valves & Fittings (Except Plumbing).	See table contents below	See table contents below	See table contents below
Hot fluid such as heating water services, heating glycol, low pressure steam and condensate piping, etc.	Type P1	Per Table 2	Per insulation type; for high temperature heating water do not use PVC; see Section 23 21 13.23 for more info on temperatures.
Domestic hot water piping	Type P1	Per Table 2	Per insulation type

INSULATION

Refrigerant liquid and suction piping	Type P3	25 mm (1 in.), unless a greater thickness is required by the manufacturer's written instructions.	Per insulation type
Domestic cold water and chilled drinking water piping	Type P1 or P3	Per Table 2 domestic cold water requirements	Per insulation type
First 4500 mm (15 ft.) of standpipe and/or sprinkler main	Type P1 or P3	12 mm (1/2 in.)	Per insulation type
Chilled glycol	Type P1 or P3	Per Table 2	Per insulation type
Piping in air handling or air conditioning units	Type P3	25 mm (1 in.)	Per insulation type
Piping serving pumps for cold fluid systems such as chilled glycol, domestic water, etc. and located inside air handling or air conditioning units	Type P3	25 mm (1 in.)	Per insulation type
Drainage piping 75 mm (3 in.) and smaller as indicated below: Storm drainage: roof drain sump; all horizontal or sloping storm piping; all elbows connecting the horizontal storm drainage piping to the vertical leaders; and where the roof drain is less than 3000 mm (10 ft.) horizontally from the vertical leader, insulate the first 3000 mm (10 ft.) of pipe length (horizontal and vertical) closest to the roof drain.	Type P1 or P3	12 mm (1/2 in.)	Per insulation type

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Sanitary drainage: sanitary drainage pipes from urinals, direct and indirect drains from drinking fountains, floor drains from air conditioning apparatus, all horizontal drainage carrying chilled condensate, all piping passing through areas with relative humidity of 70% or higher, and sanitary drainage pipe from barrier free lavatories.			
Drainage piping larger than 75 mm (3 in.) as indicated below: Storm drainage: roof drain sump; all horizontal or sloping storm piping; all elbows connecting the horizontal storm drainage piping to the vertical leaders; and where the roof drain is less than 3000 mm (10 ft.) from the vertical leader insulate the first 3000 mm (10 ft.) of pipe closest to the roof drain and the exposed portion of the roof drain. Sanitary drainage: sanitary drainage pipes from urinals; direct and indirect drains from drinking fountains; floor drains from air conditioning apparatus; all horizontal drainage carrying chilled condensate; all piping passing through areas with relative humidity of 70% or higher; and sanitary drainage pipe from barrier free lavatories.	Type P1 or P3	25 mm (1 in.)	Per insulation type

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Electrical heat traced piping – insulated for the entire length of piping	As specified for the service being traced; for services not specifically designated, insulate as specified for heating water	For pipes 250 mm (10 in.) and smaller: minimum 38 mm (1-1/2 in.) or thicker as required for the service in question. For pipes 300 mm (12 in.) and larger: minimum 50 mm (2 in.) or thicker as required for the service in question. Thickness of insulation over fittings, valves, and other appurtenances to match the pipe insulation. Provide thicker insulation as required by heat tracing manufacturer's installation requirements.	As specified for the service being traced
Duct Application	Insulation	Thickness	Jacket
Flexible duct connections do not require insulation except where a factory applied insulation has been specified with the flexible duct connection.	See ductwork spec	See ductwork spec	See ductwork spec
Exposed insulation in mechanical rooms	See table contents below	Increase thickness as necessary to give 12 mm (1/2 in.) thickness over flanges and angles.	See table contents below
Ductwork internal to the building within conditioned spaces	Type D2	25 mm (1 in.)	Per insulation type
Ductwork in conditioned concealed spaces and on round duct smaller than 600 mm (24 in.)	Type D1	38 mm (1-1/2 in.)	Per insulation type

INSULATION

Ductwork external to the building	Type D3 or D4	2 layers of 50 mm (2 in.) Provide sloped extruded polystyrene insulation support on top of ductwork to maintain slope at a minimum of 5%. Cover all flanges by a minimum of 12 mm (1/2 in.).	Per insulation type for Type D3 or Insulation jacketing system for Type D4
Apparatus casings	As per connected ductwork, see table above	As per connected ductwork, see table above	As per connected ductwork, see table above
Outside air plenums and mixed air plenums.	See indoor ductwork above	Thickness to suit minimum RSI-2.12 (R-12) for plenums exposed to outside air.	See indoor ductwork above
Outdoor air ductwork and mixed air ductwork, including ducts to and from independent heat recovery units (ERW, HRV, etc.).	See indoor ductwork above	Thickness to suit minimum RSI-2.12 (R-12).	See indoor ductwork above
Heating and cooling coil sections of ductwork and plenums.	Per indoor ductwork	Per indoor ductwork	Per indoor ductwork
Casings of supply fans in equipment rooms.	Per indoor ductwork	Per indoor ductwork	Per indoor ductwork
Supply ductwork in equipment rooms.	Per indoor ductwork	Per indoor ductwork	Per indoor ductwork
Exhaust and relief air: ductwork, plenums, and/or casings, from 1500 mm (60 in.) upstream of shut-off dampers and from dampers to connection to exterior wall or roof.	Per indoor ductwork	Thickness to suit minimum RSI-2.12 (R-12).	Per indoor ductwork
Exhaust air ductwork from independent heat recovery units (ERW, HRV, etc.) up to connection to exterior wall or roof.	Per indoor ductwork	Thickness to suit minimum RSI-2.12 (R-12).	Per indoor ductwork

INSULATION

Exhaust, relief, supply, and return air: ductwork, plenums and/or casings, through non-air conditioned or unheated internal space.	Per indoor ductwork	Use 50 mm (2 in.) thickness.	Per indoor ductwork
All supply ductwork from fans to air outlets (e.g. diffusers, grills, etc.)	Per indoor ductwork	Per indoor ductwork	Per indoor ductwork
Silencers and fan capacity monitors.	Insulate to suit service and location.	To suit service and location.	To suit service and location.
All supply ductwork from VAV box for variable volume systems up to and including terminal grill or diffuser.	Per indoor ductwork	Per indoor ductwork	Per indoor ductwork
Equipment Application	Insulation	Thickness	Jacket
Heating water tanks / thermal buffer tanks	Type E2, wired on	50 mm (2 in.)	Canvas
Shell and tube heat exchangers	Type E2, wired on	50 mm (2 in.)	Canvas
Radiant heating panels	Type E1	25 mm (1 in.)	Per insulation type
Cold water service: valves, water meters, drain valves, vent connections, thermometer wells, pressure gauges, and other irregular shaped objects	Type E6	To suit service, per Table 2	Per insulation type
Hot water service <= 66 deg. C. (150 deg. F.): valves, water meters, drain valves, vent connections, thermometer wells, pressure gauges, and other irregular shaped objects	Type E6 or E2	To suit service, Per Table 2	Per insulation type
Chilled water storage tanks / thermal storage tanks / dual temperature tanks; including legs/supports	Type E6	50 mm (2 in.)	Per insulation type
Pumps for chilled water, spray coils, and domestic water	Type E6	25 mm (1 in.)	Per insulation type

INSULATION

Equipment internal to the building within conditioned spaces	Type E4	25 mm (1 in.)	Per insulation type
Plate type heat exchangers with hot surfaces	Type E4	25 mm (1 in.)	Enclose hot surfaces in a removable galvanized steel box. Construct box using flanged, bolted and gasketed joints, with sections removable for servicing the heat exchanger. Bolt box to floor base around the heat exchanger. Provide construction similar to built-up air plenums.
Plate type heat exchangers with cold surface	Type E6, installed in sections with all joints sealed. Also insulate in accordance with the manufacturer's printed insulation instructions. Insulate plate heat exchangers when both services are insulated.	25 mm (1 in.)	Per insulation type
Site fabricated breaching, up to and including connection to chimney stack. Insulate all breaching, except for double walled insulated gas vents, from all boilers and other equipment up to the chimney stack.	Type E7, secured with pins and covered with expanded metal lath. Apply insulation to permit expansion and contraction of breaching without damage to the insulation.	100 mm (4 in.) thick	Final finish consisting of two layers of cement, reinforced with canvas and trowelled smooth, to effect a uniform finish.

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- .1 On hot services, insulate valves, fittings, couplings, unions, flanges and all other appurtenances through which the fluid passes, using mitred sections of preformed insulation of a thickness equal to the adjoining pipe insulation, and securely wire in place.
 - .2 For domestic hot water piping, apply insulation with all joints butted firmly together, and bond securely, sealing flaps by pasting down to give a smooth finish.
 - .3 Provide removable sections at access doors/manholes and all components requiring servicing.
- .17 Cold Services
- .1 Protect insulation by means of sheet steel shields at each hanger or support on the following:
 - .1 All sizes of chilled water
 - .2 All sizes of chilled glycol
 - .3 All sizes of spray coil
 - .4 All sizes of dual temperature
 - .5 All sizes of condenser water pipes
 - .6 Domestic cold water piping larger than 25 mm (1 in.)
 - .2 Provide Type P5 closed cellular glass insulation inserts the full length of shields at all hangers and supports.
 - .3 For domestic cold water piping 25 mm (1 in.) and less where hangers on cold water lines penetrate vapour barrier, ensure that the penetration is properly sealed with insulation and vapour barrier continued up hanger a further 75 mm (3 in.).
 - .4 Where sheet metal shields are used, refer to Section 20 05 29 - HANGERS AND SUPPORTS.
 - .5 On cold water service valves, water meters, drain valves, vent connections, thermometer wells, pressure gauges and other irregular shaped objects, cut and mitre insulation as necessary. Bond and seal edges of insulation to the adjacent surfaces.
 - .6 Chilled water storage tanks: provide removable sections at access doors/manholes and all components requiring servicing.
 - .7 Refer to the Table 2 for required insulation thicknesses.
- .18 Ductwork and Equipment
- .1 Butt join insulation and attach with pins and speed washers, one per 0.186 sq.m. (2 sq.ft.), but not more than 450 mm (18 in.) apart in any direction. Apply fire resistive adhesive in 100 mm (4 in.) wide strips on 300 mm (12 in.) centres. Seal all joints with adhesive and apply vapour barrier tape. Install pins of suitable length for the thickness of insulation and clip flush after final installation of washers. Tack weld pins to sheet metal.

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- .2 On exposed insulation in mechanical rooms, provide corner beads to protect corners to a height of 2135 mm (84 in.) above floor and provide channels at floor line to finish off insulation on apparatus.
- .3 Coordinate with Sheet Metal Contractor to ensure duct insulation is applied prior to ductwork being installed to underside of slabs, beams or other services or behind other duct risers and shafts.
- .19 Apply fire resistant duct insulation directly onto the ductwork and plenums in strict accordance with the manufacturer's written instructions and Listing. Tested to CAN/ULC-S144 "Standard Method of Fire Resistance Test – Grease Duct Assemblies," ISO Standard 6944-1 "Fire containment - Elements of building construction - Part 1: Ventilation ducts," and ISO Standard 6944-2 "Fire containment - Elements of building construction - Part 2: Kitchen extract ducts" as a gypsum shaft alternative per NFPA 96 "Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations" guidelines.
- .20 Except where other methods of fire rating are shown on the Drawings, where fire wrap systems for pipes are acceptable to the local authority having jurisdiction, install fire wrap system, in accordance with the CCMC listing and the manufacturer's written instructions.

INSULATION

.21 TABLE 2: MINIMUM PIPE INSULATION THICKNESS/PERFORMANCE (BASED ON ASHRAE 90.1 AND NATIONAL ENERGY CODE FOR BUILDINGS)

- .1 Comply with the more stringent (i.e. larger) minimum pipe insulation thickness when comparing ASHRAE 90.1 and National Energy Code for Buildings.
- .2 Minimum pipe insulation thickness - mm (in.)
 - .1 ASHRAE 90.1: Heating and Hot Water Systems (Steam, Steam Condensate, Hot-Water Heating, Domestic Water Systems, Heating Glycol, Other Heating)

Fluid Design Operating Temp. range deg. C. (deg. F.)	Insulation Conductivity		Nominal Pipe Diameter - mm (in.)					
	Conductivity W/(m-K) ((Btu-in.)/h-sq.ft. – deg. F.)	Mean Rating Temp deg. C. (deg. F.)	Runouts* <38.1 (<1.5)	<25.4 (<1)	25.4 to <38.1 (1 to <1-1/2)	38.1 to <101.6 (1-1/2 to <4)	101.6 to <203.2 (4 to <8)	≥203.2 (≥8)
Above 177	0.046 to 0.049	121	101.6	114.3	127.0	127.0	127.0	127.0
Above (350)	(0.32 to 0.34)	(250)	(4.0)	(4.5)	(5.0)	(5.0)	(5.0)	(5.0)
122-177	0.042 to 0.046	93	76.2	76.2	101.6	114.3	114.3	114.3
(251 to 350)	(0.29 to 0.32)	(200)	(3.0)	(3.0)	(4.0)	(4.5)	(4.5)	(4.5)
94-121	0.039 to 0.043	66	38.1	63.5	63.5	63.5	76.2	76.2
(201 to 250)	(0.27 to 0.30)	(150)	(1.5)	(2.5)	(2.5)	(2.5)	(3.0)	(3.0)
61-93	0.036 to 0.042	52	25.4	38.1	38.1	50.8	50.8	50.8
(141 to 200)	(0.25 to 0.29)	(125)	(1.0)	(1.5)	(1.5)	(2.0)	(2.0)	(2.0)
41-60	0.032 to 0.040	38	25.4	25.4	25.4	38.1	38.1	38.1
(105 to 140)	(0.22 to 0.28)	(100)	(1.0)	(1.0)	(1.0)	(1.5)	(1.5)	(1.5)

*For piping located in partitions within conditioned spaces, reduction per footnote to ASHRAE 90.1 table.

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.2 National Energy Code for Buildings: Heating Systems (Steam, Steam Condensate, Hot Water Heating, Domestic Water Systems, Heating Glycol, Other Heating)

Fluid Design Operating Temp. range deg. C. (deg. F.)	Insulation Conductivity		Nominal Pipe Diameter - mm (in.)					
	Conductivity W/(m-deg. C) ((Btu-in.)/h-sq.ft. – deg. F.)	Mean Rating Temp deg. C. (deg. F.)	Runouts ^y ≤51 (2)	≤25.4 (<1)	32 to 51 (1-1/4 to 2)	64 to 102 (2-1/2 to 4)	≥127 (≥5)	Not used
Above 177	0.046 to 0.049	121	38.1	114	127	127	127	
Above (350)	(0.32 to 0.34)	(250)	(1.5)	(4.5)	(5.0)	(5.0)	(5.0)	
122-177	0.042 to 0.045	93	38.1	76.2	101.6	114	114	
(251 to 350)	(0.29 to 0.31)	(200)	(1.5)	(3.0)	(4.0)	(4.5)	(4.5)	
94-121	0.039 to 0.043	65	38.1	63.5	63.5	76.2	76.2	
(201 to 250)	(0.27 to 0.30)	(149)	(1.5)	(2.5)	(2.5)	(3.0)	(3.0)	
61-93	0.036 to 0.042	52	25.4	38.1	50.8	50.8	50.8	
(141 to 200)	(0.25 to 0.29)	(125)	(1.0)	(1.5)	(2.0)	(2.0)	(2.0)	
41-60	0.035 to 0.040	38	25.4	25.4	38.1	38.1	38.1	
(105 to 140)	(0.24 to 0.28)	(100)	(1.0)	(1.0)	(1.5)	(1.5)	(1.5)	

^yRefers to runouts to individual terminal units not exceeding 3.7 m in length.

INSULATION

- .3 ASHRAE 90.1: Cooling Systems (Chilled Water, Brine, Refrigerant, Chilled Glycol, Dual Temperature Condenser Water (condenser water systems that may operate below 16 deg. C)) and Domestic Cold Water.

Fluid Design Operating Temp. range deg. C. (deg. F.)	Insulation Conductivity		Nominal Pipe Diameter - mm (in.)					
	Conductivity [W/(m-K)] [(Btu-in.)/h-sq.ft. – deg. F.]	Mean Rating Temp deg. C. (deg. F.)	Not used	<25.4 (<1)	25.4 to <38.1 (1 to <1-1/2)	38.1 to <101.6 (1-1/2 to <4)	101.6 to <203.2 (4 to <8)	≥203.2 (≥8)
4.4-16	0.030 to 0.039	24		12.7	12.7	25.4	25.4	25.4
(40-60)	(0.21 to 0.27)	(75)		(0.5)	(0.5)	(1.0)	(1.0)	(1.0)
<4.4	0.029 to 0.038	10		12.7	25.4	25.4	25.4	38.1
<(40)	(0.20 to 0.26)	(50)		(0.5)	(1.0)	(1.0)	(1.0)	(1.5)

- .4 National Energy Code for Buildings: Cooling Systems (Chilled Water, Brine, Refrigerant, Chilled Glycol, Dual Temperature Condenser Water (condenser water systems that may operate below 16 deg. C)) and Domestic Cold Water.

Fluid Design Operating Temp. range deg. C. (deg. F.)	Insulation Conductivity		Nominal Pipe Diameter - mm (in.)					
	Conductivity [W/(m-deg. C)] [(Btu-in.)/h-sq.ft. – deg. F.]	Mean Rating Temp deg. C. (deg. F.)	Runouts ^y ≤51 (2)	≤25.4 (<1)	32 to 51 (1-1/4 to 2)	64 to 102 (2-1/2 to 4)	≥127 (≥5)	Not used
4-16	0.030 to 0.039	24	25.4	25.4	25.4	25.4	25.4	
(39-61)	(0.21 to 0.27)	(75)	(1.0)	(1.0)	(1.0)	(1.0)	(1.0)	
<4	0.030 to 0.039	24	25.4	25.4	38.1	38.1	38.1	
<(39)	(0.21 to 0.27)	(75)	(1.0)	(1.0)	(1.5)	(1.5)	(1.5)	

^yRefers to runouts to individual terminal units not exceeding 3.7 m in length.

END OF SECTION

MECHANICAL SYSTEM COMMISSIONING

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 01 91 13 – GENERAL COMMISSIONING REQUIREMENTS.
 - .1 Where conflict exists between the above noted section and this specification, the above noted documents take precedence.
- .2 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .3 Conform to Section 20 05 02 - AS-BUILT DRAWINGS.
- .4 Conform to Section 20 05 03 - SHOP DRAWINGS.
- .5 Conform to Section 20 08 03 - OPERATING AND MAINTENANCE INSTRUCTIONS.
- .6 Conform to Section 23 05 93.13 - TESTING AND BALANCING PIPING SYSTEMS.
- .7 Conform to Section 23 05 93.23 - TESTING AND BALANCING AIR SYSTEMS.
- .8 Conform to Section 23 09 00 - BUILDING AUTOMATION SYSTEM (BAS).
- .9 The commissioning process for the Mechanical Systems shall include:
 - .1 Verification that the installation meets the requirements of the Contract Documents.
 - .2 Verification that the system's performance meets the design intent.
 - .3 Provision of building operator training.
 - .4 Provision of as-built documentation, operating and maintenance manuals, and systems operating manuals.
- .10 The Contractor, Contract Administrator and Commissioning Agent shall provide the services to complete the process. The execution portion of this Section defines the areas of responsibility.
- .11 Provide labour, equipment and material to conduct the Contractor commissioning process as outlined in this Section.
- .12 The City will hire a Commissioning Agent who will provide services identified in the Commissioning Agent articles within this Section.
- .13 An Independent Testing and Balancing Contractor will provide the services identified in the Sections for "Testing and Balancing Piping and Air Systems".

1.2 Submittals

- .1 Submittals requested in this Section shall be submitted in accordance with Section 20 05 03 – SHOP DRAWINGS.

MECHANICAL SYSTEM COMMISSIONING

PART 2 - PRODUCTS

2.1 Materials

- .1 The Contractor and manufacturers shall provide all instrumentation and equipment necessary to conduct the tests as specified in the Mechanical Sections. The Contractor shall advise the Contract Administrators or Commissioning Agent of instrumentation to be used and the dates the instruments were calibrated.

PART 3 - EXECUTION

3.1 Installation

- .1 This Section describes the commissioning process to be performed by the Contractor. The process shall provide a high level of quality control during the construction.
- .2 The commissioning process shall consist of:
 - .1 Shop Drawings/as-built drawings
 - .2 Installation review and equipment verification
 - .3 Plumbing and drainage system testing
 - .4 Testing of piping systems
 - .5 Independent Contractor balancing of piping systems
 - .6 Testing of air systems
 - .7 Independent Contractor balancing of air systems
 - .8 Testing of equipment and systems
 - .9 Building Automation System Commissioning
 - .10 Commissioning Agent performance testing
 - .11 Commissioning meetings
 - .12 Operating and maintenance manuals
 - .13 Training
 - .14 Systems acceptance

3.2 Installation Review and Equipment Verification

- .1 The Contractor shall complete the equipment verification forms for each piece of equipment. The completed forms shall be forwarded to the Contract Administrator for review and be included in the operating and maintenance manuals.

3.3 Test Forms and Verification Forms

- .1 The Commissioning Agent will prepare a test form manual, which will contain a form for every test identified in the Specification. A copy of this manual will be given to the Contractor, the Contractor and the Contract Administrator.
- .2 The Contractor shall prepare test forms for every test identified in this Specification. The Contractor shall complete each form as tests are completed and forward a copy to the Contract Administrator for review on a monthly basis.

MECHANICAL SYSTEM COMMISSIONING

- .3 The forms shall be signed by either the Authorities Having Jurisdiction, the Contract Administrator or the Commissioning Agent where applicable.

3.4 Plumbing and Drainage System Testing

- .1 The plumbing and drainage system shall be tested in accordance with Section 23 05 93.13 - TESTING AND BALANCING PIPING SYSTEMS.
- .2 The Contractor shall notify the Building Inspector when systems are available for testing. The Contractor shall document all tests performed and shall arrange for the Building Inspector to sign the forms for tests completed.

3.5 Testing of Piping Systems

- .1 Test all piping systems in accordance with Section 23 05 93.13 - TESTING AND BALANCING PIPING SYSTEMS.

3.6 Testing of Air Systems

- .1 Conform to Section 23 05 93.23 - TESTING AND BALANCING AIR SYSTEMS.

3.7 Testing of Equipment and Systems

- .1 Conform to Section 20 08 03 - OPERATING AND MAINTENANCE INSTRUCTIONS.
- .2 The Contractor shall hire the services of the manufacturer's technicians to test the equipment and associated systems. The technician shall record the results of the tests on the testing forms. The tests shall be witnessed by the Contract Administrator or the Commissioning Agent. When the tests have been completed satisfactorily the technician and witnessing authority shall sign the forms.
- .3 Should equipment or systems fail a test, the test shall be repeated after repairs or adjustments have been made. The additional tests shall be witnessed by the Contract Administrator or the Commissioning Agent.
- .4 Tests which have not been witnessed shall not be accepted and shall be repeated.

3.8 Commissioning Meetings and Scheduling

- .1 The Contractor shall include the schedule for all tests and equipment start-up tests in the construction schedule.
- .2 The commissioning meetings shall occur during the regular construction meetings unless otherwise required by the Commissioning Agent. The testing schedules and results of all tests shall be reviewed.

3.9 Operating and Maintenance Manuals

- .1 Conform to Section 20 08 03 - OPERATING AND MAINTENANCE INSTRUCTIONS.
- .2 Submit Operating and Maintenance Manuals to Commissioning Agent for review.

3.10 Operator Training

- .1 Conform to Section 20 08 03 - OPERATING AND MAINTENANCE INSTRUCTIONS.
- .2 Submit Operating and Maintenance manuals to Commissioning Agent for review.
- .3 The training shall be conducted in a classroom and at the equipment or system.

MECHANICAL SYSTEM COMMISSIONING

- .4 Training will begin when the operating and maintenance manuals have been delivered to The City and reviewed by the Contract Administrator.
- .5 Submit a course outline to the Contract Administrator before training commences. Provide course documentation for up to eight people.
- .6 Each training session will be structured to cover:
 - .1 The operating and maintenance manual
 - .2 Operating procedures
 - .3 Maintenance procedures
 - .4 Trouble-shooting procedures
 - .5 Spare parts required
- .7 The training sessions will be scheduled and co-ordinated by the Commissioning Agent. The mechanical sub-contractor will video digitally record the session and provide it to The City.
- .8 Training shall be provided for the following systems:

System	Minimum Training Times
Air Source Heat Pumps	4 hours
Boilers	2 hours
Air handling units	2 hours
Life safety & fire protection systems	2 hours
Water treatment systems	2 hours
The mechanical system	8 hours
BAS Controls System	Conform to 23 09 00
- .9 Refer to Section 23 09 00 - BUILDING AUTOMATION SYSTEMS (BAS).
- .10 The training requirement for the mechanical system shall include a walk-through of the building by the Contractor. During the walk through the Contractor shall:
 - .1 Identify equipment
 - .2 Identify starters associated with equipment
 - .3 Identify valves and balancing dampers
 - .4 Identify access doors
 - .5 Review general maintenance of equipment
 - .6 Review drain locations in pipework systems
 - .7 Identify maintenance items
- .11 When each training session has been completed with The City's representative, the Commissioning Agent will sign the associated form to verify completion.

MECHANICAL SYSTEM COMMISSIONING

3.11 Commissioning Agent

- .1 A Commissioning Agent will be hired by The City.
- .2 The Commissioning Agent responsibilities shall include:
 - .1 Preparing the commissioning plan
 - .2 Co-ordinating with the Contractor to schedule tests
 - .3 Preparing a test form manual
 - .4 Witnessing selected tests
 - .5 Receiving all test forms
 - .6 Conducting performance test
 - .7 Co-ordinating the Contractor's training
 - .8 Attend commissioning meetings
 - .9 Preparing the systems operating manuals (as required)
- .3 The Contractor shall co-ordinate and co-operate with the Commissioning Agent.

3.12 Performance Testing

- .1 The Commissioning Agent will conduct performance tests on each mechanical system to verify that the design intent performance has been met. The performance tests will cover all seasonal modes. The Commissioning Agent will visit the building in six months to retest the systems.
- .2 The Contractor shall conduct performance tests on all mechanical systems and document the results on the performance forms. Request form from the Contract Administrator.
- .3 The Contractor shall provide assistance to the Commissioning Agent and have personnel available during the performance testing procedures during construction and the warranty period.
- .4 Performance testing will begin when all mechanical systems have been completed, tested by the Contractor, reviewed by the Contract Administrator and Substantial Completion has been achieved.

3.13 Commissioning Process Allocation

- .1 The commissioning process shall be allocated a value equal to 8% of the contract. This value shall be itemized in the Statement of Prices which forms the basis for progress payment for the various portions of Work. The Contractors may draw from this allocation as the commissioning process is completed.
 - .1 The Contractors shall submit all test and verification forms. The Contract Administrator will use these forms to calculate a percentage complete.
 - .2 The Contractor may claim up to 5% of the contract, as per Schedule of Breakdown, on a monthly basis, from this allocation leading up to performance testing. The remaining 3% shall not be paid out until the performance testing, O&M manuals and training have been completed satisfactorily.
- .2 The commissioning process allocation shall be broken down as follows:

MECHANICAL SYSTEM COMMISSIONING

Shop Drawings	0.50%
Installation review and equipment verification	0.50%
Plumbing and drainage system testing	0.50%
Testing of piping systems	0.50%
Independent Contractor balancing of piping systems	0.25%
Testing of air systems	0.50%
Independent Contractor balancing of air systems	0.25%
Testing of equipment and systems (system start-up)	0.50%
BAS commissioning	1.00%
Commissioning Agent Performance Testing	2.00%
Operating and Maintenance Manuals	0.50%
Training	0.50%
As-built drawings	0.50%

END OF SECTION

CLEANING AND PROTECTION

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Not Used

PART 3 - EXECUTION

3.1 Installation

- .1 Clean thoroughly all fixtures and equipment from grease, dirt, plaster or any other foreign material. Chrome-plated fittings, piping and trim shall be polished upon completion.
- .2 Fixtures and equipment shall be properly protected from damage during the construction period and shall be cleaned and polished in accordance with manufacturer's written directions. Motors and equipment bearings shall be protected with plastic sheets, tied or taped in place. Aluminum fin heating or cooling elements shall be protected with cardboard covers.
- .3 Any dirt, rubbish, or grease on walls, floors or fixtures accumulated from the Work of the Mechanical Division shall be removed promptly from the premises by this Division.
- .4 Any unpainted steel surfaces, installed for longer than one year prior to the completion date, shall be prime coated under this Division.
- .5 During construction protect all services and equipment from dirt and debris, by using temporary caps over the open ends of pipes ductwork and equipment connections.
- .6 All equipment installed or stored on site shall be maintained in accordance with manufacturer's recommended instructions (i.e. rotate shafts on fans, pumps, etc.).
- .7 Refinish and restore to the original condition and appearance all mechanical equipment which has sustained damage to the manufacturer's prime and finish coats of enamel or paint. Materials and work quality shall be equal to the manufacturer's original.
 - .1 All cleaning and protective measures shall be in accordance with the SMACNA - IAQ Guidelines for Occupied Buildings under Construction and the IAQ Management Plan developed by the Contractor to conform to LEED requirements.

END OF SECTION

OPERATING AND MAINTENANCE INSTRUCTIONS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 Comply with all requirements of Section 20 05 02 - AS-BUILT DRAWINGS.
- .3 Comply with all requirements of Section 20 05 03 - SHOP DRAWINGS.
- .4 Comply with all requirements of Section 20 08 00 - COMMISSIONING.
- .5 Comply with all requirements of Section 01 78 00 - CLOSEOUT SUBMITTALS.

PART 2 - PRODUCTS

2.1 Requirements For Manuals

- .1 Three copies of complete and approved operating and maintenance instructions for all mechanical equipment and systems shall be supplied before Substantial Completion. Manuals shall be also submitted in electronic format. Electronic manuals shall be prepared in Adobe PDF format with all sections bookmarked for quick reference and submitted on a portable data storage device.
- .2 Binders shall be three-ring, hard-cover, loose-leaf type and identified on the binding edges as "Maintenance Instructions and Data Book", for "(Project Name)".
- .3 Terminology used in all the Sections shall be consistent.
- .4 Include the data and requirements noted in this specification section in both hardcopy and electronic versions of all manuals. Divide pages in the hardcopy manuals by tabs and sub-tabs as per the clauses and sub-clauses below. Provide only searchable PDF files as part of electronic version of the manuals and divide PDF document(s) using section cover pages and PDF bookmarks as per the clauses and sub-clauses below.
- .5 Volume One shall contain the master index of all systems, the name of the Contractor, Mechanical Subcontractors and the date of Substantial Performance of the Work.
- .6 Volume One shall contain a section with all necessary warranty information.
- .7 Each binder shall have a complete index for all volumes.
- .8 Each binder shall be no more than half filled.
- .9 There shall be a separate section for all materials used on the Project which fall under the WHMIS legislation. There shall be a hazard data sheet for each of the materials.
- .10 There shall be a separate section for all Insurance Certificates, Test Certificates, Verification Forms and Test Forms.
- .11 All relevant information relating to a system or Product shall be contained within one binder.
- .12 The manual sections shall follow the Specification sections.
- .13 Any diagrams, installation drawings, flow charts, etc. shall be mechanically reduced while maintaining full legibility to standard page size. If this cannot be achieved they shall be carefully folded and contained within a clear plastic wallet within the manual.

OPERATING AND MAINTENANCE INSTRUCTIONS

2.2 Data For Manuals

- .1 Equipment data shall contain:
 - .1 Operating instructions
 - .2 Operating conditions such as temperature and pressure
 - .3 Location of equipment
 - .4 Maintenance instructions and schedules for one year routine
 - .5 Recommended list of spare parts
 - .6 Lubrication schedule
 - .7 A trouble shooting table showing where to look for problems under various conditions of malfunction
 - .8 All wiring diagrams
 - .9 Equipment operating curves
 - .10 Equipment nameplate data and serial numbers
- .2 System data shall contain:
 - .1 A listing of all systems
 - .2 A valve schedule and locations
 - .3 Equipment name tags
 - .4 Filter schedule
 - .5 An electric pipe tracing schedule including location and electrical service location
 - .6 Cleaning, maintaining and preserving instructions for all material, Products and surfaces. Include warnings of harmful cleaning, maintaining and preserving practices.
- .3 Subcontractor manuals are required for:
 - .1 BAS
 - .2 Water treatment
 - .3 Sprinkler system
 - .4 Piping and air balancing
- .4 As-built documentation shall contain:
 - .1 Reviewed As-built Shop Drawings
 - .2 As-built construction drawings
 - .3 Originals of test forms
 - .4 Originals of test certificates
 - .5 Cyber Security Report Letter and backup schedule as required by Section 20 05 00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

OPERATING AND MAINTENANCE INSTRUCTIONS

2.3 Operating Instructions

- .1 Instruct The City's representative in all aspects of the operation and maintenance of systems and equipment.
- .2 Comply with all requirements of Section 20 08 00 - COMMISSIONING, for duration of tests.
- .3 Instruct The City for a minimum of five (5) Working Days.
- .4 Arrange for and pay for the services of engineers and other manufacturer's representatives required for instruction on the systems and the equipment as requested by the Contract Administrator and/or The City.
- .5 At the time of final review, provide a sheet for each system and piece of equipment showing the date instructions were given. Each sheet shall show the duration of instruction, name of persons receiving instruction, other persons present (manufacturer's representative, Contract Administrator, etc.), system or equipment involved and signature of The City's staff stating that they understood the system installation, operating and maintenance requirements. This information shall be inserted in the manuals after all instructions have been completed.
- .6 Review information with The City's representative to ensure that all information required has been provided.
- .7 Mechanical equipment and systems included in the instruction requirements are:
 - .1 Chillers and associated equipment
 - .2 Heating water generators and associated equipment
 - .3 Automatic controls and instrumentation
 - .4 Water treatment and cleaning
 - .5 Life safety and fire protection
 - .6 Noise and vibration
 - .7 Condenser water distribution system
 - .8 Chilled water distribution systems
 - .9 Heating water distribution systems
 - .10 Air handling distribution and components
 - .11 Miscellaneous ventilation systems
 - .12 Humidification systems
 - .13 Storm, sanitary and domestic water pumping and distribution system

2.4 Trial Usage

- .1 The City shall be permitted trial usage of systems or parts of systems for the purpose of testing and learning operational procedures. Trial usage shall not affect the warranties nor be construed as acceptance, and no claim for damage shall be made against The City for any injury or breakage to any part or parts due to the tests, where such injuries or breakage are caused by a weakness or inadequacy of parts, or by defective materials or work quality of any kind.

OPERATING AND MAINTENANCE INSTRUCTIONS

PART 3 - EXECUTION

3.1 Not Used

END OF SECTION

FIRE DEPARTMENT CONNECTIONS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Submittals

- .1 Submit Shop Drawings and/or catalogue cuts for all equipment supplied in accordance with Section 20 05 03 - SHOP DRAWINGS.

PART 2 - PRODUCTS

2.1 Materials

- .1 Fire Department connection: National Fire Equipment or Wilson and Cousins, either 100 mm (4 in.) or 150 mm (6 in.) size to suit connected piping. Provide two 65 mm (2½ in.) threaded connections to suit type of threads on hose used by local fire department. Connections shall be complete with threaded caps, chained to body. All exposed parts shall be polished and chrome plated bronze.
- .2 Wall Fire Department connection: National Fire Equipment Model 229 Flush type with wording as specified below, cast into face plate.
- .3 Fire Department connection shall bear the following wording as applicable.
 - .1 Standpipe fire department connection
 - .2 Sprinklers fire department connection, or
 - .3 Standpipe and sprinkler fire department connection

PART 3 - EXECUTION

3.1 Not Used

END OF SECTION

SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 Sprinkler system shall conform to NFPA 13 and to all authorities' requirements.

1.2 Related Work Specified Elsewhere

- .1 Low Voltage wiring of alarms, excess pressure pumps, flow switches, supervisory valves, and alarm horn to annunciator panel - under Electrical Division.
- .2 Power wiring to dry system air compressors - under Electrical Division.

1.3 Description of System

- .1 The sprinkler systems shall be wet and/or dry type as shown, consisting of distribution and interconnecting piping, sprinkler heads, hangers, flush and test connections, sprinkler riser, pressure reducing valves, alarm check valves, dry alarm valves, pre-action alarm valve, supervised valves, drain valves, sprinkler pumps and controls, excess pressure pump, fire department connections, water motor gong, air compressors, and all necessary equipment to provide a complete sprinkler system ready for immediate operation.
- .2 Sprinkler system shall connect to water supply where shown on Drawings.

1.4 Density and Area Requirements

- .1 The following minimum density and area requirements shall be the basis of the hydraulic design. Any request for modifying the density requirement shall be submitted by the Contractor for review by the Contract Administrator.

Location Served	Hazard	Density L/m/sq. m. (gpm/sq. ft)	Area Sq. m. (sq. ft)	Remarks
Office areas	Light	4.1 (0.10)	139.5 (1500)	Wet Type. Loop main shall have the capacity to serve 5 additional sprinkler heads at the most remote 139.5 sq.m. (1500 sq.ft.) area of application.
Office areas	Light	2.9 (0.07)	279 (3000)	Wet Type
Lobby space	Light	4.1 (0.10)	139.5 (1500)	Wet Type. Loop main shall have the capacity to serve 5 additional sprinkler heads at the most remote 139.5 sq.m (1500 sq.ft.) area of application

SPRINKLER SYSTEMS

Vestibules	Light	4.1 (0.10)	139.5 (1500)	Dry Type
Basement storage and Mechanical rooms	Ordinary Group 1	4.9 (0.12)	279 (3000)	Wet Type
Loading Docks (Exterior and Interior)	Based on occupancy and materials handled			Dry Type
Transformer, Electrical, Communications and Telephone Rooms	Ordinary Group 1	4.9 (0.12)	362 (3900)	Single or Double Interlocked Preaction Type

- .2 Where systems are hydraulically designed obtain water flow data of street mains. The estimated static pressure at the street is 345 kPa (50 psi). Submit all calculations and data on approved forms with Shop Drawings. Minimum street pressure shall be 207 kPa (30 psi) if no information is available at the time of bid.

1.5 Submittals

- .1 Shop Drawings: Submit sprinkler drawing layouts in accordance with Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS and Section 20 05 03 - SHOP DRAWINGS showing all component parts complete with Shop Drawings of all pumps, starters, valves and accessories to IAO (FM) and to the Contract Administrator for review. These drawings shall be designed and bear the signed stamp of an engineer licensed to practice in the appropriate discipline and in the Place of the Work. The Contractor's design Engineer shall provide periodic review in accordance with all applicable requirements of their licence and the building code and shall sign and seal an occupancy letter indicating the installation is in conformance with their design.
- .1 Clearly indicate on sprinkler layout drawings the location of all drain connections.
- .2 Prepare complete sprinkler layout drawings, arranging piping runs and sprinkler heads in proper relation with bus ducts, air conditioning ducts, piping, etc., and to ensure clear ceiling heights indicated on the Drawings. Where piping occurs in ceiling spaces, keep piping above level of top of lighting fixtures.
- .2 Submit flow and residual test results.
- .3 Submit hydraulic calculations in approved formats.
- .4 Samples: Submit samples of all hangers for review.

SPRINKLER SYSTEMS

.5 Operating and Maintenance Instructions:

- .1 Supply three approved hard covered loose-leaf binders containing three complete sets of manufacturer's operating and maintenance instructions, in accordance with Section 20 08 03 - OPERATING AND MAINTENANCE INSTRUCTIONS, showing all major equipment, control valves, wiring diagrams and schematics, and apparatus requiring maintenance. Spare part Suppliers, lists and addresses shall be supplied. Instructions shall be reviewed with The City to ensure a thorough understanding of the equipment and its operation.
- .2 At the completion of the installation submit a complete set of as-built drawings as outlined in Section 20 05 02 – AS-BUILT DRAWINGS. As-built drawings shall be complete including all valve tag numbers and symbols.

.6 Spare Parts: Provide spare heads as follows:

Number of Heads of a Particular Type Used	Number of Spare Heads of each Type to be Provided
0 to 299 heads	6 spares
300 to 1000 heads	12 spares
Over 1000 heads	24 spares

1.6 Qualifications

- .1 The installation company shall be a member of the Canadian Sprinkler Association and regularly engaged in this Work.

PART 2 - PRODUCTS

2.1 Materials

- .1 General:
 - .1 All components used in the sprinkler system shall be ULC Listed and FM Approved. UL Listed and/or FM Approved equipment not bearing a ULC listing shall only be acceptable if written approval from the local authority is obtained.
 - .2 All components used in the sprinkler system shall be manufactured in Canada or USA, whenever available.
- .2 Pipe, valves and fittings less than 1207 kPa (175 psi) working pressure shall be as follows:
 - .1 Pipe, black steel, Schedule 40, ASTM A53 "Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless."
 - .2 Fittings for a minimum of: 1207 kPa (175 psi) working pressure, 1035 kPa (150 psi) malleable iron ASME B16.3 "Malleable Iron Threaded Fittings: Classes 150 and 300," 860 kPa (125 psi) cast iron ASME B16.4 "Gray Iron Threaded Fittings: Classes 125 and 250," butt welding schedule 40 ASME B16.25 "Buttwelding Ends," or roll grooved Victaulic, ASC Engineered Solutions Gruvlok or Johnson Controls Tyco Grinnell.
 - .3 Dry pipe and fittings for all Projects shall be galvanized.
 - .4 Provide ULC Listed and FM Approved valves of the same manufacturer for the entire system.

SPRINKLER SYSTEMS

- .5 Acceptable valve manufacturers:
 - .1 Viking Nibco
 - .2 ASC Engineered Solutions Gruvlok
 - .3 MA Stewart W Series
 - .4 Victaulic
 - .5 Johnson Controls Tyco Grinnell
- .6 Gate valves 50 mm (2 in.) and smaller, all bronze OS&Y screwed, 1207 kPa (175 psi) working pressure.
- .7 Ball valves 50 mm (2 in.) and smaller may be used as an alternative to specified gate valves, bronze body, chrome plated brass ball, stainless steel stem, TFE seat.
- .8 Butterfly valves 50 mm (2 in.) and smaller may be used as an alternative to specified gate valves, bronze body, screwed ends, stainless steel disc and stem.
- .9 Gate valves 65 mm (2-1/2 in.) and larger iron body bronze mounted, OS&Y flanged or grooved ends.
- .10 Butterfly valves 65 mm (2-1/2 in.) and larger may be used as an alternative to specified gate valves, threaded lug type body, ductile iron body, stainless steel stem, gear operator, 1207 kPa (175 psi) working pressure.
- .11 Butterfly valves 65 mm (2-1/2 in.) and larger grooved ends may be used as an alternative to specified gate valves, ductile iron body, stainless steel stem, gear operator, 1207 kPa (175 psi) working pressure.
- .12 Check valves 50 mm (2 in.) and smaller, all bronze replaceable seat, screwed ends.
- .13 Check valves 65 mm (2-1/2 in.) and larger iron body, bronze mounted, flanged or grooved ends.
- .14 All grooved Products including couplings and fittings shall be of one manufacturer.
- .15 Provide fittings with grooved connections at all legs of the fitting or couplings equal to Victaulic 920, Johnson Controls Tyco Grinnell Figure 730, or Gruvlok Figure 7045 Clamp-T. Fittings and couplings that are not acceptable are ones equal to Victaulic 921, Tyco/Central Sprinkler Strap 40-5, or Gruvlok Figure 7045 U-bolt.
- .16 Alternative pipe downstream of alarm check valves on dry systems, Schedule 10 galvanized to ASTM A795 "Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use" minimum roll grooved ends for 1207 kPa (175 psi) working pressure. Refer to Bid Form and provide alternative price.

SPRINKLER SYSTEMS

- .3 No grooved fittings or Products shall be used except for those supplied by specified manufacturers.
- .4 Provide pipe valves and fittings over 1207 kPa (175 psi) working pressure as follows:
 - .1 Pipe, black steel, schedule 40, ASTM A53 "Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless" (up to 2070 kPa (300 psi)).
 - .2 Fittings, 2070 kPa (300 psi) malleable iron ASME B16.3 "Malleable Iron Threaded Fittings: Classes 150 and 300," 1720 kPa (250 psi) cast iron ASME B16.4 "Gray Iron Threaded Fittings: Classes 125 and 250," or butt welding schedule 40 ASME B16.25 "Buttwelding Ends" to suit maximum system pressure.
 - .3 Galvanized dry pipe and fittings for all FM Global Projects.
 - .4 Provide ULC Listed and FM Approved valves of the same manufacturer for the entire system.
 - .5 Acceptable valve manufacturers:
 - .1 Viking Nibco
 - .2 MA Stewart
 - .3 Victaulic
 - .4 Johnson Controls Tyco Grinnell
 - .6 Gate valves 50 mm (2 in.) and smaller all bronze, rising stem, screwed Class 200.
 - .7 Ball valves 50 mm (2 in.) and smaller may be used as an alternative to specified gate valves, bronze body, chrome plated brass ball, stainless steel stem, TFE seat.
 - .8 Gate valves 65 mm (2-1/2 in.) and larger, steel body, flanged or welded, Exalloy stellite trim, OS&Y equal to Class 150 1930 kPa (150 to 280 psi) and Class 300 above 1930 kPa (280 psi).
 - .9 Check valves 50 mm (2 in.) and smaller all bronze, swing check, Class 200, to local authorities' approval.
 - .10 Check valves 65 mm (2-1/2 in.) and larger, steel body, flanged or welded Exalloy trim, equal to Class 150 1930 kPa (150 to 280 psi) and Class 300 above 1930 kPa (280 psi).
 - .11 Express riser shall be welded pipe and fittings.
 - .12 Alternative pipe downstream of alarm check valves on dry systems, (galvanized) Schedule 10 to ASTM A795 "Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use" minimum roll grooved ends for up to 2070 kPa (300 psi) working pressure. Refer to bid form and provide alternative price.
- .5 Combination test and drain valve 50 mm (2 in.) inlet, 50 mm (2 in.) outlet, sprinkler test orifice and sight glass. This valve may be used in lieu of separate 50 mm (2 in.) drain valve, 25 mm (1 in.) test valve, sprinkler test orifice and sight glass. Victaulic 720 TestMaster II.

SPRINKLER SYSTEMS

- .6 Sight glasses shall be 1207 kPa (175 psi) working pressure.
- .7 Hangers, hanger rods and inserts in all parking and ramp areas shall meet the requirements of CSA S413 "Parking Structures" and shall be of corrosion resistant material or shall have an effective, durable, corrosion resistant coating.
- .8 Provide approved type backflow prevention complete with supervised valves, on glycol loops.
- .9 The pressure reducing valves on the sprinkler down-feed riser shall be hydraulically operated globe valve with ULC label rated at 1207 kPa (175 psi) working pressure. Valves to be sized for maximum 69 kPa (10 psi) pressure drop at 31.5 L/s (500 USGPM) flowing. Singer 106-PR-8702 or Cla-val 90G-21.
- .10 Pressure reducing valve stations shall consist of two valves each sized for 100% flow in parallel each with supervised isolating valves to permit servicing. All isolating valves on sprinkler system shall be located not higher than 1828 mm (72 in.) above the floor.
- .11 Alarm flow switches shall be ULC Listed and equal to Potter VSR-F. Wiring to annunciator panel shall be by the Electrical Division.
- .12 Switches for supervised valves shall indicate a trouble when valve not fully open. Switch shall be complete with contacts for alarm and supervision. All wiring to annunciator panel shall be by the Electrical Division. Plug in type switches are not acceptable. Switches shall be equal to Potter OSYSU.
- .13 Alarm check valve shall be complete with all appurtenances including contacts for wiring to the building fire alarm system for low pressure and flow, electric alarm bell mounted where shown or directed, and all valve, gauges, fittings and drains. Victaulic Series 751 Firelock, Johnson Controls Tyco Grinnell AV-1-175/AV-1-300, or Viking Model J-1.
- .14 Dry pipe valve shall be complete with all appurtenances as noted above with the addition of compressed air connection. Victaulic Series 756 Firelock, Johnson Controls Tyco Grinnell F3061, Tyco DPV-1, or Viking Model F-1.
- .15 Provide dry type alarm valves complete with automatic air compressors and receiver tank with sufficient capacity to meet systems requirements and low pressure alarm switch. Provide listed quick opening devices (accelerators, exhausters) if required. Provide inlet air filters and automatic air dryer downstream of compressor. Air dryer shall be of refrigerant type capable of producing compressed air with a dew point of 4 deg. C (40 deg. F).
- .16 Provide automatic air maintenance device with the following features:
 - .1 Equal to Reliable Model A Automatic Pressure Maintenance Device.
 - .2 ULC Listed & FM Approved.
 - .3 Complete with line size by-pass, servicing valves, pressure regulator and orifice and check valve.
 - .4 Minimum inlet pressure rating: 150 PSI.
 - .5 Outlet pressure range of at least 5 to 50 PSI.
 - .6 12.7 mm (1/2 in.) threaded inlet and outlet.

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- .17 Excess pressure pump shall be capable of raising the system pressure 517 kPa (75 psi) above the city water pressure. Capacity shall be 0.12 L/s (2 USGPM) when driven by a 0.25 kW (1/3 hp) motor. Pumps shall be mounted on a bracket adjacent to the alarm check valve. Pumps shall be automatic start/stop from pressure switch set to start at 760 kPa (110 psi) and stop at 830 kPa (120 psi). Provide a trouble alarm to show loss of excess pressure.
- .18 Pressure switches shall be ULC listed and shall alarm on low pressure in system. Pressure switches shall be suitable for wet systems, dry systems or pre-action systems as applicable. Potter PS40A or PS120A as applicable.
- .19 Pressure gauges shall be 6 mm (1/4 in.) NPT, (3-1/2 in) dial, 1207 kPa (175 psi) working pressure.
- .20 Sprinkler zone control cabinets shall be recessed type, 1.19 mm (0.0478 in. - 18 MSG) thick steel tub with baked white enamel interior corrosion resistant and maximum inside dimensions of 750 mm x 750 mm x 225 mm (30 in. x 30 in. x 9 in.) deep. Front shall be adjustable, 2 mm (0.0747 in. - 14 MSG) thick steel door and frame with hollow channel reinforcement and 12 mm (0.5 in.) turn back. Hinges shall be full length, semi-concealed piano type for 180 degree rotation. Glass shall be 5 mm (3/16 in.) clear. Door latch shall be flush stainless steel type with no visible mounting screws. All metal shall be prime coated with the exception of the door latch. National Fire Equipment CV-200.
- .21 Sprinkler heads shall be the automatic spray type, ULC listed and as approved by IAO or FM as applicable. Where heads are located close to heating coils, unit heaters or other hot equipment, they shall be of the high temperature type to suit regulations.
- .22 Sprinkler heads in unfinished areas with no ceiling indicated as light hazard shall be quick response, standard coverage, bronze heads, upright. Reliable Model F1FR, Viking Microfast Model M, Tyco TY3131, Victaulic V2704.
- .23 Sprinkler heads in finished areas in sidewall application indicated as light hazard shall be quick response, standard coverage, chrome plated sidewall heads with chrome plated escutcheon. Reliable Model F1FR HSW 1, Viking Microfast Model HSW F1, Tyco TY3331, Victaulic V2710.
- .24 Sprinkler heads in finished areas in sidewall application indicated as light hazard extended coverage shall be quick response, extended coverage, chrome plated sidewall heads with chrome plated escutcheon. Reliable Model F1FR QREC, Viking Microfast Model HSW F1, Tyco TY3332, Victaulic V3802.
- .25 Sprinkler heads in finished areas with acoustic or gypsum wall board ceiling indicated as light hazard or ordinary hazard shall be quick response, concealed type with white cover plate. Reliable Model G5, Viking Mirage, Tyco RFII, Victaulic V3802.
- .26 Provide extended coverage sprinkler heads only as required by NFPA to satisfy general sprinkler head layouts as shown without reducing the area of protection.
- .27 Unless otherwise specified, hangers shall conform to the requirements of NFPA 13 "Standard for the Installation of Sprinkler Systems."
- .28 Connection between fire protection system and the domestic water system shall have a ULC listed backflow assembly conforming to CSA B64 Series "Backflow preventers and vacuum breakers" or to the requirements of the Authority Having Jurisdiction. The assembly shall incorporate a metered by-pass to detect leaks and unauthorized water use. All valves shall be supervised and shall be by one of the manufacturers listed in Section 22 11 13 - PIPES, VALVES AND FITTINGS (PLUMBING SYSTEM).

SPRINKLER SYSTEMS

- .1 Minimum requirement for systems filled with untreated potable water provide a double check valve assembly equal to Zurn-Wilkins Model 350ADA.
- .2 For systems that have chemical treatment or other substances added that contaminate the water the connection between the fire protection system and the domestic water system shall have a reduced pressure backflow preventer assembly with the features listed above and in conformance with CSA B64 Series "Backflow preventers and vacuum breakers."
- .29 Fire department connections shall be in accordance with Section 21 11 19 – FIRE DEPARTMENT CONNECTIONS.
- .30 Site main shall be ductile iron (cement lined ductile iron) (JM Eagle Blue Brute plastic pipe with CIMJ fittings).
- .31 In lieu of rigid pipe offsets or return bends for sprinkler drops, a flexible stainless steel sprinkler drop system may be used to locate sprinklers. The drop system shall consist of a UL Listed and FM Approved braided type 304 stainless steel hose for sprinkler services up to 1207 kPa (175 psi). The hose shall have a bend radius of 50 mm (2 in.) to allow for proper installation in confined spaces. The braided hose assembly shall be listed for a minimum of 5 bends per 915 mm (36 in.) of length. The flexible drop shall attach to the ceiling grid using a one-piece open gate bracket. The bracket shall allow installation before the ceiling system is in place. All hoses shall be factory tested to 2758 kPa (400 psi).

PART 3 - EXECUTION

3.1 Installation

- .1 Spacing of sprinklers shall suit the hazard of the occupancy shown. Where specific locations of sprinkler heads have been shown on Drawings, these shall be maintained. Sizing of piping shall be based on hydraulic design. Submit all calculations to the city, The City's Insurers and the Contract Administrator for review. The calculations shall be designed and bear the signed stamp the engineer.
- .2 Pipe sizing where shown on the Drawings is to assist in design, layout and coordination. Ensure that the sizing is correct for the design criteria. Pipe sizes can also be decreased from those shown except where indicated as a minimum size, provided it meets all codes and IAO or FM approval.
- .3 For exposed structures the sprinkler head layout, where shown, is to assist in design, layout, and coordination. Ensure that all heads required to suit as-built beam, ducts or other obstructions are provided. Where specific pipe locations have been indicated these shall be maintained.
- .4 Provide listed sprinkler guards for all heads where required.
- .5 Supply and install where directed spare heads and any special types of wrenches in a cabinet.
- .6 Installation shall conform to all applicable codes.
- .7 Review all other Sections of the Specifications and include for all Work that may affect this section. Pay particular attention to the requirements for valve tags and identification.

SPRINKLER SYSTEMS

- .8 Fully coordinate the sprinkler piping with that of other trades on the job. Mains and branches shall be run so as not to interfere with the building's structure, electrical, plumbing, ventilation and heating installations. Sprinkler heads shall be located in the centre and/or quarter points of ceiling tile as shown on the reflected ceiling plans.
- .9 Remove and reinstall sprinkler piping and heads installed without coordination with other trades Work at the cost of this division.
- .10 Co-ordinate with the plumbing trades to ensure proper connections and drains are available. This Section shall pay for any costs associated with ensuring proper drainage is provided.
- .11 Provide all alarm, supervisory, and trouble points as required by code and coordinate with the Fire Alarm Annunciator Supplier and installer to ensure all points are included in the annunciator.
- .12 In all office areas, any additional sprinkler heads added to the floor because of increased requirements, shall be piped directly from the loop main.
- .13 Provide for each new dry zone / dry valve, an automatic air maintenance device.
 - .1 Install as per NFPA and manufacturer's written instructions and technical bulletins.
 - .2 Adjust from factory pressure setting to suit required site conditions.
 - .3 Commission and test configuration through range of operation.

3.2 Testing of Systems

- .1 All testing shall be executed in accordance with the latest regulations of NFPA 13 "Standard for the Installation of Sprinkler Systems" and with any other regulations that the authoritative inspector demands.
- .2 Testing shall include the flushing and cleaning of the entire system, all components operate as designed and verification of all alarm devices and indication on the building alarm panel. Provide written report on all items tested.
- .3 Make all required arrangements, pay for, perform and witness flow and residual tests at the site before making hydraulic calculations. A copy of these results shall be submitted with the Shop Drawings.
- .4 Arrange for proper drainage from test/drain connections including but not limited to:
 - .1 Main drain test connections.
 - .2 On-floor test connections.
 - .3 System, main drain or sectional drain connections.

END OF SECTION

PORTABLE FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Related Work Specified Elsewhere

- .1 Finish painting for prime painted cabinets - under Section 09 90 00 - PAINTING AND COATING.

1.3 Submittals

- .1 Submit Shop Drawings and/or catalogue cuts of all items supplied in accordance with requirements of Section 20 05 03 - SHOP DRAWINGS.

PART 2 - PRODUCTS

2.1 Materials

- .1 Portable fire extinguishers shall be rated and identified in accordance with CAN/ULC-S508 "Standard for the Rating and Fire Testing of Fire Extinguishers." All ratings identified below shall be considered as a minimum.
- .2 Provide 6A80BC rating, 4.53 kg (10 lbs.) multi-purpose dry chemical powder type and ULC labelled in Mechanical and Electrical Rooms, as well as in bike / scooter storage spaces.
- .3 Provide 1-A:K rating, 6 L (1.59 US gal.) wet chemical type, stainless steel, and ULC labelled in kitchens in addition to general coverage extinguishers.
- .4 Provide 4A80BC rating, 4.53 kg (10 lbs.) multi-purpose dry chemical powder type and ULC labelled (ammonium phosphate) in general areas.
- .5 Extinguishers in non-finished areas not accessible to the general public shall be mounted on wall brackets.
- .6 Portable fire extinguisher cabinets in finished areas shall be recessed type with 6 mm (1/4 in.) return frame, 0.76 mm (0.0299 in. - 22 MSG) thick steel tub with enamel interior and maximum inside dimensions of 229 mm x 610 mm x 152 mm (9 in. x 24 in. x 6 in.) deep. Front shall be adjustable, 1.57 mm (0.0618 in. - 16 MSG) thick steel door. Glass shall be 5 mm (3/16 in.) clear. Hinge shall be full length semi-concealed piano type. Door latch shall be flush stainless steel type with no visible mounting screws. All exterior metal shall be prime coated with the exception of the door latch. National Fire Equipment Model CE-950-3.
- .7 Extinguishers in non-finished areas accessible to the general public, such as Parking Garages, shall be surface mounted type with 1.19 mm (0.0478 in. - 18 MSG) thick steel tub with enamel interior and maximum inside dimensions of 266 mm x 610 mm x 159 mm (10.5 in. x 24 in. x 6.25 in.) deep with cylinder locked door and breakable plexi-glass. All cabinets shall be keyed alike. National Fire Equipment Model ECS-999.

PORTABLE FIRE EXTINGUISHERS

PART 3 - EXECUTION

3.1 Installation

- .1 Spacing of extinguishers shall conform to the Authority Having Jurisdiction. Maximum spacing for Class B fires in ordinary hazard occupancies shall be 9 m (29.5 ft.) for 10 BC extinguisher and 15 m (49.2 ft.) for 20 BC extinguishers, but in no case shall there be less than one extinguisher in each electrical room, kitchen or mechanical room. Maximum spacing for Type A extinguishers in Class A fires shall be 22.9 m (75 ft.).
- .2 Install type ABC fire extinguishers in bike / scooter storage spaces, as a protection measure for lithium-ion battery fires.

END OF SECTION

WATER METER

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Submittals

- .1 Submit Shop Drawings of all items supplied in accordance with requirements of Section 20 05 03 - SHOP DRAWINGS.

PART 2 - PRODUCTS

2.1 Materials

PART 3 - PROVIDE INCOMING MUNICIPAL WATER METER OF NEPTUNE TRU/FLO COMPOUND TYPE ACCEPTABLE TO AUTHORITY HAVING JURISDICTION (MUNICIPALITY) WITH ALL REQUIRED ACCESSORIES FOR REMOTE MONITORING, ETC. AS REQUIRED. PROVIDE SIZE AS SHOWN ON THE DRAWINGS.EXECUTION

3.1 Installation

- .1 Install water meter assembly in accordance with manufacturer's written instructions, municipal requirements and the Authority Having Jurisdiction. Provide meter assembly complete with all required accessories and a valved by-pass where permitted.
- .2 Water meter shall be supplied by the Municipality and installed by this Contractor. This Contractor shall include for cost of meter and make all necessary arrangements with the Municipality as required.
- .3 This division shall provide and install a spool piece for each meter supplied by others. The meters shall not be installed until the system has been flushed. After the system is flushed, this division shall receive the individual meters from the Metering Contractor. Remove the spool pieces and install water meters where shown. Return the spool piece to the Metering Contractor if they are provided by the Metering Contractor.

END OF SECTION

CLEANOUTS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Submittals

- .1 Submit Shop Drawings and/or catalogue cuts of all items supplied in accordance with requirements of Section 20 05 03 - SHOP DRAWINGS.

PART 2 - PRODUCTS

2.1 Materials

2.2 Finished Areas

- .1 Cleanouts in finished areas with membrane floors shall be coated cast iron body with adjustable nickel bronze frame and round scoriated gas tight access cover with secondary gas tight plug. J.R. Smith 4020-F-C, Zurn ZN 1400-KC, Mifab C1100C-R-1-34, Watts CO-100-C-R-1-34G.
- .2 Cleanouts with recess for terrazzo shall be similar to cleanouts in finished areas with membrane floors but shall have terrazzo recess. J.R. Smith 4180-F-C, Zurn ZN 1400-Z-KC, Mifab C1100C-UR-1-34, Watts CO-100-C-R-1-34G.
- .3 Cleanouts with recess for tile shall be similar to cleanouts in finished areas with membrane floors but shall have 3 mm (1/8 in.) tile recess. J.R. Smith 4140-F-C, Zurn ZN 1400-X-KC, Mifab C1100C-T-1-34, Watts CO-100-C-R-1-34G.
- .4 Cleanouts for carpeted areas shall be similar to cleanouts in finished areas but shall have stamped stainless steel carpet marker. J.R. Smith 4020-Y, Zurn ZN 1400-CM, Mifab C1100-RC-1-34, Watts CO-100-C-R-1-34G.

2.3 Non-Finished Areas

- .1 Cleanouts in non-finished areas shall be all coated cast iron body with heavy duty cast iron or ductile iron top. J.R. Smith 4220-F-C, Zurn Z-1400-KC, Mifab C1100-XR-4-34, Watts CO-100-C-R-1-34G.
- .2 Cleanouts at the base of each vertical stack and rain water leader shall be either Daisy or Barrett type.

PART 3 - EXECUTION

3.1 Installation

- .1 Cleanouts in furred ceiling spaces shall extend up through floor slab above, except where the Contract Administrator gives specific approval to its location in the ceiling space.
- .2 Cleanouts shall be installed in horizontal drains at each change of direction and as required.

END OF SECTION

SERVICE CONNECTIONS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 Arrange and pay for all service connections.
- .3 Include the cost of all service connections required for the gas, plumbing and drainage systems, including water meter, in the mechanical bid price.

PART 2 - PRODUCTS

2.1 Not Used

PART 3 - EXECUTION

3.1 Not Used

END OF SECTION

PIPES, VALVES AND FITTINGS (PLUMBING SYSTEM)

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Submittals

- .1 Submit Shop Drawings and/or catalogue cuts of all items supplied in accordance with requirements of Section 20 05 03 - SHOP DRAWINGS.
- .2 Submit Shop Drawings showing the proposed sanitary vent pipe routing.
- .3 Submit Shop Drawings showing the location of all proposed water hammer installation locations.

PART 2 - PRODUCTS

2.1 Materials

- .1 Pipes and fittings shall be in accordance with the following unless specified otherwise by local authorities.
- .2 All valves on potable water systems shall be equal in performance to the models specified, shall be lead free or low lead meeting the requirements of CSA B125.3 "Plumbing fittings," CSA B125.14 "Manually operated valves for use in plumbing systems," NSF/ANSI 372 "Drinking Water System Components - Lead Content," NSF/ANSI 61 "Drinking Water System Components - Health Effects," NSF/ANSI 14 "Plastics Piping System Components and Related Materials," and/or ANSI/AWWA C550 "Protective Interior Coatings for Valves and Hydrants" as applicable.
- .3 All city and domestic water, above ground, 75 mm (3 in.) and smaller, less than 1380 kPa (200 psi) working pressure:
 - .1 Pipe: Copper Tubing, Type "L", Hard Drawn, ASTM B88 "Standard Specification for Seamless Copper Water Tube." Fittings: wrought copper solder joint pressure fittings, ANSI/ASME B16.22 "Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings" or cast copper alloy solder joint pressure fittings, ANSI/ASME B16.18 "Cast Copper Alloy Solder Joint Pressure Fittings."
 - .2 Joints made with 95-5 tin antimony, 96-6 tin silver, or 96-4 tin silver solder, ASTM B32 "Standard Specification for Solder Metal."
 - .3 Grooved end copper fittings designed to accept grooved end couplings of the same manufacturer. Fittings shall be wrought copper or bronze casting, conforming to ASTM B75/B75M "Standard Specification for Seamless Copper Tube." Victaulic Copper Connection Fittings.
 - .4 Press fittings
 - .1 For use in accordance with manufacturer's: written application and installation instructions.
 - .2 Provide proof of Viega training for proposed installation tradespeople.
 - .3 For copper piping: Viega Propress.

PIPES, VALVES AND FITTINGS (PLUMBING SYSTEM)

- .5 Couplings to be designed with angle bolt pads to provide a rigid joint.
 - .1 Installation ready for direct stab installation without field disassembly, complete with grade P fluoroelastomer gasket, rated for -18 deg. C. to 82 deg. C. (0 deg. F. to 180 deg. F.). Victaulic 607.
- .6 Stainless steel pipe may be used as an alternative material if acceptable to Local Authorities. Follow applicable codes for stainless steel pipe joints. Stainless steel pipe to conform to ASTM A312 "Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes." Stainless steel fittings to conform to ASTM A403 "Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings."
 - .1 Schedule 10 Type 304/304L to ASTM A312.
- .7 Butterfly valves, bubble-tight service up to 2065 kPa (300 psi) with cast brass bronze body, aluminum-bronze disc, pressure-responsive grade P fluoroelastomer seat, and stainless steel stem. Victaulic 608N.
- .8 Gate valves, 860 kPa (125 psi) WSP or 1380 kPa (200 psi) non-shock WOG with lead free bronze body, rising stem screwed. Kitz 827/828, Toyo 206A-LF/207A-LF, Apollo 101T-LF.
- .9 Globe valves, 860 kPa (125 psi) WSP or 1380 kPa (200 psi) non-shock WOG with lead free bronze body, solder ends or with screwed to solder adapter and composition disc for water service. Kitz 811/812, Toyo 211A-LF/212A-LF, Apollo 120S-LF.
- .10 Check valves 860 kPa (125 psi) WSP or 1380 kPa (200 psi) non-shock WOG with lead free bronze body, swing check, solder ends. Kitz 822/823, Toyo 236A-LF/237A-LF, Apollo 161S-LF.
- .11 Non-slam check valves downstream from pumps, ANSI Class 150, 1032 kPa (150 psi) WSP pressure rating, dual flapper design with 316 stainless steel body and stainless steel check, renewable disc and resilient seat for flanged installation. Non-slam check valves shall be Velan-ProQuip Model DDD11-1D, Duo CHEK II H15CMF3-14, Mueller 72-HHH-3-H, or NCI/SSI 150WTTTV-T.
- .12 Strainers shall be lead free bronze Y body equal to Colton Industries Model 125YTB, Mueller LF351.
- .13 Drain valves and blow-off valves shall be 4137 kPa (600 psi) WG 19 mm (3/4 in.) ball valves with lead free, bronze body or forged brass body, solid ball, male threaded garden hose end, brass cap and chain equal to Watts B6000, Toyo 5046-LF, Kitz 868C or Apollo 78-100. Hose bibs shall be for 860 kPa (125 psi) non-shock, bronze body with composition disc and 19 mm (3/4 in.) garden hose thread, complete with a ULC vacuum breaker.
- .14 Pipe sizes 12 mm (1/2 in.) to 50 mm (2 in.) Schedule 10 Type 304/304L to ASTM A312/A312M "Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes."
 - .1 Vic-Press 304 ASTM A312 stainless steel housings with ASTM A276 "Standard Specification for Stainless Steel Bars and Shapes" and A312 outlets and austenitic stainless steel plain or grooved ends, type 304, complete with synthetic rubber Grade "H" (HNBR) seals rated for applicable services to 82 deg. C (180 deg. F).

PIPES, VALVES AND FITTINGS (PLUMBING SYSTEM)

- .4 All city and domestic water above ground 100 mm (4 in.) and larger, less than 1380 kPa (200 psi) working pressure.
 - .1 Pipe: Copper Tubing, Type "L", Hard Drawn, ASTM B88 "Standard Specification for Seamless Copper Water Tube." Fittings: wrought copper solder joint pressure fittings, ANSI/ASME B16.22 "Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings" or cast copper alloy solder joint pressure fittings, ANSI/ASME B16.18 "Cast Copper Alloy Solder Joint Pressure Fittings."
 - .2 Joints made with 96-6 tin silver, or 96-4 tin silver solder, ASTM B32 "Standard Specification for Solder Metal."
 - .3 Grooved end copper fittings designed to accept grooved end couplings of the same manufacturer. Fittings shall be wrought copper or bronze casting, conforming to ASTM B75/B75M "Standard Specification for Seamless Copper Tube." Victaulic Copper Connection Fittings.
 - .4 Press fittings
 - .1 For use in accordance with manufacturer's: written application and installation instructions.
 - .2 Provide proof of Viega training for proposed installation tradespeople.
 - .3 For copper piping: Viega ProPress.
 - .5 Couplings to be designed with angle bolt pads to provide a rigid joint.
 - .6 Installation ready for direct stab installation without field disassembly, complete with grade P fluoroelastomer gasket, rated for -18 deg. C. to 82 deg. C. (0 deg. F. to 180 deg. F). Victaulic 607.
 - .7 Butterfly valves, bubble-tight service up to 2065 kPa (300 psi), with cast brass bronze body, aluminum-bronze disc, pressure-responsive grade P fluoroelastomer seat, and stainless steel stem.. Victaulic 608N.
 - .8 Stainless steel pipe may be used as an alternative material if acceptable to Local Authorities. Follow applicable codes for stainless steel pipe joints. Stainless steel pipe to conform to ASTM A312 "Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes." Stainless steel fittings to conform to ASTM A403 "Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings." Schedule 10 Type 304/304L to ASTM A312.
 - .9 Rigid type: Couplings to be designed with angle bolt pads to provide a rigid joint. Installation ready for direct stab installation without field disassembly, complete with grade P fluoroelastomer gasket, rated for -18 deg. C. to 82 deg. C. (0 deg. F. to 180 deg. F. Victaulic 807N.
 - .10 Flexible Type: For use in locations where vibration attenuation and stress relief are required or in a Victaulic riser design. Three flexible couplings may be used in lieu of a flexible connector. Flexible grooved couplings may be used where system flexibility is desired. Installation ready for direct stab installation without field disassembly, complete with grade P fluoroelastomer gasket, rated for -18 deg. C. to 82 deg. C. (0 deg. F. to 180 deg. F). Victaulic Style 877N.
 - .11 Butterfly valves, bubble-tight service up to 2065 kPa (300 psi), with stainless steel body, grade P fluoroelastomer seat. Victaulic 861.

PIPES, VALVES AND FITTINGS (PLUMBING SYSTEM)

- .12 Check valves, Stainless steel body, grade P fluoroelastomer seat, stainless steel disc with spring loaded design for non slam operation. Victaulic Series 816.
- .13 Gate valves, 860 kPa (125 psi) WSP or 1380 kPa (200 psi) non-shock WOG with ANSI/AWWA C550 "Protective Interior Coatings for Valves and Hydrants" coated iron body, lead free bronze mounted, outside screw and yoke, and flanged ends.
- .14 Globe valves, 860 kPa (125 psi) WSP or 1380 kPa (200 psi) non-shock ANSI/AWWA C550 "Protective Interior Coatings for Valves and Hydrants" coated iron body, lead free bronze mounted, outside screw and yoke, flanged ends and composition disc for water service.
- .15 Check valves 860 kPa (125 psi) WSP or 1380 kPa (200 psi) non-shock WOG with ANSI/AWWA C550 "Protective Interior Coatings for Valves and Hydrants" coated iron body, lead free bronze mounted, swing check, flanged ends.
- .16 Non-slam check valves downstream from pumps, 1032 kPa (150 psi) pressure rating, dual flapper design with 316 stainless steel body and stainless steel check, renewable disc and resilient seat for flanged installation. Non-slam check valves shall be Velan-ProQuip Model DDD11-1D1, Duo CHEK II H15CMF3-14, Mueller Sure Check #72-HHH-3-H, or NCI/SSI 150WTTTV-T.
- .17 Strainers shall be grooved or flanged ANSI/AWWA C550 "Protective Interior Coatings for Valves and Hydrants" coated cast iron Y body equal to Victaulic 968-F, Colton Industries Model 125YFI or Mueller #758.
- .18 Drain valves and blow-off valves shall be 4137 kPa (600 psi) WG 19 mm (3/4 in.) ball valves with lead free, bronze or forged brass body, solid ball, virgin Teflon seat and packing, male threaded hose end, brass cap and chain equal to Watts B6000, Toyo 5046, Kitz 58CC or Apollo 78-100.
- .5 All city and domestic water, buried, 50 mm (2 in.) and smaller:
 - .1 Soft copper Type K conforming to ASTM B88 "Standard Specification for Seamless Copper Water Tube."
 - .2 Minimum number of joints brazed using BCuP-3 alloy with 5% silver, 89% copper, and 6% phosphorus.
 - .3 Gate valves, bronze body, non-rising stem, extension sleeve and box to grade, to local authorities' approval.
- .6 All city and domestic water, buried, 65 mm (2-1/2 in.) and larger:
 - .1 Copper pipes Type L with wrought or cast couplings and fittings conforming to ASTM B88 "Standard Specification for Seamless Copper Water Tube," etc.
 - .2 Joints brazed using BCuP-3 alloy with 5% silver, 89% copper, and 6% phosphorus.
 - .3 Alternate for underground pipe; cast or ductile iron coated to AWWA.
 - .4 Gate valves, AWWA iron body, non-rising stem, extension sleeve and box to grade, to local authorities' approval.
- .7 For storm and sanitary drains and vents above ground, provide cast iron or copper pipe installed as in regulations; except where copper pipe is used, make joints with 95-5 solder. ABS and asbestos cement (Transite) pipes are not acceptable.

PIPES, VALVES AND FITTINGS (PLUMBING SYSTEM)

- .8 Storm and sanitary, not buried, inside the building, to CSA B1800 "Thermoplastic non-pressure piping compendium":
 - .1 Provide PVC DWV pipe and fittings manufactured by IPEX or engineer reviewed equivalent. Provide Products from one manufacturer throughout the Project.
 - .2 For Buildings that are not classified as High Buildings, except for retail spaces: IPEX System 15 PVC DWV Schedule 40 pipe and fittings, meeting flame-spread rating not more than 25, per CAN/ULC-S102.2 "Standard Method of Testing for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies," with pipe manufacturer's approved solvent weld joints or pipe manufacturer's approved mechanical joint couplings.
 - .3 For inside air plenums: IPEX System XFR PVC DWV Schedule 40 pipe and fittings, meeting flame-spread rating not more than 25, and smoke developed classification not more than 50, both per CAN/ULC-S102.2, with pipe manufacturer's approved solvent weld joints or pipe manufacturer's approved mechanical joint couplings.
- .9 Vent stack covers:
 - .1 1100-OT alloy aluminum with vandal proof removable cap
 - .2 EPDM base seal
 - .3 PVC coated deck flange or bituminous deck flange as required to suit roof membrane
 - .4 Insulated for inverted steel roof construction with insulation on top of deck
 - .5 Uninsulated for concrete roof construction
 - .6 Uninsulated: Thaler Metal Industries SJ-24/SJ-25
 - .7 Insulated: Thaler Metal Industries SJ-26/SJ-27
- .10 Buried storm and sanitary inside the building shall be SDR 28 rigid for 100 mm (4 in.) to 150 mm (6 in.), SDR 35 for 200 mm (8 in.) and larger, green PVC gasketed hub and spigot pattern sewer pipe and injection molded and fabricated gasketed fittings to meet the requirements of CSA B182.2 "PSM type polyvinylchloride (PVC) sewer pipe and fittings" assembled with PVC pipe lubricant.
- .11 Buried storm and sanitary, inside the building: PVC DWV Schedule 40 to CSA B1800 "Thermoplastic non-pressure piping compendium."
- .12 Sump and sewage pump discharge, non potable, buried:
 - .1 Type "L" copper, brazed; or
 - .2 Schedule 80 PVC pressure piping conforming to CSA B137.3 "Rigid polyvinylchloride (PVC) pipe and fittings for pressure applications."
- .13 Butterfly valves may be used in lieu of gate valves in size 65 mm (2-1/2 in.) and over in systems 1380 kPa (200 psi) and less. Where specifically shown on Drawings, butterfly valves must be used. Install between 860 kPa (125 psi) flanges.
 - .1 Valves shall have NSF/AWWA coated iron body, one piece or split alloy steel shaft, top and bottom bearings, lead free bronze disc or coated iron disc with stainless steel trim and resilient elastomer replaceable seat with integral reinforcing ring or keyed to body.
 - .2 Body shall have threaded lugs.

PIPES, VALVES AND FITTINGS (PLUMBING SYSTEM)

- .3 Valve shall have bubble tight shut-off to 1035 kPa (150 psi) pressure in either direction when the piping and connecting flange is removed from one side of the valve.
 - .4 Valves 100 mm (4 in.) and smaller shall have lever operator with lock.
 - .5 Valves larger than 100 mm (4 in.) shall have worm gear manual operator with indication of valve opening.
 - .6 Butterfly valves for grooved end systems shall be Victaulic 608N for copper and Victaulic 861 for stainless steel.
- .14 Backflow Preventers – Reduced Pressure Back Flow Preventer:
- .1 Reduced pressure zone assemblies to prevent the reverse flow of polluted water from entering into the potable water supply due to backsiphonage and or backpressure.
 - .2 Lead Free bronze body construction (1/4 to 2 in.).
 - .3 Lead Free epoxy coated ductile or cast iron (2 1/2 to 10 in.).
 - .4 Two, in-line independent check valves, replaceable check seats with an intermediate relief valve, and ball valve test cocks.
 - .5 Maximum Working Pressure: 1207 kPa (175 psi).
 - .6 BEECO FRP, Zurn-Wilkins 975XL2/375A or Watts LF009/LF909 Series.
- .15 Ball valves 50 mm (2 in.) and smaller shall be lead free, bronze body or forged brass 4137 kPa (600 psi) WOG, virgin Teflon seat, TFE stem packing and thrust washer, 1/4 turn open-closed operation with solid ball. Ball valves shall be Watts No. LFB-6000, Toyo 5044A-LF/5049A-LF, Kitz 858/859, Apollo 70LF-100/200, or NCI 600FP-T/S. Stem extensions shall be provided on all ball valves. Ball valves may be substituted for gate valves only.
- .16 Except where special features are required or unless otherwise approved or noted, all valves shall be of one manufacturer with the manufacturer's name and the pressure rating clearly marked on the outside of the valve body.
- .17 Pressure Reducing Valves:
- .1 For all sizes of grooved piping, provide pressure reducing valves equal to Victaulic Series 386-SB single branch pressure reducing valve stations with integral low flow bypass. For single stage pressure reducing valves, provide valves equal to Victaulic 386A-SB. For two stage pressure reducing valve stations, provide valves equal to Victaulic 386B-SB. Provide valves at capacity shown in PRV Schedule and with a pressure drop not exceeding 69 kPa (10 psi) under full flow. Provide valves that maintain downstream pressure within a range of plus or minus 35 kPa (5 psi). Provide required outlet pressure, inlet pressure, and flow rate as shown. Alternate manufacturers will not be accepted.
 - .1 Provide pressure reducing station that is complete with inlet and outlet isolation valve, strainer, and pressure reducing valve with integral low flow by-pass.

PIPES, VALVES AND FITTINGS (PLUMBING SYSTEM)

- .2 For 65 mm (2-1/2 in.) and larger, non grooved, provide Cla-Val 90-01 or equal with capacity shown and a pressure drop not exceeding 69 kPa (10 psi) under full flow. Provide valve that maintains downstream pressure within a range of plus or minus 35 kPa (5 psi). Provide required outlet pressure, inlet pressure and flow rate as shown. Alternate manufacturers will not be accepted.
 - .1 Provide valve that maintains a constant downstream pressure regardless of fluctuations in demand and that also prevents a pressure rise when demand is zero.
 - .2 Provide valve that is single-seated, hydraulically operated, pilot controlled diaphragm type globe valve. Provide valve stem that is top and bottom guided and actuated by a resilient diaphragm. Provide cast iron, flanged valve body and cover. Provide bronze trim. Provide replaceable valve seat. Do not provide external packing glands. Provide valve that is NSF/ANSI 61 "Drinking Water System Components - Health Effects" and NSF/ANSI 372 "Drinking Water System Components - Lead Content" compliant.
 - .3 Provide pilot control that is a direct acting, adjustable, spring-loaded valve with bronze body and stainless steel trim.
 - .4 Factory assemble main valve, pilot control valve, and all trim into one unit.
 - .5 Provide valve that is Class 125 for low pressure systems less than 1380 kPa (200 psi) working pressure and Class 250 for high pressure systems greater than 1380 kPa (200 psi) working pressure.
 - .6 See Drawing for capacities and operating pressures.
 - .7 For isolation valves, provide full port ball valves for 64 mm (2-1/2 in.) and smaller and butterfly valves for 76 mm (3 in.) and larger.
 - .8 For combination pressure reducing and check valve, provide Cla-Val 90-01-D and as specified for the pressure reducing valve, but with a check valve and isolation valve.
- .3 50 mm (2 in.) and smaller: Threaded lead free water pressure reducing valve and integral strainer, suitable for 2068 kPa (300 psi) incoming pressure with downstream pressure adjustable range from 172 to 517 kPa (25 psi to 75 psi). Provide thermal expansion by-pass check valve that allows water to flow back to main when the downstream pressure exceeds setpoint.
 - .1 Materials:
 - .1 Lead free copper silicon alloy body
 - .2 Sealed spring cage with stainless steel fasteners
 - .3 High temperature reinforced diaphragm
 - .4 Replaceable seat
 - .5 Stainless steel strainer
 - .2 Acceptable Manufacturers:
- .4 Watts LFU5B-Z3Cash Acme E3See Drawings for capacities and operating pressures.

PIPES, VALVES AND FITTINGS (PLUMBING SYSTEM)

- .18 Backwater valves for services larger than 100 mm (4 in.) shall be by J.R. Smith. Valves shall be complete with cast iron body and bolted cover, plain end inlet and outlet, bronze flap and bronze valve seat. Valve shall be normally open.
 - .1 Unit up to 300 mm (12 in.) underground, shall be complete with access cover at grade and extension sleeve between cover and valve casing.
 - .2 Unit more than 300 mm (12 in.) underground, shall be complete with minimum 600 mm (24 in.) dia. galvanized steel, concrete or vitrified clay tile access pit with 600 mm (12 in.) dia. heavy duty scoriated manhole cover and frame.
- .19 Provide extendable backwater valve complete PVC extendable valve body and normally open cassette for services 100 mm (4 in.) and smaller. Extend to grade with PVC DWV pipe and provide 19 mm (3/4 in.) cassette pipe extension to grade for cassette retrieval. Provide cleanout access suitable for floor finish in accordance with Section 22 05 76 - CLEANOUTS. Backwater Valve shall be Mainline Adapt-A-Valve Model ML-#XP to suit size of drain.
- .20 Water hammer arresters shall be stainless steel bellows type and shall bear the Plumbing and Drainage Institute seal of approval. JR Smith 5000 Series, Zurn Z1700, Mifab WHB, Watts SS Series. Piston type are not permitted.
- .21 Exterior site sewers shall be PVC non-pressure, SDR 28, cement, or concrete of class and type to suit depth of trench and bedding. PVC non-pressure sewer piping shall be IPEX for sizes 100 mm (4 in.) to 150 mm (6 in.) conforming to CSA B182.1 "Plastic drain and sewer pipe and pipe fittings" and ASTM D3034 "Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings." For sizes 200 mm (8 in.) to 375 mm (15 in.) shall be IPEX conforming to CSA B182.2 "PSM type polyvinylchloride (PVC) sewer pipe and fittings" and ASTM D3034. For size 450 mm (18 in.) to 1200 mm (48 in.) shall be IPEX conforming to CSA B182.4 "Profile polyvinylchloride (PVC) sewer pipe and fittings" and ASTM F794 "Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter." Sewers shall be laid in accordance with manufacturer's written instructions and in accordance with regulatory requirements.
- .22 Exterior site PVC pressure piping shall be IPEX Blue Brute conforming to AWWA C900 "Polyvinyl chloride (pvc) pressure pipe and fabricated fittings, 4 in. through 60 in. (100 mm through 1,500 mm)" and CSA B137.3 "Rigid polyvinylchloride (PVC) pipe and fittings for pressure applications" standards laid in accordance with the manufacturer's written instructions and in accordance with regulatory requirements.
 - .1 Thermostatic mixing valves
 - .1 Thermostatic mixing valves shall be Armstrong DRV electronic thermostatic mixing valve. The valve shall maintain output temperature for changes in inlet pressure and temperature. Valve construction shall be bronze body and stainless steel piston and liner. Mixing valve shall include a union end stop and check valve with removable strainer on each inlet. Complete with 0 - 200 deg. F. dial thermometer and shut off valve on tempered water outlet.
- .23 Main Incoming Domestic Cold Water Filtration:
 - .1 Equal to Judo Water Treatment PROFIMAT-ATP solid filtration device.
 - .2 20 kPa (2.9 psi) pressure loss at backwash.
 - .3 1034 kPa (150 psi) maximum flow pressure.

PIPES, VALVES AND FITTINGS (PLUMBING SYSTEM)

- .4 Upper housing: high-grade polymer based materials.
- .5 Bottom housing: high-grade cast iron coated with Rilsan.
- .6 Equipped with a clear sight-glass to allow view of filtration, dirt build-up, and backwash function.
- .7 100 microns stainless steel filter sieve.
- .8 Automatic backwash generated by time actuated relay with adjustable range from 1 to 2000 hours and differential pressure control setting adjustable from 0 - 179 kPa (0 - 26 psi).
- .9 Point-of-rotation system without interruption of water supply or filtration process.
- .10 Simultaneous cleaning of sight glass during the backwash process.
- .11 Electronic control enclosure with computer display for system diagnostics equipped with LED display indicators for operation.
- .12 Alarm fault buzzer and manual over-ride button for backwash start-up.
- .13 120 / 24 VAC plug-in transformer (25 W), maximum load current 1 A, 3-prong duplex box outlet with GFI required.
- .14 Flanged connections to ASME B16.1. "Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250."
- .15 Filter equipped with two (2) potential-free output dry contact remote transmissions for building automation system.
- .16 CSA and NSF/ANSI/CAN 61 "Drinking Water System Components – Health Effects" approval and certification for domestic potable water supplies.

2.2 Flushing and Disinfecting:

- .1 Chlorine:
 - .1 Sodium hypochlorite to ANSI/AWWA B300 "Hypochlorites."

PART 3 - EXECUTION

3.1 Installation

- .1 Valves shall be provided as shown and as required for the satisfactory operation and control of all equipment and shall be installed to enable each piece of equipment to be isolated.
- .2 Isolation valves shall be installed at the base of each riser and at each branch take-off. Where the equipment is to be isolated within easy view of and not more than 6000 mm (20 ft.) from the main, at the branch take-off, then the branch take-off valve may serve as the equipment isolating valve.
- .3 Drain valves shall be installed at each low point in the piping systems and at each tank.
- .4 Blow-off valves shall be provided on each 65 mm (2-1/2 in.) strainer and larger.
- .5 Globe valves shall be installed as shown and in each bypass.
- .6 Install manual flow balancing valves where shown on the Drawings or where required.
- .7 Install automatic flow balancing valves where shown on the Drawings or where required.

PIPES, VALVES AND FITTINGS (PLUMBING SYSTEM)

- .8 Where combined domestic water and fire protection services are provided, provide master isolation supervised shut off valve. Refer to Section 21 13 00 – SPRINKLER SYSTEMS for valve specifications.
- .9 Install building premise isolation back flow prevention as required by CSA B64.
- .10 Install reduced pressure backflow preventers where required by CSA B64 and in the following locations:
 - .1 Chilled water systems make-up
 - .2 Heating water systems make-up
 - .3 Glycol systems make-up (where provided)
 - .4 Laboratory sink supply systems, both hot and cold water
 - .5 Fume hood plumbing systems
 - .6 RO and other systems not used as potable water
 - .7 Upstream of all trap seal primer assemblies unless the trap seal primer assembly includes a 1" air gap, or other device suitable for Severe Hazard sources
 - .8 Where shown on the Drawings
 - .9 As requested by the Authority Having Jurisdiction
- .11 Install check valves as shown, and as required by the Authority Having Jurisdiction.
- .12 Buried piping shall be of a class and type and laid in a bedding as noted and/or as recommended by the manufacturer and any Authority Having Jurisdiction. Class of pipe and bedding shall take into consideration location, size of pipe, type, width and depth of trench and type of soil.
- .13 The following publications shall be used to establish class of bedding and class of piping for installation other than the above. They shall also serve as guide for preparation of bedding, installation and testing.
 - .1 Cast Iron Soil Pipe and Fittings Handbook of the Cast Iron Soil Pipe Institute.
 - .2 Sewer pipe manual of Canron.
 - .3 Sewer Design & Construction of the Water Pollution Control Federation.
 - .4 The Blue Brute and Ring Tite PVC gravity sewer pipe installation Guide by Manville.
- .14 Pipe passing under a driveway or parking lot with less than 1.5 m (5 ft.) of cover shall be encased in 150 mm (6 in.) of 13800 kPa (2000 psi) concrete on top, bottom and sides.
- .15 Provide thrust blocks of 20 MPa (3000 psi) concrete at each tee, elbow, valve and other fitting where thrust forces could occur. Thrust blocks shall be sized to suit the local authorities' requirements, but in no case be smaller than 150 mm (6 in.) greater on all sides than the pipe served.
- .16 PC4 jointing material shall not be used on buried piping. PC4 or similar jointing material shall be used for caulking waste pipes from sinks or dishwashers and other waste pipes carrying hot discharge liquids.
- .17 Connections between copper and steel pipe shall be made with brass or bronze fittings where other type of connection is not specified in regulations.

PIPES, VALVES AND FITTINGS (PLUMBING SYSTEM)

- .18 All piping shall run parallel with closest wall.
- .19 Piping in walk-in pipe spaces shall be installed as close to one wall as possible.
- .20 Each water hammer arrester shall be accessible for service and replacement. They shall be installed in compliance with the recommendations of the Plumbing and Drainage Institute as found in Standard PDI-WH 201 "Water Hammer Arresters." including but not limited to; at the end of every water-closet and lavatory supply main, clothes washer, and sink. The water pressure at fixture level on the first floor is 414 kPa (60 psig). Contractor to confirm the incoming water pressure with flow test.
- .21 Slope all drains and vents in accordance with the Plumbing Code but not less than the minimum slopes shown on the Drawings. Slope all water lines 25 mm in 12 m (1 in. in 40 ft.) unless shown otherwise.
- .22 Install vent piping in accordance with requirements of the authority having jurisdiction.
- .23 Vent stack covers shall be properly sized for each vent penetrating the roof. Division 23 shall supply vent stack covers for installation and flashing by the Roofing Contractor.
- .24 Provide bird screen on all vents terminating horizontally, with a gooseneck or other configurations where a vent stack cover is not provided.
- .25 Refer to Section 22 63 53 - LABORATORY LIQUID SYSTEMS.
- .26 Provide an isolation valve downstream of all flow balancing valves on the domestic water distribution.
- .27 Provide all mechanical piping and fittings within the cistern. Rainwater cistern floating device shall intake water 150 mm below the water surface and shall ensure that the foot valve is always submerged.
- .28 Provide a thermostatic mixing valve on discharge of domestic hot water systems.
- .29 Grooved pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing. All grooved Products to be from a single manufacturer. All couplings shall meet the manufacturer's standards for visual inspection. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Install in accordance with manufacturer's latest recommendations. A manufacturer's factory trained representative shall periodically visit the site and review the installation for best practices. The Contractor shall correct any identified deficiencies. Grooved Product that has been examined and has not met the visual inspection criteria for proper installation must be corrected and re-examined by the manufacturer prior to the completion of the Work.
- .30 Install flexible expansion joints in the locations indicated on the Drawings and as required by piping manufacturer.
- .31 Where site servicing expansion joints are required, provide signed and sealed engineered drawings for review and record.
- .32 Main Incoming Domestic Cold Water Filtration:
 - .1 Insulate per manufacturer's written recommendations.
 - .2 Pipe backwash flush connection to nearest drain using an indirect connection.
- .33 Do not install combustible (e.g. PVC, etc.) piping in a vertical service space.

PIPES, VALVES AND FITTINGS (PLUMBING SYSTEM)

3.2 Flushing and Disinfecting

- .1 Flush and disinfect all new or reworked domestic water piping, ensure water flows through all fixtures, hose outlets, service connections and/or any other potable water outlet. Remove sediment from aerators as required.
- .2 Provide circulating pumps, connections and valves as required for complete flushing and disinfection of the system.
- .3 When flushing is complete, disinfect the piping with a solution of chlorine in accordance with ANSI/AWWA C651 "Disinfecting Water Mains."
- .4 Test water samples from disinfected water system at a certified laboratory for purity and conformance with governing standards.
 - .1 Submit a copy of the test results prior to building occupancy.

END OF SECTION

CIRCULATORS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Submittals

- .1 Submit Shop Drawings and/or catalogue cuts of all items supplied in accordance with requirements of Section 20 05 03 - SHOP DRAWINGS.

PART 2 - PRODUCTS

2.1 Materials

- .1 Circulators, in the line type with flanged inlet and outlet, mechanical seal and suitable for 125 psig working pressure from:
 - .1 Armstrong
 - .2 Grundfos-Paco
 - .3 Xylem Bell & Gossett
 - .4 Patterson Pump Company
 - .5 Taco Industries
- .2 For domestic water systems (potable) pump body shall be lead free bronze or stainless steel with impeller meeting the low lead requirements of NSF/ANSI/CAN 372 "Drinking Water System Components - Lead Content" for all wetted parts.
- .3 All systems except domestic water pump shall be cast iron, steel impeller and stainless steel shaft.
- .4 Pump capacity shall be as shown in the Pump Schedule.

PART 3 - EXECUTION

3.1 Installation

- .1 Support pump as shown on Standard Details.

END OF SECTION

FLOOR DRAINS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Submittals

- .1 Submit Shop Drawings and/or catalogue cuts of all items supplied in accordance with requirements of Section 20 05 03 - SHOP DRAWINGS.

PART 2 - PRODUCTS

2.1 Materials

- .1 Floor drains shall be J.R. Smith, Mifab, Watts, or Zurn.

2.2 Finished Areas

- .1 Floor drains in finished areas and stainless steel top shall be all coated cast iron body, flashing clamp with seepage openings and adjustable 127 mm (5") diameter stainless steel heavy duty strainer with No. 4 satin finish, secured with SS screws, 100 mm (4") throat on strainer. Drain shall be complete with trap primer connection. J.R. Smith 2005-A05SS-P050, Zurn ZXSS-415-A5, Mifab F1000C-5-3, Watts FD-1100-C-5-3.
- .2 Funnel floor drains in finished areas shall be similar to floor drains in finished areas but with minimum nominal 127 mm (5") dia. strainer, full opening for funnel and nominal 75 mm x 225 mm (3 in. x 9 in.) oval funnel. J.R. Smith 2005-A05-NB-3591-OT-P050, Zurn ZN-415-BF, Mifab F1100C-EG-1, Watts FD-100-C-EG-1.
- .3 Floor drains in Safety Sheet Vinyl Flooring Areas shall be similar to floor drains in finished areas but with 2 piece flashing clamp collar. J.R. Smith 2051, Zurn ZN-415-R9, Mifab F1100C-FC9-1, Watts FD-100-C-FC9-1.
- .4 Hub drains shall be similar to floor drains in finished areas but with cast iron hub. J.R. Smith 2005-2645, Zurn Z-415-S, Mifab F1100C-DD-50, Watts FD-100-DD-50.

2.3 Non-Finished Areas

- .1 Floor drains in non-finished areas shall be coated cast iron body, drainage flange, adjustable nominal 200 mm (8 in.) dia. heavy-duty strainer. Drain shall be complete with trap primer connection. J.R. Smith 2110, Zurn Z-536-8, Mifab F1320C-4, Watts FD320-4.
- .2 Funnel floor drains in non-finished area shall be similar to floor drains in non-finished areas but with nominal 75 mm x 225 mm (3 in. x 9 in.) oval funnel. J.R. Smith 2110-3591, Zurn Z-536-8-F0, Mifab 1320C-4-G-50, Watts FD320-4-G-50.
- .3 Plenum drains (Plenum Floor Drains) for use in suspended sheet metal plenums shall nominally be 225 mm (9 in.) overall dia. strainer with screwed attachment for sheet metal pan. J.R. Smith SQ-4-1753-SM, Zurn ZN-211-R9, Watts FD-200-FC9-1.
- .4 Floor drains in floating floor areas shall be cast iron body, drainage flange, nominal 200 mm (8 in.) dia. heavy-duty strainer, movement compensator and vibration isolator. J.R. Smith 9340, Zurn Z-556-FS, Mifab F1600C-4, Watts FD-620-C.

FLOOR DRAINS

- .5 Funnel floor drains in floating floors shall be similar to floor drains in floating floors but with nominal 75 mm x 225 mm (3 in. x 9 in.) oval funnel. J.R. Smith 9340-3591, Zurn Z-556-FS-F0, Mifab F1600C-4-G-50, Watts FD-620-C-G-50.
- .6 Elevator pit drains: Vertical wall or angled scupper drain, coated cast iron body, secured cast iron grate, clamping collar. Zurn Z187 or Z629-C-LV, J.R. Smith 1510 or 2090-C, Mifab R1310-50, Watts RD-270-50.
- .7 Electronic automatic trap seal primer system with 12 mm (1/2 in.) connection, complete with integral ball valve and CSA B64 backflow prevention to the requirements of the Authority Having Jurisdiction. Pre-pipe the unit with a copper manifold and distribution system suitable for the number of drains served. Provide electrical components with a single point power connection at 120 V. Include with unit a manual override switch and 24 hour timer with relay and adjustable delay. Factory assemble all components and install into a coated steel box with access door for surface mounted installation. Mifab MI 100-UA series; Zurn Z1020 series; Precision Plumbing Products PT Series; or Smith Fluid Controls 270/271/272 Series.

PART 3 - EXECUTION

3.1 Installation

- .1 Provide floor drains in air plenums on the suction and discharge side of fans with deep seal traps.
- .2 Provide electronic trap seal primer assemblies for all floor drain traps. Trap primer shall be installed at the nearest cold water served fixture or faucet, except drinking fountains.
 - .1 Provide access to primer assembly for repair or replacement.
 - .2 Provide a globe valve on the water supply for regulation and shut-off.
 - .3 Where integral backflow prevention is not sufficient to meet the requirements of CSA B64, provide a reduced pressure backflow prevention device on the water supply to the trap seal primer in a suitable location and discharge piped to drain.
- .3 Provide a running trap and cleanout for each pit drain. For elevator pits provide an external backwater valve in accordance with Section 22 11 13 - PIPES, VALVES AND FITTINGS (PLUMBING SYSTEM).
- .4 Provide a backwater valve in accordance with Section 22 11 13 - PIPES, VALVES AND FITTINGS (PLUMBING SYSTEM) on floor drains within walk-in coolers before connecting to sanitary drainage system.

END OF SECTION

INTERCEPTORS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Submittals

- .1 Submit Shop Drawings and/or catalogue cuts of all items supplied in accordance with requirements of Section 20 05 03 - SHOP DRAWINGS.

PART 2 - PRODUCTS

2.1 Materials

- .1 Interceptors shall be J.R. Smith, Zurn, Mifab, or Watts.

2.2 Electronic Grease Interceptor (Stainless Steel)

- .1 Electronic grease interceptors shall be fabricated entirely of stainless steel construction. Interceptor shall be at minimum rated for a 133 lpm (35 USGPM) flow rate and a 31.7 kg (70 lb) grease holding capacity unless shown otherwise. Interceptor extensions shall be provided as required.
- .2 Electronic grease interceptors shall be complete with failsafe electronic controls, including 120/24 VAC 12 VA, class II transformer, epoxy encapsulated multi-level probe assembly, failsafe knife edge valve on inlet side, compact control panel with 3 position switch, multilevel LED display, diagnostic LEDs audible alarm and auxiliary contacts for remote alarm/control functions.
- .3 Electronic grease interceptor shall be complete with removable baffle assembly and cross bar, deep seal trap, cleanout, securing bolt(s) or lock and lift rings, flow control fitting, internal air relief bypass and non skid, rectangular gasketed lid(s). Interceptor extensions shall be provided as required to suit invert of the drains.
- .4 Unit shall be suitable for floor, semi-recessed or recessed (underground) installation as shown. Where required provide stainless steel extension sleeve to finished grade, or floor. Where required provide flashing flange and collar for waterproof membrane.
- .5 Size of unit shall be suitable for a single three compartment sink. J.R. Smith 8000E-ELECT-SS Series, Zurn ZSS-1160, Mifab ME-G-SS, Watts GE-100-SS.

PART 3 - EXECUTION

3.1 Installation

- .1 Provide auxiliary flow control for interceptors installed with a head of more than 1500 mm (5 ft).
- .2 For recessed or semi-recessed installations where direct bury is not an accepted manufacturer's installation, provide a pre-cast or poured concrete pit to receive the interceptor. Coordinate pit with Structural.

INTERCEPTORS

- .1 Provide trapped and primed floor drain in pit complete with backwater valve in accordance with Section 22 11 13 - PIPES, VALVES AND FITTINGS (PLUMBING SYSTEM).
- .2 Provide a stainless steel tread cover plate that shall be sufficiently strong and rigid to support traffic without vibration or deflection. An inspection cover shall be provided in the cover plate.
- .3 A stainless steel frame shall be provided for receiving the cover plate. Frame shall include a gasketed recess dimensioned for the cover plate, stainless steel threaded studs and nuts for fastening the cover and concrete anchors welded on at approximately 450 mm (18 in.) centres. Intermediate supports shall be removable for servicing the grease interceptor.
- .4 The size of the cover plate and frame shall be determined from the pit size required.
- .5 All openings in cover plate and frame shall be gasketed for sanitary drainage systems.

END OF SECTION

SUMP PUMPS AND SUMP PITS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Submittals

- .1 Submit Shop Drawings and/or catalogue cuts of all items supplied in accordance with requirements of Section 20 05 03 - SHOP DRAWINGS.
- .2 Ensure Shop Drawings include unit Short Circuit Current Rating (SCCR).

PART 2 - PRODUCTS

2.1 Materials

- .1 Obtain flow tests to determine actual ground water flow rates before ordering pumps.
- .2 Pump capacity shall be as shown in the Pump Schedule.
- .3 Submersible Pumps
 - .1 Non-clog submersible pumps from:
 - .1 Leader (Barnes)
 - .2 Liberty Pumps
 - .3 Grundfos – Chicago
 - .4 Xylem – Flygt
 - .5 Pentair – Hydromatic.
 - .2 Pumps shall be cast iron casing with heavy duty base bronze wear ring, two vane impeller, heavy duty ball bearings, double mechanical seals, stainless steel shaft and double epoxy potted and compression fitted power cord and control cord fittings.
 - .3 Pumps on sanitary sewer systems conveying solid waste shall be grinder type.
 - .4 Pump shall be complete with coupling kit and guide rail assembly to allow for pump removal without entering the pit. Provide chain on pump and hoisting ring in structure above for hoisting pump.
- .4 Controls
 - .1 There shall be two float operated switching mechanisms.
 - .2 The switching mechanism connected to one of the floats shall be a mechanical alternator. Action of the alternator shall be to alternate the lead pump in sequential starts. The switching mechanism connected to the other float shall start both pumps should the water level rise above the operating level of the alternator float.
 - .3 There shall be a high water alarm switch complete with transformer and bell, and auxiliary contacts for wiring to the building BAS system.

SUMP PUMPS AND SUMP PITS

- .4 All controls shall be mounted in a CSA Type 3R control panel and shall be complete with all starters, power wiring, control wiring, hand-off-auto switch and LED pilot light for each pump, transformer and wiring to the alarm panel and shall require only a single power supply by the Electrical Division. All conduit shall enter from the bottom only.
- .5 System shall bear a minimum Short Circuit Current Rating (SCCR) listed by a Nationally Recognized Testing Lab, acceptable to the local Authority Having Jurisdiction, and shall be 10,000 A Lower SCCR listed units implying the use of current limiting fuses ahead of them in the field, in lieu of an actual appropriate SCCR rating, are not acceptable.
- .5 Cover and Sump Pit
 - .1 Sump pit shall be provided by this Division and be pre-cast concrete to match the dimensions shown on the drawings. Coordinate with Division 03 for concrete requirements.
 - .2 Pumps shall be mounted on/covered by a galvanized steel cover plate that shall be sufficiently strong and rigid to support the pump or pumps as required, pump accessories and service technician without vibration or deflection. An inspection cover shall be provided in the cover plate.
 - .3 A galvanized steel frame shall be provided for receiving the cover plate in a concrete sump. Frame shall include a gasketed recess dimensioned for the cover plate, stainless steel threaded studs and nuts for fastening the cover and concrete anchors welded on at approximately 450 mm (18 in.) centres.
 - .4 The size of the cover plate and frame shall be determined from the pit size shown on the Drawings.
 - .5 Gasket all openings in cover plate and frame.
 - .6 Provide frames and cover plates for sand traps and inspection pits. Material shall be as specified for main cover plate.
 - .7 Provide galvanized steel ladder rungs at 300 mm (12 in.) on centres for full depth of all pits.

PART 3 - EXECUTION

3.1 Installation

- .1 Provide gate valve, check valve and union or flange as applicable on pump discharge pipes and union or flange as applicable on vent pipe for sanitary pits.
- .2 Check valves downstream of pumps shall be swing type with external lever and adjustable weight.
- .3 The frame, intermediate platform, and ladder rungs shall be provided to Division 3 for setting in place.
- .4 If the main control panel is shipped without a splitter to serve the alarm panel, supply and install an additional junction box before the control panel to serve all related panels.
- .5 Intermediate platforms shall be equally spaced over the height of the pit and the maximum distance between shall not exceed 4.5 m (15 ft.). Platforms shall be installed clear of pump removal space.

SUMP PUMPS AND SUMP PITS

- .6 Install fibreglass sump base flange in light weight concrete anchor slab prior to backfilling.

END OF SECTION

ROOF DRAINS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Submittals

- .1 Submit Shop Drawings and/or catalogue cuts of all items supplied in accordance with requirements of Section 20 05 03 - SHOP DRAWINGS.

PART 2 - PRODUCTS

2.1 Materials

- .1 Provide roof drains by J.R. Smith, Zurn, Mifab, or Watts.
- .2 Provide roof drains in metal decks or poured concrete roofs as follows: coated cast iron body, large sump, wide non-crimping flange, vandal proof aluminum or ductile iron mushroom dome strainer, extension frame to suit thickness of insulation, sump receiver, under-deck clamps and flashing clamp with integral gravel stop. J.R. Smith 1010-AD-E-R-C-U, Zurn ZA-100-E-C-R-VP, Mifab R1200-6-M-B-U-V, Watts RD-100-B-D-K80-L-V.
- .3 Provide screens as required to prevent gravel from entering the drain pipes.
- .4 Provide roof drains with integrated emergency overflow drains in metal decks or poured concrete roofs as follows: coated cast iron body, large sump, integral 150 mm (6 in.) diameter cast iron standpipe or 200 mm (8 in.) diameter cast iron standpipe to match the drawings, dual outlet, wide non-crimping flange, vandal proof aluminum or ductile iron mushroom dome strainer, extension frame to suit thickness of insulation, sump receiver, under-deck clamps and flashing clamp with integral gravel stop. J.R. Smith 1077-45, Zurn 100C Froet Drain, Mifab R1200-SO, or Watts RD-700.

PART 3 - EXECUTION

3.1 Installation

- .1 For roof drains connected to vertical rain water leaders with less than 1200 mm (4 ft.) of horizontal offset, provide complete with expansion compensators.
- .2 Turn drain bodies over to roofing and waterproofing trades on site for priming and setting into bearing pads of waterproofing materials.
 - .1 DO NOT REMOVE, ADJUST, OR TAMPER WITH FLOW CONTROL WIER.

END OF SECTION

DOMESTIC ELECTRIC HOT WATER HEATERS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Submittals

- .1 Submit Shop Drawings and/or catalogue cuts of all items supplied in accordance with requirements of Section 20 05 03 - SHOP DRAWINGS.
- .2 Ensure Shop Drawings include unit Short Circuit Current Rating (SCCR).

PART 2 - PRODUCTS

2.1 Materials

- .1 Tank based domestic electric hot water heaters:
 - .1 Provide CSA approved domestic electric hot water heaters by John Wood, Bradford White, AO Smith or Rheem.
 - .2 Provide glass lined steel tank, factory insulated and covered with an enamelled steel jacket. Provide tank rated for 860 kPa (125 psi) working pressure.
 - .3 Provide heater elements of electric immersion type located at the top and bottom of the tank and complete with thermostats. Arrange elements to operate alternatively or simultaneously, as shown. Provide an additional high limit thermostat that prevents overheating. Provide access panels in jacket that provide access to thermostats and elements.
 - .4 Provide tanks complete with temperature pressure relief valve. Pipe relief valve to nearest drain.
 - .5 Provide tanks of size and heaters of capacity shown.
 - .6 Provide tanks of size and heaters of capacity as shown on the Domestic Hot Water Heater Schedule.
- .2 Rec Centre: System shall bear a minimum Short Circuit Current Rating (SCCR) listed by a Nationally Recognized Testing Lab, acceptable to the local Authority Having Jurisdiction, and shall be 35,000 A Lower SCCR listed units implying the use of current limiting fuses ahead of them in the field, in lieu of an actual appropriate SCCR rating, are not acceptable.
- .3 Child Care: System shall bear a minimum Short Circuit Current Rating (SCCR) listed by a Nationally Recognized Testing Lab, acceptable to the local Authority Having Jurisdiction, and shall be 25,000 A Lower SCCR listed units implying the use of current limiting fuses ahead of them in the field, in lieu of an actual appropriate SCCR rating, are not acceptable.

DOMESTIC ELECTRIC HOT WATER HEATERS

PART 3 - EXECUTION

3.1 Not Used

END OF SECTION

FIXTURES AND TRIM

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Submittals

- .1 Submit Shop Drawings and/or catalogue cuts of all items supplied in accordance with requirements of Section 20 05 03 – SHOP DRAWINGS.
- .2 Confirm project LEED requirements and required water use reductions prior to submitting Shop Drawings. Include page in Shop Drawings confirming that coordination with LEED Consultant has occurred prior to submitting Shop Drawings.

1.3 References

- .1 Comply with CSA B45 Series of standards for fixtures.

PART 2 - PRODUCTS

2.1 Materials

- .1 Plumbing fixtures shall be as indicated and specified with all required supports, accessories, drainage, vent and water connections to make the fixtures complete.
- .2 Fittings that supply water to a fixture shall not exceed the maximum flow rates in accordance with the following:
 - .1 LEED
 - .2 Manitoba Plumbing Code
- .3 Provide fixtures from American Standard, T&S Brass, Toto, Kohler, Franke, Zurn, Blanco, Mirolin or Novanni, equivalent to the fixtures specified. American Standard – Eljer and Placidus are not permitted. Provide white vitreous china fixtures unless indicated otherwise.
- .4 Provide fittings and trim from American Standard, T&S Brass, Kohler, Sloan, Chicago Faucets, Zurn, Moen, Symmons, or Delta/Cambridge except where specified otherwise. Provide polished chrome plated brass for all exposed valves, fittings, escutcheons, trim, etc., at each fixture, unless specified otherwise.
- .5 Provide Fixtures and Trim equal to Product Specification sheets. Specification sheets follow Section 22 42 46 - FIXTURE CARRIERS.
- .6 Carriers shall be furnished for all wall hung water closets, urinals, and lavatories. Carriers shall be in conformance with Section 22 42 46 - FIXTURE CARRIERS.

FIXTURES AND TRIM

PART 3 - EXECUTION

3.1 Installation

- .1 Provide necessary plates, brackets, cleats, supports, etc., for rigidly securing fixtures in place. Accurately lay out all roughing piping, avoiding offsets.
- .2 Examine fixtures for defects. Remove and replace any fixture which, in the opinion of the Contract Administrator, is damaged. Make necessary adjustments to ensure fixtures function as per manufacturer's operating criteria. Clean and polish all fixtures and trim upon completion.
- .3 Ensure wall-mounted fixtures with back water connections have an adjacent access door, unless the pipe space is sufficiently wide to allow the water connection to be made from within the pipe space. For this, pipe space shall be 600 mm (24 in.) minimum clear width.
- .4 Provide cleanouts in accordance with the requirements of Section 22 05 76 – CLEANOUTS.
- .5 Fixtures shall be installed symmetrical with wall tile pattern, unless otherwise dimensioned or shown on Architectural Drawings.

END OF SECTION

FIXTURE CARRIERS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Submittals

- .1 Submit Shop Drawings and/or catalogue cuts of all items supplied in accordance with requirements of Section 20 05 03 - SHOP DRAWINGS.

PART 2 - PRODUCTS

2.1 Materials

- .1 Fixtures carriers shall be J.R. Smith, Zurn, or Mifab, or Watts.
- .2 Carriers shall be furnished for all wall hung water closets, urinals, lavatories, service sinks and drinking fountains. Carriers shall be floor mounted and supported independently of the wall. Carriers shall be suitable for each particular fixture. Carrier feet shall not project beyond finished wall.
- .3 Provide carriers equal to Product Specification sheets.
- .4 All fixture carriers with integral cast iron fittings shall be certified to CSA B70 "Cast iron soil pipe, fittings, and means of joining" as required by Authority Having Jurisdiction.

PART 3 - EXECUTION

3.1 Installation

- .1 Rigidly secure all fixture carriers to the floor using approved anchor bolts and inserts.
- .2 Verify the finished wall location and type of wall construction and elevation of finished floor before installation of carriers.

END OF SECTION



R-WC-1

Toilet - Wall-hung

AFWALL® MILLENNIUM™ FloWise®

To be specified

Centoco - Seat



☒ 500STSCCFE-001

Sloan - Flush Valve



☒ SOLIS 8111-1.1-OR

Watts - Carrier



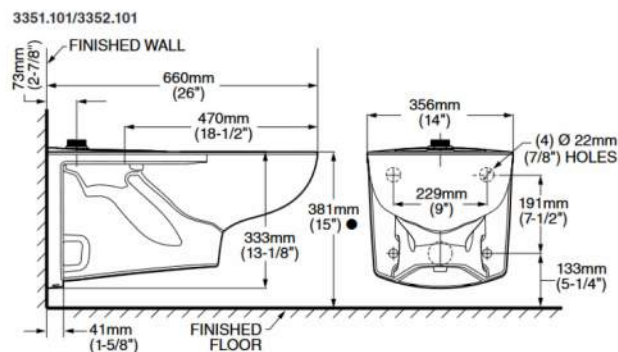
☒ **ISCA-101-L/R-M11** Industry Standard single Horizontal adjustable Closet Carrier, patented compression seal faceplate assembly, epoxy coated cast iron, epoxy coated cast iron, with incremental measurements embossed onto legs to easily adjust height of carrier to most commonly used fixture requirements, epoxy coated cast iron, Plated hardware, neoprene bowl gasket, Adjustable ABS nipple, integral test cap, 51 mm (2") no hub vent connections, 102 mm (4") no hub waste, Adjustable for standard and wheelchair height, chrome cap nuts, Carrier complies with requirements of ASME A112.6.1M up to a 500 lb (227 kg) static load, required minimum space is 292 mm (11-1/2")

American Standard- Toilet

☒ **3351101.020**



Refer to the product specification sheet for complete information



Note:



R-WC-1

Toilet - Wall-hung

AFWALL® MILLENNIUM™ FloWise®

Mission Rubber Products Corp - Coupling



☒ **NO HUB Series** Unsized, One-piece molded elastomeric sealing gasket

Note:



R-WC-2

Toilet - Wall-hung

AFWALL® MILLENNIUM™
FloWise®



To be specified

Centoco - Seat



☒ 500STSCCFE-001

Sloan - Flush Valve



☒ SOLIS 8111-1.1-OR

Watts - Carrier



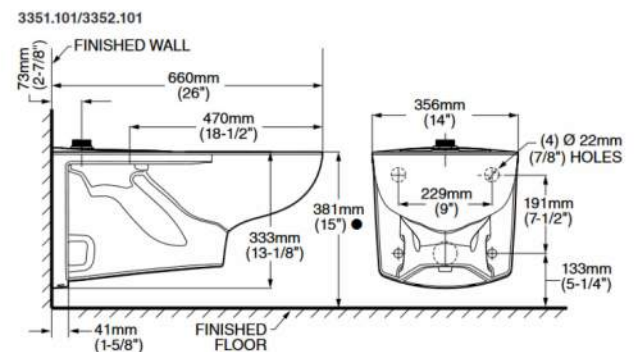
☒ **ISCA-101-L/R-M11** Industry Standard single Horizontal adjustable Closet Carrier, patented compression seal faceplate assembly, epoxy coated cast iron, epoxy coated cast iron, with incremental measurements embossed onto legs to easily adjust height of carrier to most commonly used fixture requirements, epoxy coated cast iron, Plated hardware, neoprene bowl gasket, Adjustable ABS nipple, integral test cap, 51 mm (2") no hub vent connections, 102 mm (4") no hub waste, Adjustable for standard and wheelchair height, chrome cap nuts, Carrier complies with requirements of ASME A112.6.1M up to a 500 lb (227 kg) static load, required minimum space is 292 mm (11-1/2")

American Standard- Toilet

☒ **3351101.020**



Refer to the product specification sheet for complete information



Note:



R-WC-2

Toilet - Wall-hung

AFWALL® MILLENNIUM™
FloWise®



Mission Rubber Products Corp - Coupling



☒ **NO HUB Series** Unsized, One-piece molded elastomeric sealing gasket

Franke Commercial - Backrest



☒ **CM-16104-WM** wall mounting, back rest, solid core plastic laminate panel back, Antique white, 305 mm (12") wide, 102 mm (4") high, 137 mm (5-3/8"), 18 gauge stainless steel bar with #4 gloss with flanges and covers, concealed snap flanges and mounting hardware included, Provide adequate backing in wall for support and comply to local codes for barrier free requirements

Note:



To be specified

☒ **SL-SOLIS 8186-0.13**

☒ **CA-321** Floor Mounted Urinal Carrier with Bearing Plate, Wall Plate, Plated hardware, required minimum space is 76 mm (3")

☒ **CO-380-RD** Unsized pipe

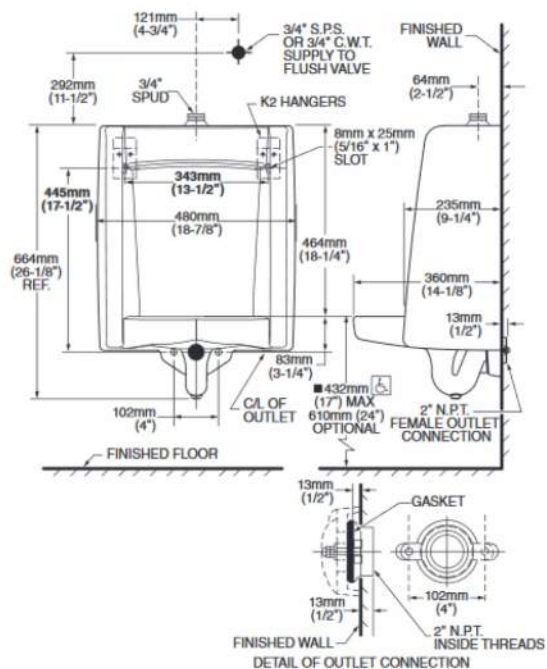
American Standard- Urinal

☒ 6590001EC.020 7381755-200.0020A



Wall-hung, Vitreous china, Flush valve urinal, White finish, 51 mm (2") NPT female outlet, Top spud, The flush valve can be installed either on left or right side

Refer to the product specification sheet for complete information



Note:



R-UR-1

**WASHBROOK® FLOWISE® - Top
spud**

**Flush valve urinal Top
spud**

Mission Rubber Products Corp - Coupling



☒ **NO HUB Series** Unsized, One-piece molded elastomeric sealing gasket

Note:



R-L-1

LUCERNE™ WALL-HUNG LAVATORY

Wall-hung Lavatory
Vitreous china

To be specified

Sloan - Faucet



☒ **EAF-275-SOL-CP-0.35GPMGPM-MLM-IR-FCT** Automatic no-touch, Counter mounted, Single hole centerset, Metal, Lavatory faucet, Polished chrome finish, 1.3 LPM (0.35 GPM) maximum flowrate, Fixed spout, Multi-laminar spray outlet, 110 mm (4-5/16") spout reach, 136 mm (5-11/32") high, Solar powered, Mixing valve ordered separately, Water supply connection with flexible high pressure hose and strainer, Above deck control access, Double infrared sensors with automatic setting feature, Less drain, ANSI A117.1 compliant

Lawler - Mixing Valve



☒ **570-86820** Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, Nickel plated finish, Lead free brass body construction, 1.9 - 30 LPM (0.5 - 8 GPM) range for flowrate, To adjust the mixed outlet temperature of the valve, remove the cap to gain access to the adjusting spindle. The spindle should be rotated-clockwise to reduce the temperature, counter-clockwise to increase the temperature until the desired set point is reached, The temperature is adjusted with the help of Spindle, 4-7/8" (124 mm) Height, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) outlet, internal checks, ASSE 1070 approved Certified to CSA B125.3 for ASSE 1070 applications, 95-115 °F outlet water temperature range, Offers choice of temperature settings from 95° through 115 °F., 125 PSI max hydrostatic pressure, ±20% pressure variation, 11 LPM (3 GPM) tempered flowrate @ 5 PSI pressure drop, 40-80 °F, 10 °F, 180 °F max, 7 GPM flowrate @ 45 PSI, ±5 °F, Protects against scalding and chilling

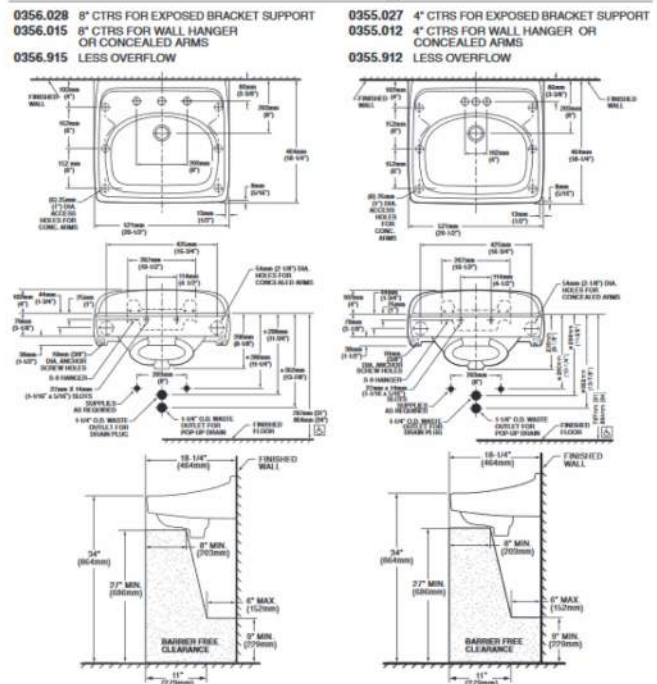
American Standard- Basin

☒ **0356421.020**



Vitreous china, Wall-hung, Lavatory, White finish, Single hole centerset, 165 mm (6-1/2") deep, 254 mm (10") long, 381 mm (15") wide, 464 mm (18-1/4") wide, With faucet ledge, Front overflow, 102 mm (4") high backsplash, No shroud

Refer to the product specification sheet for complete information



Note:



R-L-1

Wall-hung Lavatory
Vitreous china

LUCERNE™ WALL-HUNG LAVATORY

McGuire - Fixture Drain



☒ **155A** Straight drain, Cast brass, Chrome-plated finish, Open grid PO plug, 7/32" (5.5 mm) Ø holes size, 17 gauge 32 mm (1-1/4") Ø tailpiece, 17 gauge 152 mm (6") long

McGuire - Supply



☒ **LFBV170** Lead Free, Supply kit, Chrome-plated finish, Convertible loose key/triangle handle, For commercial applications

McGuire - P-Trap



☒ **8872C** Heavy cast brass, Adjustable P-Trap, 292 mm (11-1/2") distance, With cleanout plug, Shallow steel flange, Neoprene gasket, Slipnuts, 17 gauge seamless tubular wall bend, ASME A112.18.2 CSA B125.2, CSA compliant

Note:



R-L-1

Wall-hung Lavatory
Vitreous china

LUCERNE™ WALL-HUNG LAVATORY

Watts - Carrier



☒ **WCA-411** Single floor-mounted lavatory carrier with concealed arms, For concealed arm carrier, Plated hardware, required minimum space is 3-5/8" (92 mm)

Note:



R-L-2

MURRO



Wall-hung Lavatory
Vitreous china

To be specified

Sloan - Faucet



☑ **EAF-275-SOL-CP-0.35GPMGPM-MLM-IR-FCT** Automatic no-touch, Counter mounted, Single hole centerset, Metal, Lavatory faucet, Polished chrome finish, 1.3 LPM (0.35 GPM) maximum flowrate, Fixed spout, Multi-laminar spray outlet, 110 mm (4-5/16") spout reach, 136 mm (5-11/32") high, Solar powered, Mixing valve ordered separately, Water supply connection with flexible high pressure hose and strainer, Above deck control access, Double infrared sensors with automatic setting feature, Less drain, ANSI A117.1 compliant

Lawler - Mixing Valve



☑ **570-86820** Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, Nickel plated finish, Lead free brass body construction, 1.9 - 30 LPM (0.5 - 8 GPM) range for flowrate , To adjust the mixed outlet temperature of the valve, remove the cap to gain access to the adjusting spindle. The spindle should be rotated-clockwise to reduce the temperature, counter-clockwise to increase the temperature until the desired set point is reached, The temperature is adjusted with the help of Spindle, 4-7/8" (124 mm) Height, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) outlet, internal checks, ASSE 1070 approved Certified to CSA B125.3 for ASSE 1070 applications, 95-115 °F outlet water temperature range, Offers choice of temperature settings from 95° through 115 °F., 125 PSI max hydrostatic pressure, ±20% pressure variation, 11 LPM (3 GPM) tempered flowrate @ 5 PSI pressure drop, 40-80 °F, 10 °F, 180 °F max, 7 GPM flowrate @ 45 PSI, ±5 °F, Protects against scalding and chilling

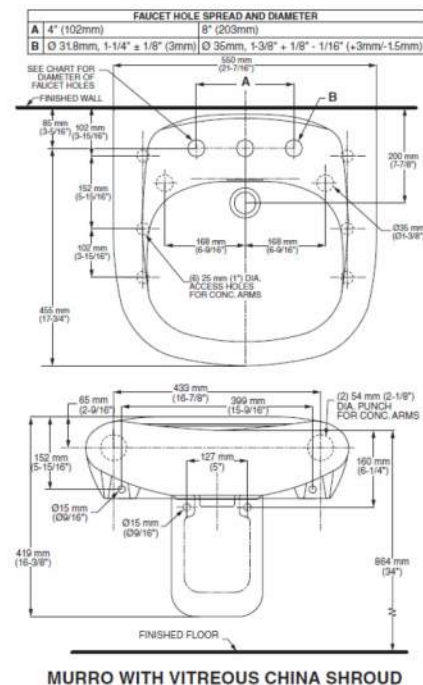
American Standard- Basin

☑ **0955001EC.020 0097000.020**



Vitreous china, Wall-hung, Lavatory, White finish, Single hole centerset, 127 mm (5") deep, 343 mm (13-1/2") long, 394mm (15-1/2") wide, 152 mm (6") high, 540 mm (21-1/4") wide, ANSI A117.1 compliant, EverClean® antimicrobial surface, Faucet ledge with recessed self-draining deck, Rear overflow, Acrylic shroud, conceals control box and thermostatic mixing valve (0097000), When installed with a below deck electronics faucet which has the control box, the accessories will not fit under the shroud and will need to be installed outside the shroud

Refer to the product specification sheet for complete information



Note:



R-L-2

**Wall-hung Lavatory
Vitreous china**

MURRO



McGuire - Fixture Drain



☒ **155WC** Offset drain, offset lavatory strainer, Lavatory, Cast brass, Chrome-plated finish, Inorganic microbial compound, 7/32" (5.5 mm) Ø holes size, Polished chrome, Cast brass elbow, 17 gauge 32 mm (1-1/4") Ø tailpiece, 146 mm (5-3/4") offset

McGuire - Supply



☒ **LFBV170** Lead Free, Supply kit, Chrome-plated finish, Convertible loose key/triangle handle, For commercial applications

McGuire - P-Trap



☒ **8872C** Heavy cast brass, Adjustable P-Trap, 292 mm (11-1/2") distance, With cleanout plug, Shallow steel flange, Neoprene gasket, Slipnuts, 17 gauge seamless tubular wall bend, ASME A112.18.2 CSA B125.2, CSA compliant

Note:



R-L-2

Wall-hung Lavatory
Vitreous china

MURRO



Watts - Carrier



☒ **WCA-411** Single floor-mounted lavatory carrier with concealed arms, For concealed arm carrier, Plated hardware, required minimum space is 3-5/8" (92 mm)

Note:



R-L-3

MEZZO



Semi-countertop Lavatory
Fine fire clay

To be specified

Sloan - Faucet



☑ **EAJ-275-SOL-CP-0.35GPMGPM-MLM-IR-FCT** Automatic no-touch, Counter mounted, Single hole centerset, Metal, Lavatory faucet, Polished chrome finish, 1.3 LPM (0.35 GPM) maximum flowrate, Fixed spout, Multi-laminar spray outlet, 110 mm (4-5/16") spout reach, 136 mm (5-11/32") high, Solar powered, Mixing valve ordered separately, Water supply connection with flexible high pressure hose and strainer, Above deck control access, Double infrared sensors with automatic setting feature, Less drain, ANSI A117.1 compliant

Lawler - Mixing Valve



☑ **570-86820** Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, Nickel plated finish, Lead free brass body construction, 1.9 - 30 LPM (0.5 - 8 GPM) range for flowrate , To adjust the mixed outlet temperature of the valve, remove the cap to gain access to the adjusting spindle. The spindle should be rotated-clockwise to reduce the temperature, counter-clockwise to increase the temperature until the desired set point is reached, The temperature is adjusted with the help of Spindle, 4-7/8" (124 mm) Height, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) outlet, internal checks, ASSE 1070 approved Certified to CSA B125.3 for ASSE 1070 applications, 95-115 °F outlet water temperature range, Offers choice of temperature settings from 95° through 115 °F., 125 PSI max hydrostatic pressure, ±20% pressure variation, 11 LPM (3 GPM) tempered flowrate @ 5 PSI pressure drop, 40-80 °F, 10 °F, 180 °F max, 7 GPM flowrate @ 45 PSI, ±5 °F, Protects against scalding and chilling

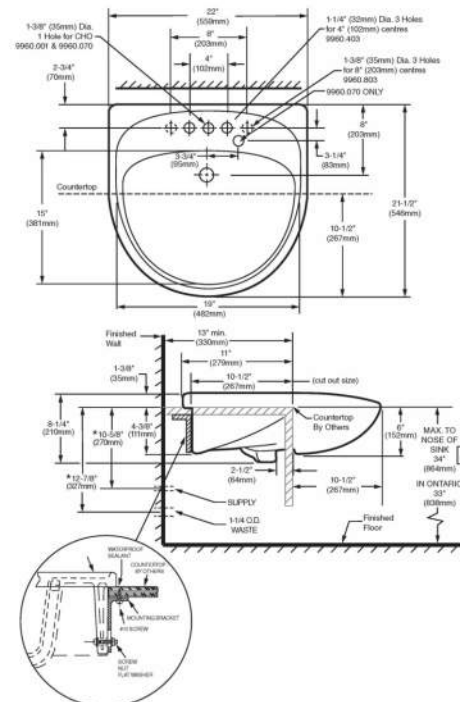
American Standard- Basin

☑ **9960001.020**



Fine fire clay, Counter mounted, Lavatory, White finish, Single hole centerset, 175 mm (6-7/8") deep, 483 mm (19") long, 381 mm (15") wide, 172 mm (6-25/32") high, 546 mm (21-1/2") wide, ANSI A117.1 compliant, With faucet ledge, Rear overflow, No shroud

Refer to the product specification sheet for complete information



Note:



R-L-3

MEZZO



Semi-countertop Lavatory
Fine fire clay

McGuire - Fixture Drain



☒ **155WC** Offset drain, offset lavatory strainer, Lavatory, Cast brass, Chrome-plated finish, Inorganic microbial compound, 7/32" (5.5 mm) Ø holes size, Polished chrome, Cast brass elbow, 17 gauge 32 mm (1-1/4") Ø tailpiece, 146 mm (5-3/4") offset

McGuire - Supply



☒ **LFBV170** Lead Free, Supply kit, Chrome-plated finish, Convertible loose key/triangle handle, For commercial applications

McGuire - P-Trap



☒ **PW8090** Molded Closed cell vinyl (anti-microbial) wrapped cast brass, Glossy White, With Cleanout, ASME A112.18.2, CSA B125.2

Note:



R-L-4

**Drop-in Lavatory
Vitreous china**

Aqualyn Drop In Sink

McGuire - Fixture Drain



☒ **155A** Straight drain, Cast brass, Chrome-plated finish, Open grid PO plug, 7/32" (5.5 mm) Ø holes size, 17 gauge 32 mm (1-1/4") Ø tailpiece, 17 gauge 152 mm (6") long

McGuire - Supply



☒ **LFBV170** Lead Free, Supply kit, Chrome-plated finish, Convertible loose key/triangle handle, For commercial applications

McGuire - P-Trap



☒ **8872CB** Heavy cast brass, Adjustable P-Trap, 292 mm (11-1/2") distance, With cleanout plug, Box flange, chrome-plated wrought steel, Neoprene gasket, Slipnuts, 17 gauge seamless tubular wall bend, ASME A112.18.2 CSA B125.2, CSA compliant

Note:



R-L-5

Aqualyn Drop In Sink

Drop-in Lavatory
Vitreous china

To be specified

Sloan - Faucet



☒ **EAF-275-SOL-CP-0.35GPMGPM-MLM-IR-FCT** Automatic no-touch, Counter mounted, Single hole centerset, Metal, Lavatory faucet, Polished chrome finish, 1.3 LPM (0.35 GPM) maximum flowrate, Fixed spout, Multi-laminar spray outlet, 110 mm (4-5/16") spout reach, 136 mm (5-11/32") high, Solar powered, Mixing valve ordered separately, Water supply connection with flexible high pressure hose and strainer, Above deck control access, Double infrared sensors with automatic setting feature, Less drain, ANSI A117.1 compliant

Lawler - Mixing Valve



☒ **570-86820** Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, Nickel plated finish, Lead free brass body construction, 1.9 - 30 LPM (0.5 - 8 GPM) range for flowrate , To adjust the mixed outlet temperature of the valve, remove the cap to gain access to the adjusting spindle. The spindle should be rotated-clockwise to reduce the temperature, counter-clockwise to increase the temperature until the desired set point is reached, The temperature is adjusted with the help of Spindle, 4-7/8" (124 mm) Height, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) outlet, internal checks, ASSE 1070 approved Certified to CSA B125.3 for ASSE 1070 applications, 95-115 °F outlet water temperature range, Offers choice of temperature settings from 95° through 115 °F., 125 PSI max hydrostatic pressure, ±20% pressure variation, 11 LPM (3 GPM) tempered flowrate @ 5 PSI pressure drop, 40-80 °F, 10 °F, 180 °F max, 7 GPM flowrate @ 45 PSI, ±5 °F, Protects against scalding and chilling

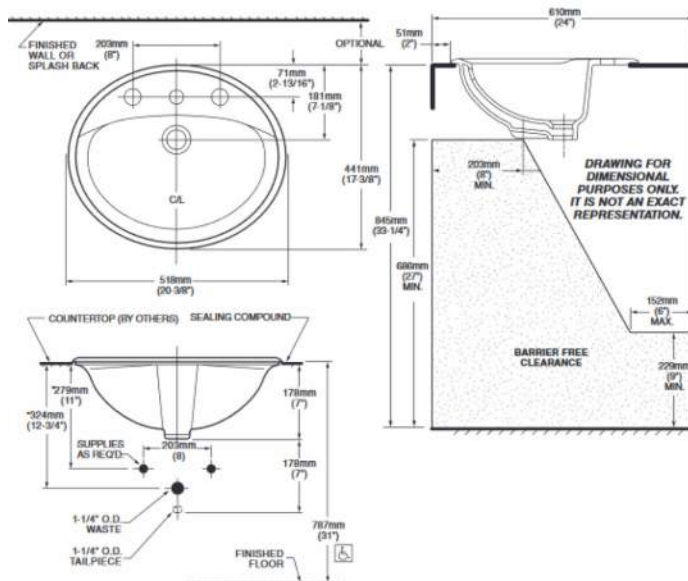
American Standard- Basin

☒ **0475047.020**



Vitreous china, Counter mounted, Lavatory, White finish, Single hole centerset, 143 mm (5-5/8") deep, 406 mm (16") long, 254 mm (10") wide, 178 mm (7") high, 441 mm (17-3/8") wide, With faucet ledge, Front overflow, No shroud

Refer to the product specification sheet for complete information



Note:



R-L-5

**Drop-in Lavatory
Vitreous china**

Aqualyn Drop In Sink

McGuire - Fixture Drain



☒ **155WC** Offset drain, offset lavatory strainer, Lavatory, Cast brass, Chrome-plated finish, Inorganic microbial compound, 7/32" (5.5 mm) Ø holes size, Polished chrome, Cast brass elbow, 17 gauge 32 mm (1-1/4") Ø tailpiece, 146 mm (5-3/4") offset

McGuire - Supply



☒ **LFBV170** Lead Free, Supply kit, Chrome-plated finish, Convertible loose key/triangle handle, For commercial applications

McGuire - P-Trap



☒ **PW8090** Molded Closed cell vinyl (anti-microbial) wrapped cast brass, Glossy White, With Cleanout, ASME A112.18.2, CSA B125.2

Note:



R-L-6

MEZZO

Semi-countertop Lavatory
Fine fire clay

To be specified

Sloan - Faucet



☒ **EAJ-275-SOL-CP-0.35GPMGPM-MLM-IR-FCT** Automatic no-touch, Counter mounted, Single hole centerset, Metal, Lavatory faucet, Polished chrome finish, 1.3 LPM (0.35 GPM) maximum flowrate, Fixed spout, Multi-laminar spray outlet, 110 mm (4-5/16") spout reach, 136 mm (5-11/32") high, Solar powered, Mixing valve ordered separately, Water supply connection with flexible high pressure hose and strainer, Above deck control access, Double infrared sensors with automatic setting feature, Less drain, ANSI A117.1 compliant

Lawler - Mixing Valve



☒ **570-86820** Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, Nickel plated finish, Lead free brass body construction, 1.9 - 30 LPM (0.5 - 8 GPM) range for flowrate , To adjust the mixed outlet temperature of the valve, remove the cap to gain access to the adjusting spindle. The spindle should be rotated-clockwise to reduce the temperature, counter-clockwise to increase the temperature until the desired set point is reached, The temperature is adjusted with the help of Spindle, 4-7/8" (124 mm) Height, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) outlet, internal checks, ASSE 1070 approved Certified to CSA B125.3 for ASSE 1070 applications, 95-115 °F outlet water temperature range, Offers choice of temperature settings from 95° through 115 °F., 125 PSI max hydrostatic pressure, ±20% pressure variation, 11 LPM (3 GPM) tempered flowrate @ 5 PSI pressure drop, 40-80 °F, 10 °F, 180 °F max, 7 GPM flowrate @ 45 PSI, ±5 °F, Protects against scalding and chilling

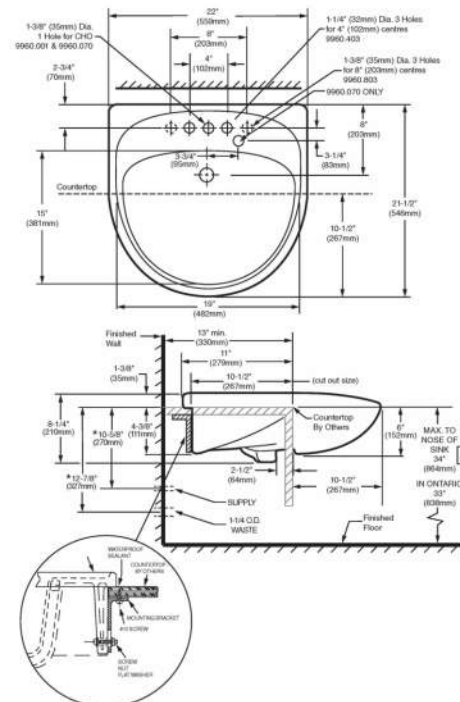
American Standard- Basin

☒ **9960001.020**



Fine fire clay, Counter mounted, Lavatory, White finish, Single hole centerset, 175 mm (6-7/8") deep, 483 mm (19") long, 381 mm (15") wide, 172 mm (6-25/32") high, 546 mm (21-1/2") wide, ANSI A117.1 compliant, With faucet ledge, Rear overflow, No shroud

Refer to the product specification sheet for complete information



Note:



R-L-6

Semi-countertop Lavatory
Fine fire clay

MEZZO

McGuire - Fixture Drain



☒ **155A** Straight drain, Cast brass, Chrome-plated finish, Open grid PO plug, 7/32" (5.5 mm) Ø holes size, 17 gauge 32 mm (1-1/4") Ø tailpiece, 17 gauge 152 mm (6") long

McGuire - Supply



☒ **LFBV170** Lead Free, Supply kit, Chrome-plated finish, Convertible loose key/triangle handle, For commercial applications

McGuire - P-Trap



☒ **8872CB** Heavy cast brass, Adjustable P-Trap, 292 mm (11-1/2") distance, With cleanout plug, Box flange, chrome-plated wrought steel, Neoprene gasket, Slipnuts, 17 gauge seamless tubular wall bend, ASME A112.18.2 CSA B125.2, CSA compliant

Note:



R-S-1

- Type 302 Stainless steel

Single compartment -
Counter mounted - Drop-in
Commercial sinks

To be specified

Chicago Faucets - Faucet



☒ **434-ABCP** Manual, Counter mounted, Single hole centerset, ECAST® brass construction, Sink faucet, Polished chrome finish, 5.7 LPM (1.5 GPM) maximum flowrate, Gooseneck spout, Spray outlet, 210 mm (8-1/4") spout reach, 432 mm (17") high, With supply, EPA WaterSense® compliant, Ceramic cartridge with volume control, Less drain, ANSI A117.1 compliant

Lawler - Mixing Valve



☒ **570-86820** Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, Nickel plated finish, Lead free brass body construction, 1.9 - 30 LPM (0.5 - 8 GPM) range for flowrate , To adjust the mixed outlet temperature of the valve, remove the cap to gain access to the adjusting spindle. The spindle should be rotated-clockwise to reduce the temperature, counter-clockwise to increase the temperature until the desired set point is reached, The temperature is adjusted with the help of Spindle, 4-7/8" (124 mm) Height, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) outlet, internal checks, ASSE 1070 approved Certified to CSA B125.3 for ASSE 1070 applications, 95-115 °F outlet water temperature range, Offers choice of temperature settings from 95° through 115 °F., 125 PSI max hydrostatic pressure, ±20% pressure variation, 11 LPM (3 GPM) tempered flowrate @ 5 PSI pressure drop, 40-80 °F, 10 °F, 180 °F max, 7 GPM flowrate @ 45 PSI, ±5 °F, Protects against scalding and chilling

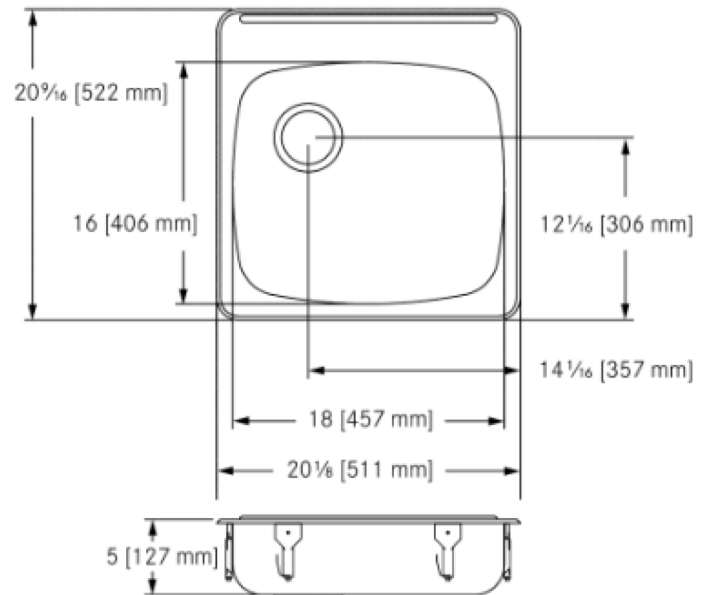
Franke Commercial- Sink

☒ **ALBS6805P-1-1**



Single hole centerset, With faucet ledge, 18 gauge Type 304 Stainless steel, Polished to #4 satin finish, Factory installed EZ TORQUE™ fasteners, Factory applied rim seal, Left rear waste location, 38 mm (1-1/2") (DN38) brass tailpiece, 89 mm (3-1/2") crumb cup strainer, waste fitting included, Undercoated to reduce condensation and resonance.
Compliances and certifications: ANSI A117.1 compliant, ASME A112.19.3 compliant, CSA B45.4 compliant, CSA B651-04 compliant.
Bowl Dimension: Left bowl is 457mm (18") long and right bowl is 305mm (12") long, 406 mm (16") wide, 127 mm (5") deep.
Overall Dimension: 511 mm (20-1/8") long, 522 mm (20-9/16") wide, 127 mm (5") high.

Refer to the product specification sheet for complete information



Note:



R-S-1

**Single compartment -
Counter mounted - Drop-in**
Commercial sinks

- Type 302 Stainless steel

McGuire - P-Trap



☒ **8912C** Heavy cast brass, Adjustable P-Trap, 292 mm (11-1/2") length, With cleanout plug, Shallow steel flange, Neoprene gasket, 17 gauge seamless tubular wall bend, Slipnuts

McGuire - Supply



☒ **LFH165LKN3** Lead Free, Supply kit, Chrome-plated finish, Loose key handle

Note:



R-S-2

- Molded stone

Single compartment - Wall-hung -
Laundry sink

To be specified

Chicago Faucets - Faucet



☒ **891-317-E36VPXKABCP** Manual, Counter mounted, 102 mm (4") centerset, Brass construction, Sink faucet, Polished chrome finish, 5.7 LPM (1.5 GPM) maximum flowrate, S-type spout, Vandal-resistant laminar flow outlet, 153 mm (6") spout reach, 111 mm (4-3/8") high, Less supply risers, 1/4 turn compression cartridge, Less drain, ANSI A117.1 compliant

Lawler - Mixing Valve



☒ **570-86820** Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, Nickel plated finish, Lead free brass body construction, 1.9 - 30 LPM (0.5 - 8 GPM) range for flowrate , To adjust the mixed outlet temperature of the valve, remove the cap to gain access to the adjusting spindle. The spindle should be rotated-clockwise to reduce the temperature, counter-clockwise to increase the temperature until the desired set point is reached, The temperature is adjusted with the help of Spindle, 4-7/8" (124 mm) Height, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) outlet, internal checks, ASSE 1070 approved Certified to CSA B125.3 for ASSE 1070 applications, 95-115 °F outlet water temperature range, Offers choice of temperature settings from 95° through 115 °F., 125 PSI max hydrostatic pressure, ±20% pressure variation, 11 LPM (3 GPM) tempered flowrate @ 5 PSI pressure drop, 40-80 °F, 10 °F, 180 °F max, 7 GPM flowrate @ 45 PSI, ±5 °F, Protects against scalding and chilling

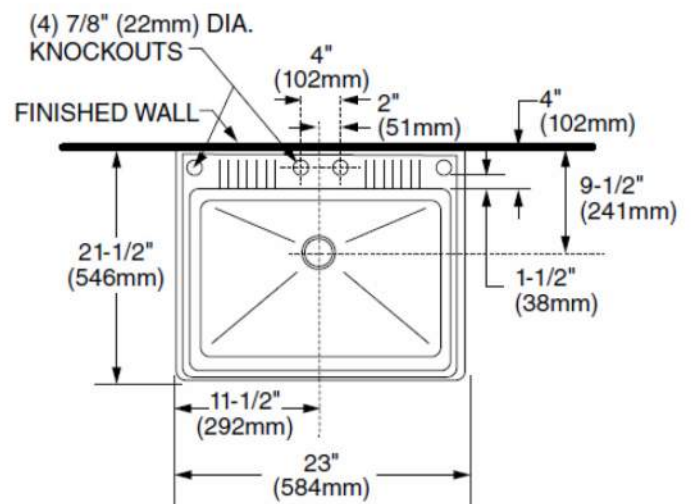
Fiat- Sink

☒ **L1100**



Wall-hung, Molded stone, White finish, Laundry sink, Single compartment, 102 mm (4") knockout center (field drilled), 341 mm (13-7/16") deep, Left bowl is 584mm (23") long and right bowl is 381mm (15") long, 445 mm (17-1/2") wide, 341 mm (13-7/16") high, 546 mm (21-1/2") wide, With faucet ledge, White molded plastic polymer side fillers and bottom tub support, assembled in field to the mounting brackets

Refer to the product specification sheet for complete information



Note:



R-S-2

- Molded stone

Single compartment - Wall-hung -
Laundry sink

McGuire - P-Trap



☒ **8912C** Heavy cast brass, Adjustable P-Trap, 292 mm (11-1/2") length, With cleanout plug, Shallow steel flange, Neoprene gasket, 17 gauge seamless tubular wall bend, Slipnuts

McGuire - Supply



☒ **LFH165LKN3** Lead Free, Supply kit, Chrome-plated finish, Loose key handle

Note:



R-S-3

- Type 304 Stainless steel

Double compartment -
Counter mounted - Drop-in
Commercial sinks

To be specified

Chicago Faucets - Faucet



☒ **919-613XKCAB** Manual, Counter mounted, Single hole centerset, ECAST® brass construction, Pre-rinse fitting, Chrome finish, 3.8 LPM (1.0 GPM) maximum flowrate, Culinary spring spout with metal reinforced hose, Spray outlet, 292 mm (11-1/2") spout reach, 1219 mm (48") high, Less supply risers, Ceramic cartridge, Less drain

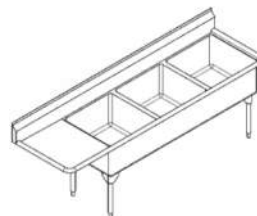
Lawler - Mixing Valve



☒ **570-86820** Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, Nickel plated finish, Lead free brass body construction, 1.9 - 30 LPM (0.5 - 8 GPM) range for flowrate , To adjust the mixed outlet temperature of the valve, remove the cap to gain access to the adjusting spindle. The spindle should be rotated-clockwise to reduce the temperature, counter-clockwise to increase the temperature until the desired set point is reached, The temperature is adjusted with the help of Spindle, 4-7/8" (124 mm) Height, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) outlet, internal checks, ASSE 1070 approved Certified to CSA B125.3 for ASSE 1070 applications, 95-115 °F outlet water temperature range, Offers choice of temperature settings from 95° through 115 °F., 125 PSI max hydrostatic pressure, ±20% pressure variation, 11 LPM (3 GPM) tempered flowrate @ 5 PSI pressure drop, 40-80 °F, 10 °F, 180 °F max, 7 GPM flowrate @ 45 PSI, ±5 °F, Protects against scalding and chilling

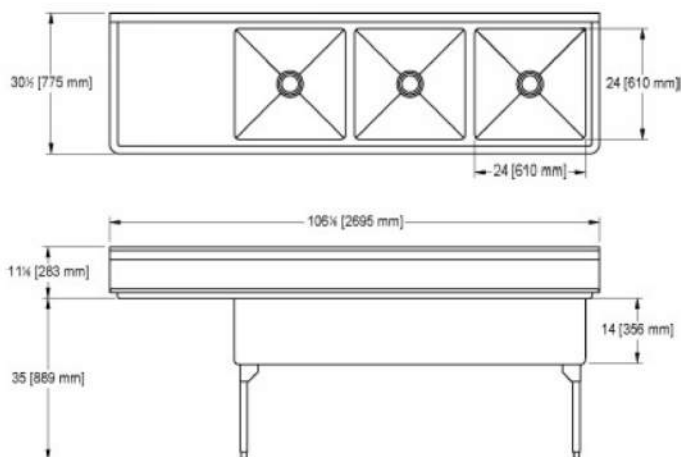
Franke Commercial- Sink

☒ **WTL2472L-1-2**



203 mm (8") centerset, Without faucet ledge, 14 gauge Type 304 Stainless steel Polished to #4 satin finish. Finished with rolled rim, With backsplash, Designed for hygiene and food safety, Drainboard is located to the left of sink bowl, Stainless steel tubular legs with adjustable feet for leveling, Center waste location, 38 mm (1-1/2") (DN38) brass tailpiece, 89 mm (3-1/2") crumb cup strainer, waste fitting included, Compliances and certifications: ASME A112.19.3 compliant, CSA B45.4 compliant, Bowl Dimension: Left bowl is 610 mm (24") long, middle bowl is 610 mm (24") long and right bowl is 610 mm (24") long, Left bowl is 610 mm (24") wide, middle bowl is 610 mm (24") wide and right bowl is 610 mm (24") wide, Left bowl is 356 mm (14") deep, middle bowl is 356 mm (14") deep and right bowl is 356 mm (14") deep, Overall Dimension: 2502 mm (98-1/2") long, 724 mm (28-1/2") wide, 1118 mm (44") high.

Refer to the product specification sheet for complete information



Note:



R-S-3

**Double compartment -
Counter mounted - Drop-in**
Commercial sinks

- Type 304 Stainless steel

McGuire - P-Trap



☒ **8912C** Heavy cast brass, Adjustable P-Trap, 292 mm (11-1/2") length, With cleanout plug, Shallow steel flange, Neoprene gasket, 17 gauge seamless tubular wall bend, Slipnuts

McGuire - Supply



☒ **LFH165LKN3** Lead Free, Supply kit, Chrome-plated finish, Loose key handle

Note:



R-S-4

- Type 316 Stainless steel

**Single compartment - Floor
mounted -
Mop service sinks**

To be specified

Delta Commercial - Faucet



☑ **28C2364** Manual, Wall-hung, 197 - 210 mm (7-3/4" - 8-1/4") adjustable centerset, Brass construction, Mop sink faucet, Rough chrome finish, No flowrate, 267 mm (10-1/2") long rigid spout with pail hook, No flow control, CER-TECK 1/4 turn ceramic cartridge, Less drain, ANSI A117.1 compliant

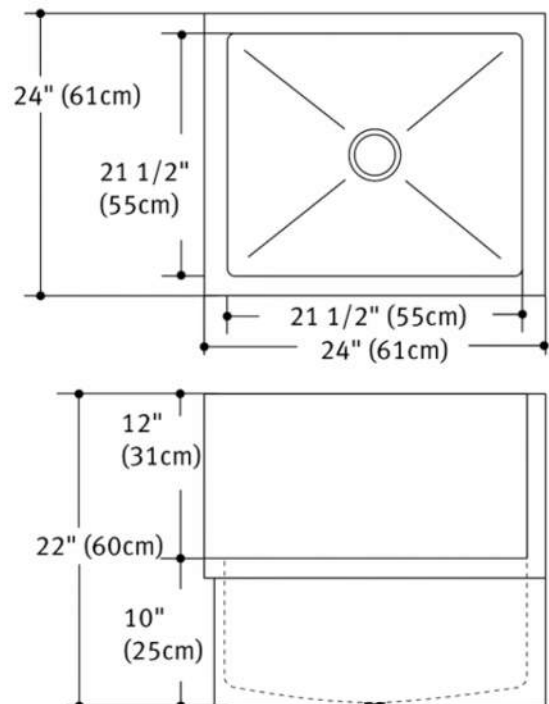
Franke Commercial- Sink

☑ **FSS222210-316-1**



Floor mounted, Stainless steel, Polished to #4 satin finish, Mop service sinks, Single compartment, With 305 mm (12") high backsplash and integral corner splashguard, 254 mm (10") deep, 546 mm (21-1/2") long, 546 mm (21-1/2") wide, 559 mm (22") high, 610 mm (24") wide, Without faucet ledge, Center waste location

Refer to the product specification sheet for complete information



Note:



R-EW-1

Eye wash

Emergency Equipment
Eye wash with stainless
steel bowl

To be specified

Lawler - Mixing Valve



☒ **911E/F-Unit 84908** Emergency mixing valve, Thermostatic High-low master water mixing valve, Rough bronze finish, Temperature adjustment shall be vandal-resistant, 229 x 205 x 127 mm (9" x 8" x 5") , In the event that the liquid motor fails, the control mechanism closes off the hot water port with the reverse seat and fully opens the internal variable bypass to allow cold water flow, The control mechanism shall employ a liquid-filled thermostatic motor to drive the valve without additional power requirements. The control mechanism shall employ a stainless steel sliding piston control device with reverse seat closure and both fixed and variable cold water bypass, 32 mm (1-1/4") NPT inlet, 32 mm (1-1/4") NPT outlet, In the event of interruption of the cold water supply, the control mechanism closes off the hot water port, stopping all flow. Positive hot water shut-off, Listed to ASSE 1071, Outlet Thermometer, 85 F, 70-90 F, 125 PSI max inlet pressure, 120 F Recommended inlet temperature, 65 PSI recommended operating pressure, 7.5 LPM (2 GPM) tempered flowrate @ 5 PSI pressure drop, 11 LPM (3 GPM) tempered flowrate @ 10 PSI pressure drop, 18 LPM (5 GPM) tempered flowrate @ 20 PSI pressure drop, 26 LPM (7 GPM) tempered flowrate @ 20 PSI pressure drop, 38 LPM (10 GPM) tempered flowrate @ 40 PSI pressure drop

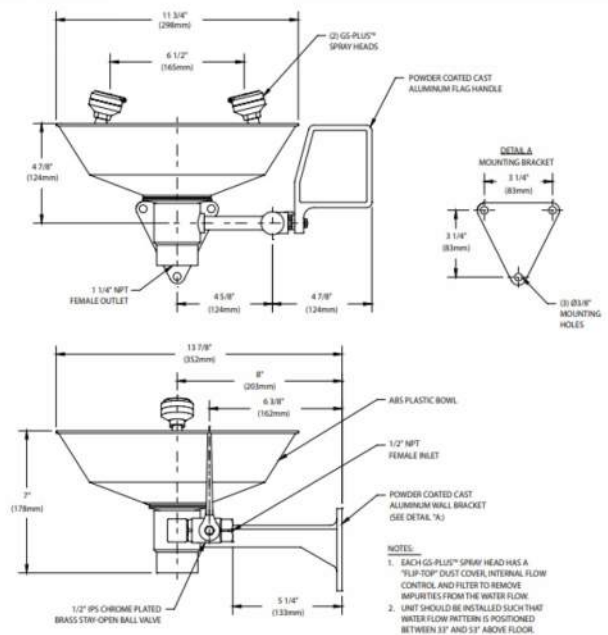
Guardian- Emergency Equipment

☒ **G1814**



Eye wash with stainless steel bowl, Wall-hung, Corrosion resistant powder coated finish, 283 mm (11-1/8") Ø bowl size, Two GS-Plus spray heads with flip top dust cover each, 13 mm (1/2") Ø IPS Chrome plated brass stay open ball valve, Eye wash

Refer to the product specification sheet for complete information



Note:

*Wall mount and surface mounted -
Surface installation*

To be specified

McGuire - Stop Valves



☒ **LFHST11LK** Lead Free, Chrome-plated finish, 3/8" I.P.S x 3/8" O.D, Loose key handle, Full turn brass stem

McGuire - P-Trap



☒ **8872C** Heavy cast brass, Adjustable P-Trap, 292 mm (11-1/2") distance, With cleanout plug, Shallow steel flange, Neoprene gasket, Slipnuts, 17 gauge seamless tubular wall bend, ASME A112.18.2 CSA B125.2, CSA compliant

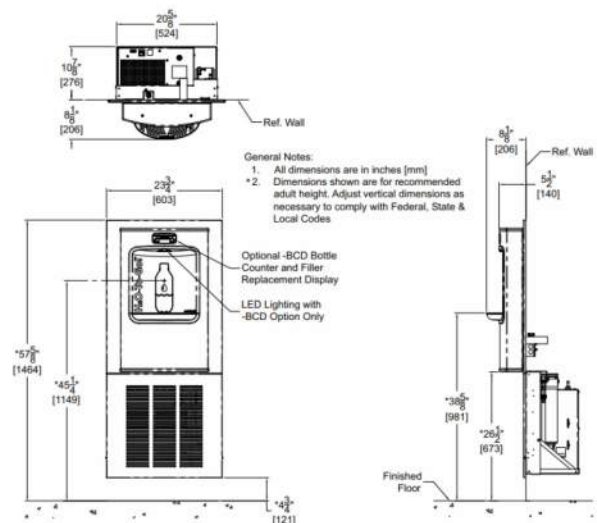
Murdock Mfg- Drinking Fountain

☒ **BF168**



Sensor Operated, Wall mount and surface mounted, Surface installation, Type 304 stainless steel, 3.79 LPM (1 GPM) fill rate, Laminar flow water supply, No bubbler included, 1 station, Indoor application, Cooling system shall use R-134a refrigerant and be capillary tube regulated, 100-micron mesh inlet strainer, ADA compliant when installed without shroud option

Refer to the product specification sheet for complete information



Note:

*Pressure balancing tub and shower
valve with trim*

To be specified

Chicago Faucets - Showerhead



☑ **621-LCP** Wall Mounted, Full Spray, 1.5 GPM (5.5 LPM), 1/2 " (13 mm) Ø NPT Female Thread inlet, 25°- 30° spray angle, 80 PSI max operating pressure, Watersense Listed

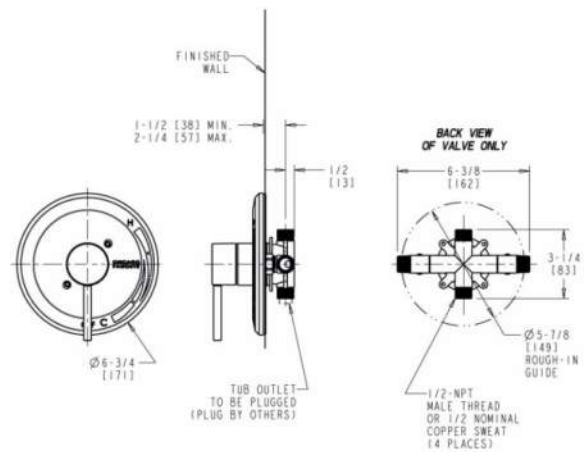
Chicago Faucets- Complete Shower Trim

☑ **SH-PB1-00-000**



Polished chrome finish, Pressure balancing tub and shower system with valve trim, Cold to hot cycle, Wall mounted, Round, 216 mm (8-1/2") Ø trim size, Lever handle, Pressure balancing valve, Built-in integral check stops, Pressure balancing valve cartridge, 13 mm (1/2") nominal Ø copper sweat inlet, 13 mm (1/2") nominal Ø copper sweat outlet, ADA compliant

Refer to the product specification sheet for complete information



Note:



R-SH-1 & R-SH-2

Channel, Waterline Shower



AISI type 304 stainless steel.

To be specified

Outlet Option

- ☐ PVC Socket
- ☐ ABS Socket
- ☐ Threaded
- ☐ End Outlet

Product Option

- ☐ Vandal-resistant grate

Top Size W x L

- ☒ 82 x 660 mm (3-1/4" x 26")
- ☐ 82 x 762 mm (3-1/4" x 30")
- ☐ 82 x 914 mm (3-1/4" x 36")
- ☐ 82 x 1067 mm (3-1/4" x 42")
- ☐ 82 x 1220 mm (3-1/4" x 48")
- ☐ 82 x 1372 mm (3-1/4" x 54")
- ☐ 82 x 1524 mm (3-1/4" x 60")
- ☐ 82 x 1829 mm (3-1/4" x 72")

Grate Option

- ☐ Special (specify - 100pc Minimum)
- ☐ Copenhagen

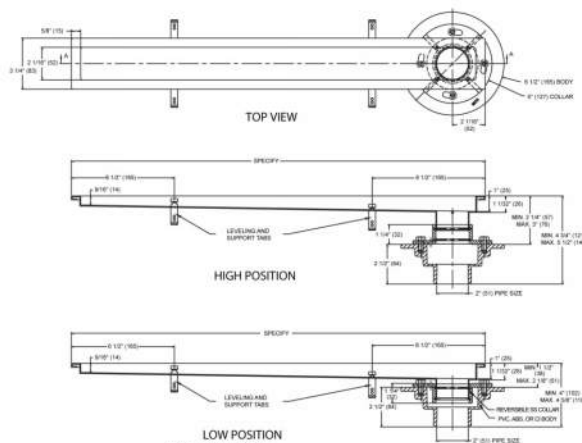
BLÜCHER- Trench Drain

☒ **BWC-126**



BWC-100, AISI type 304 stainless steel, Waterline Shower, Channel, 50 mm (2") no Hub, 2 1/8" (55mm) no hub, epoxy coated cast iron, Vienna (standard), reversible cast stainless steel collar with dual O-ring seals, weepholes

Refer to the product specification sheet for complete information



Dimensional Chart		
Model	Pipe Size D	Top Size W x L
BWC-126	2" (50) No Hub	3-1/4" x 26" (82x660)
BWC-130	2" (50) No Hub	3-1/4" x 30" (82x762)
BWC-136	2" (50) No Hub	3-1/4" x 36" (82x914)
BWC-142	2" (50) No Hub	3-1/4" x 42" (82x1067)
BWC-148	2" (50) No Hub	3-1/4" x 48" (82x1220)
BWC-160	2" (50) No Hub	3-1/4" x 60" (82x1524)
BWC-172	2" (50) No Hub	3-1/4" x 72" (82x1829)

Note:

For Commercial Applications

Job Name _____

Contractor _____

Job Location _____

Approval _____

Engineer _____

Contractor's P.O. No. _____

Approval _____

Representative _____

Tag _____

WSD-CP

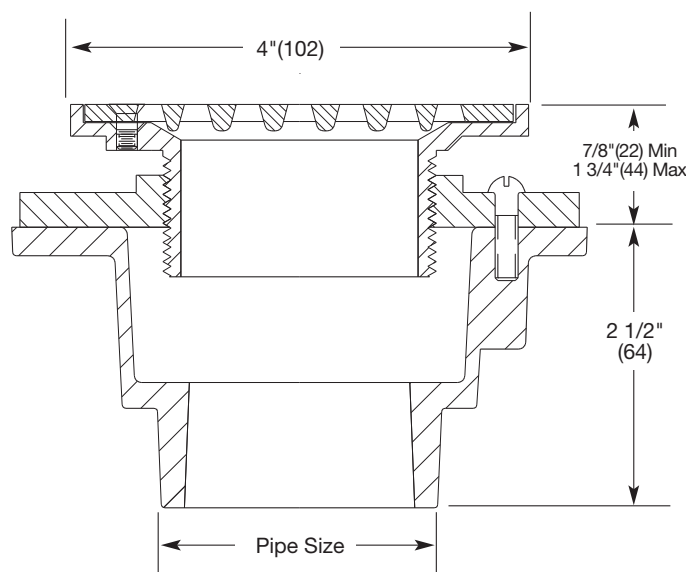
Heavy Duty Shower Floor Drain with Round Adjustable Strainer

Specification

Watts WSD-CP heavy duty shower floor drain with round chrome plated brass adjustable strainer assembly.



Pipe Sizing (Select One)		
Suffix	Description	
-1 1/2T	1 1/2" Threaded	☐
-2ABS	2"(51) ABS	☐
-2NH	2"(51) No Hub	☐
-2THD	2"(51) Threaded	☐



NOTICE

The information contained herein is not intended to replace the full product installation and safety information available or the experience of a trained product installer. You are required to thoroughly read all installation instructions and product safety information before beginning the installation of this product.

Watts product specifications in U.S. customary units and metric are approximate and are provided for reference only. For precise measurements, please contact Watts Technical Service. Watts reserves the right to change or modify product design, construction, specifications, or materials without prior notice and without incurring any obligation to make such changes and modifications on Watts products previously or subsequently sold.



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ES-WD-WSD-CP-CAN 2015

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C-WC-1

Toilet - Floor mounted with floor outlet

AFWALL® MILLENNIUM™ FloWise®

To be specified

Centoco - Seat



☒ 500STSCFE-001

Delta Commercial - Flush Valve



☒ 81T201SP-42-MMO

American Standard- Toilet

☒ 3461001.020



Toilet, Floor mounted with floor outlet, Toilet operates in the range of 4.2 to 6.0 LPF (1.1 - 1.6 GPF), Vitreous china, White finish, EverClean® antimicrobial surface, Elongated bowl, 419 mm (16-1/2") rim height, 254 mm (10") to 305 mm (12") rough-in from wall to the center of waste outlet, Direct-fed siphon jet flush action, 38 mm (1-1/2") top spud, Flush valve by others, Fully-glazed 54 mm (2-1/8") trapway, Condensation channel, Toilet seat not included, Two (2) colour-matched bolt caps with retainers (481310-100).

Consisting of:

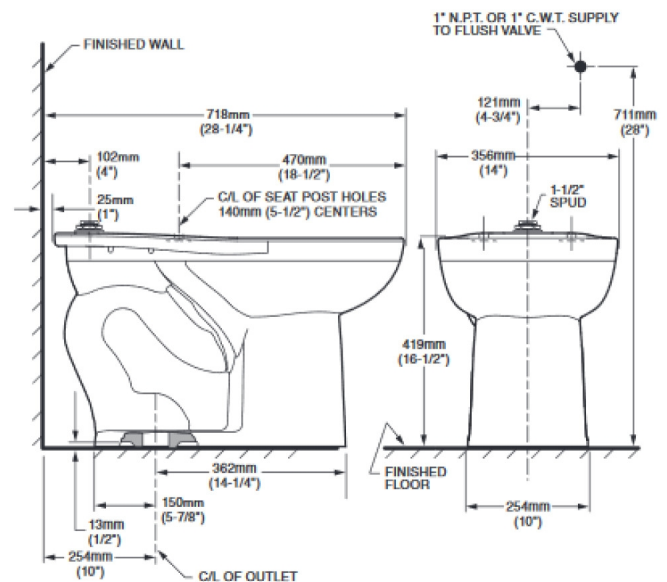
Overall Dimensions: 356 mm (14") wide x 718 mm (28-1/4") from finished wall x. Water Surface: 254 x 305 mm (10" x 12") water surface area.

Map Score: >=1000 MaP® flush score (when use with proper flush valve).

Compliances and certifications: ASME A112.19.2 compliant, CSA B45.1 compliant.

Refer to the product specification sheet for complete information

3461.001/3462.001



Note: Rec center water closet / child care staff water closet



C-WC-2

AFWALL® MILLENNIUM™
FloWise®



Toilet - Floor mounted with
floor outlet

To be specified

Centoco - Seat



☑ 500STSCCFE-001

Delta Commercial - Flush Valve



☑ 81T201SP-42-MMO

Franke Commercial - Backrest



☑ **CM-16104-WM** wall mounting, back rest, solid core plastic laminate panel back, Antique white, 305 mm (12") wide, 102 mm (4") high, 137 mm (5-3/8"), 18 gauge stainless steel bar with #4 gloss with flanges and covers, concealed snap flanges and mounting hardware included, Provide adequate backing in wall for support and comply to local codes for barrier free requirements

American Standard- Toilet

☑ **3461001.020**



Toilet, Floor mounted with floor outlet, Toilet operates in the range of 4.2 to 6.0 LPF (1.1 - 1.6 GPF), Vitreous china, White finish, EverClean® antimicrobial surface, Elongated bowl, 419 mm (16-1/2") rim height, 254 mm (10") to 305 mm (12") rough-in from wall to the center of waste outlet, Direct-fed siphon jet flush action, 38 mm (1-1/2") top spud, Flush valve by others, Fully-glazed 54 mm (2-1/8") trapway, Condensation channel, Toilet seat not included, Two (2) colour-matched bolt caps with retainers (481310-100).

Consisting of:

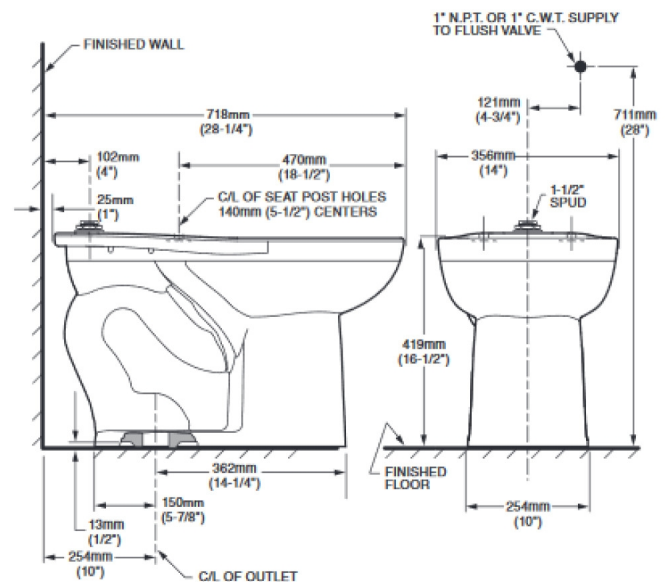
Overall Dimensions: 356 mm (14") wide x 718 mm (28-1/4") from finished wall x. Water Surface: 254 x 305 mm (10" x 12") water surface area.

Map Score: >=1000 MaP® flush score (when use with proper flush valve).

Compliances and certifications: ASME A112.19.2 compliant, CSA B45.1 compliant.

Refer to the product specification sheet for complete information

3461.001/3462.001



Note:

	C-WC-3	Toilet - Floor mounted with floor outlet
	CADET FloWise®	

To be specified

Centoco - Seat



☒ **500STSCCFE-001** FAST-N-LOCK, For elongated bowl, Open front, Heavy-duty, For commercial applications, Polypropylene, Toilet seat, Less seat cover, Plastic commercial check hinges, and Stainless steel hinge pin, Specified in White finish, FAST-N-LOCK mounting system takes the guess work out when tightening the hardware. The specially designed fasteners in click" when the appropriate torque is reached. The bolt and nut material shall be stainless steel, Dimensions:25 mm (1") high, 473 mm (18-5/8") long, 371 mm (14-5/8") wide.

McGuire - Supply



☒ **LFBV172** CONVERTIBLE™ Commercial Toilet Supply kit, consisting of (1) stop valve, (1) riser, (1) flange, Lead Free Brass body, Chrome-plated finish, 138 - 862 kPa (20 - 125 PSI) operating pressure, Convertible loose key/triangle handle, Quarter turn ball valve, Angle stop, Brass ball valve, C.P. wrought steel deep bell wall flange (standard), C.P. prefabricated 127 mm (5") copper sweat tube extension nipple, 305 mm (12") C.P. toilet flexible copper riser tube (standard), 13 mm (1/2") Sweat inlet x 10 mm (3/8") O.D. outlet, Compliances and certifications: AB 100 compliant, ASME A112.18.1 compliant, ASME A112.18.2-2 (risers), CSA B125.2 compliant (risers), Certified to NSF/ANSI 372, Certified to NSF/ANSI 61, UPC compliant.

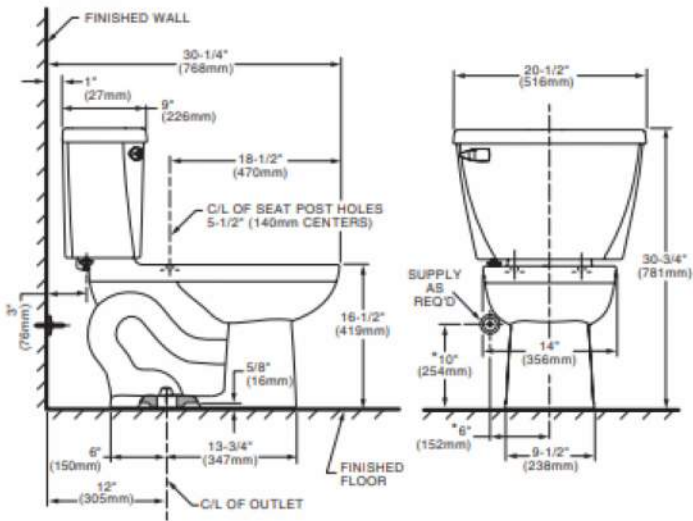
American Standard- Toilet

☒ **2467601.020**



Tank type Toilet, Floor mounted with floor outlet, Ultra High Efficiency UHET 4.2 LPF (1.1 GPF), Vitreous china, White finish, EverClean® antimicrobial surface, Elongated bowl, Right Height® rim at 419 mm (16-1/2"), Minimum 305 mm (12") rough-in from wall to the center of waste outlet, Siphon jet flush action, Manual, Polished chrome left-hand trip lever (7381886-201.0020A), Tank not lined, With tank cover locking device, Pressure-assisted flush, Speed Connect® tank/bowl coupling system, close-coupled flushometer tank, Fully-glazed 54 mm (2-1/8") trapway, Sanitary dam on bowl, Toilet seat not included, Two (2) bolt caps, Consisting of: 3483001 bowl, 4142601 tank and tank cover only with tank cover locking device tank, Overall Dimensions: 521 mm (20-1/2") wide x 768 mm (30-1/4") from finished wall x 781 mm (30-3/4") high Water Surface: 254 x 305 mm (10" x 12") water surface area Map Score: Compliances and certifications: ASME A112.19.2 compliant, CSA B45.1 compliant, EPA WaterSense® compliant.

Refer to the product specification sheet for complete information



Note:



**Toilet - Floor mounted with
floor outlet**

Bemis - Seat



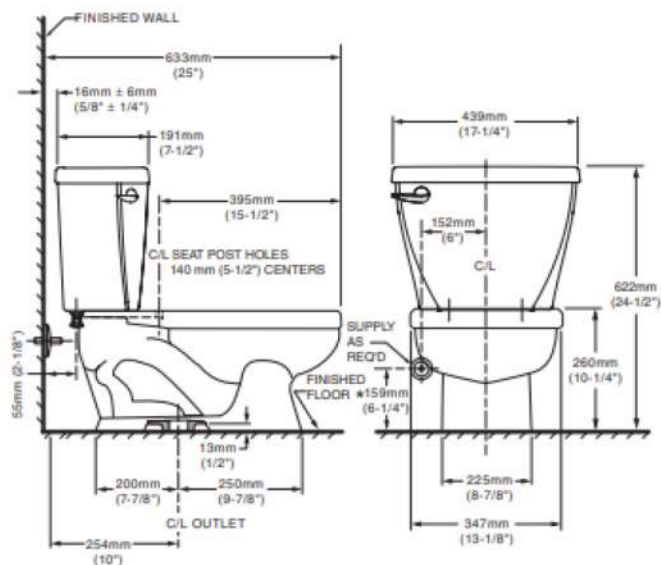
☒ 2315228.020



McGuire - Supply



Refer to the product specification sheet for complete information



Note:



C-L-1

LUCERNE™ WALL-HUNG LAVATORY

Wall-hung Lavatory
Vitreous china

To be specified

Delta Commercial - Faucet



☒ **590TF0190-060704A** Automatic no-touch, Counter mounted, Single hole centerset, Metal, Lavatory faucet, Polished chrome finish, 1.32 LPM (0.35 GPM) maximum flowrate, Mid-arc spout, Spray outlet, Hardwired, Less drain, ANSI A117.1 compliant

Lawler - Mixing Valve



☒ **570-86820** Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, Nickel plated finish, Lead free brass body construction, 1.9 - 30 LPM (0.5 - 8 GPM) range for flowrate , To adjust the mixed outlet temperature of the valve, remove the cap to gain access to the adjusting spindle. The spindle should be rotated-clockwise to reduce the temperature, counter-clockwise to increase the temperature until the desired set point is reached, The temperature is adjusted with the help of Spindle, 4-7/8" (124 mm) Height, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) outlet, internal checks, ASSE 1070 approved Certified to CSA B125.3 for ASSE 1070 applications, 95-115 °F outlet water temperature range, Offers choice of temperature settings from 95° through 115 °F., 125 PSI max hydrostatic pressure, ±20% pressure variation, 11 LPM (3 GPM) tempered flowrate @ 5 PSI pressure drop, 40-80 °F, 10 °F, 180 °F max, 7 GPM flowrate @ 45 PSI, ±5 °F, Protects against scalding and chilling

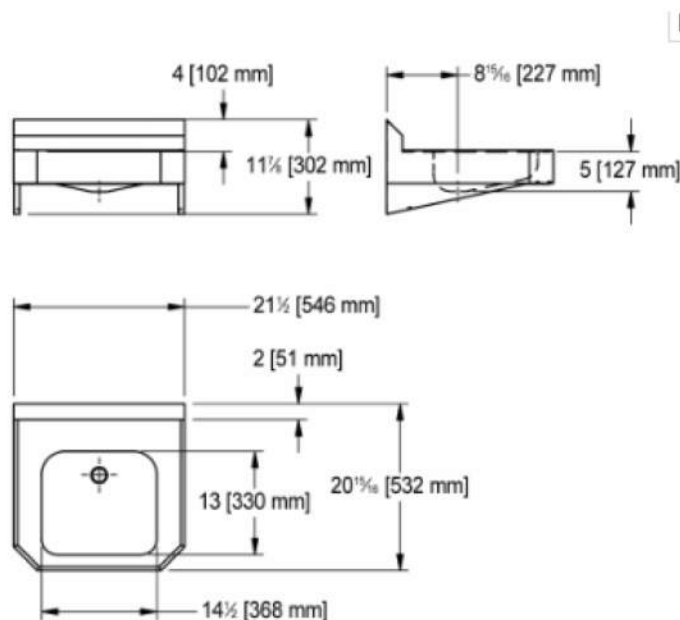
Franke Commercial- Basin

☒ **WHB2221-8-1**



Wall-hung Lavatory, Type 304 18 gauge Stainless steel, Polished to #4 satin finish, Single hole centerset, Single compartment, With overflow, With faucet ledge, Radius coved bowl corners, With backsplash, Center back waste location, For Wall Plate Carrier,
Overall Dimensions: 546 mm (21-1/2") long, 532 mm (20-15/16") wide, 302 mm (11-7/8") high,
Bowl Dimensions: 368 mm (14-1/2") long, 330 mm (13") wide, 127 mm (5") deep, Weight:

Refer to the product specification sheet for complete information



Note:



C-L-1

Wall-hung Lavatory
Vitreous china

LUCERNE™ WALL-HUNG LAVATORY

Delta Commercial - Faucet and Flush Valve Power Kit



☒ **060704A** Power kit, Supplies power for up to five Delta Commercial 590-PAHDF, 590TPA, 591TPA, 620TPA or 630TPA series electronic hardwire units

Watts - Carrier



☒ **CA-421** Single, Wall Plate, Plated hardware, required minimum space is 3-1/4" (83 mm)

Note:



C-L-1

Wall-hung Lavatory
Vitreous china

LUCERNE™ WALL-HUNG LAVATORY

McGuire - Fixture Drain



☒ **155A** Straight drain, Cast brass, Chrome-plated finish, Open grid PO plug, 7/32" (5.5 mm) Ø holes size, 17 gauge 32 mm (1-1/4") Ø tailpiece, 17 gauge 152 mm (6") long

McGuire - Supply



☒ **LFBV170** Lead Free, Supply kit, Chrome-plated finish, Convertible loose key/triangle handle, For commercial applications

McGuire - P-Trap



☒ **8872C** Heavy cast brass, Adjustable P-Trap, 292 mm (11-1/2") distance, With cleanout plug, Shallow steel flange, Neoprene gasket, Slipnuts, 17 gauge seamless tubular wall bend, ASME A112.18.2 CSA B125.2, CSA compliant

Note:



C-L-2

MURRO



Wall-hung Lavatory
Vitreous china

To be specified

Delta Commercial - Faucet



☑ **590TF0190-060704A** Automatic no-touch, Counter mounted, Single hole centerset, Metal, Lavatory faucet, Polished chrome finish, 1.32 LPM (0.35 GPM) maximum flowrate, Mid-arc spout, Spray outlet, Hardwired, Less drain, ANSI A117.1 compliant

Delta Commercial - Faucet and Flush Valve Power Kit



☑ **060704A** Power kit, Supplies power for up to five Delta Commercial 590-PAHDF, 590TPA, 591TPA, 620TPA or 630TPA series electronic hardwire units

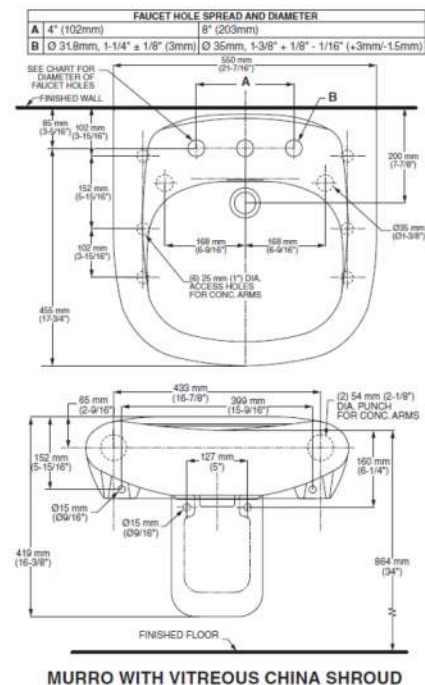
American Standard- Basin

☑ **0955001EC.020 0097000.020**



Vitreous china, Wall-hung, Lavatory, White finish, Single hole centerset, 127 mm (5") deep, 343 mm (13-1/2") long, 394mm (15-1/2") wide, 152 mm (6") high, 540 mm (21-1/4") wide, ANSI A117.1 compliant, EverClean® antimicrobial surface, Faucet ledge with recessed self-draining deck, Rear overflow, Acrylic shroud, conceals control box and thermostatic mixing valve (0097000), When installed with a below deck electronics faucet which has the control box, the accessories will not fit under the shroud and will need to be installed outside the shroud

Refer to the product specification sheet for complete information



Note:



C-L-2

Wall-hung Lavatory
Vitreous china

MURRO



Lawler - Mixing Valve



☒ **570-86820** Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, Nickel plated finish, Lead free brass body construction, 1.9 - 30 LPM (0.5 - 8 GPM) range for flowrate , To adjust the mixed outlet temperature of the valve, remove the cap to gain access to the adjusting spindle. The spindle should be rotated-clockwise to reduce the temperature, counter-clockwise to increase the temperature until the desired set point is reached, The temperature is adjusted with the help of Spindle, 4-7/8" (124 mm) Height, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) outlet, internal checks, ASSE 1070 approved Certified to CSA B125.3 for ASSE 1070 applications, 95-115 °F outlet water temperature range, Offers choice of temperature settings from 95° through 115 °F., 125 PSI max hydrostatic pressure, ±20% pressure variation, 11 LPM (3 GPM) tempered flowrate @ 5 PSI pressure drop, 40-80 °F, 10 °F, 180 °F max, 7 GPM flowrate @ 45 PSI, ±5 °F, Protects against scalding and chilling

McGuire - Fixture Drain



☒ **155WC** Offset drain, offset lavatory strainer, Lavatory, Cast brass, Chrome-plated finish, Inorganic microbial compound, 7/32" (5.5 mm) Ø holes size, Polished chrome, Cast brass elbow, 17 gauge 32 mm (1-1/4") Ø tailpiece, 146 mm (5-3/4") offset

McGuire - Supply



☒ **LFBV170** Lead Free, Supply kit, Chrome-plated finish, Convertible loose key/triangle handle, For commercial applications

Note:



C-L-2

Wall-hung Lavatory
Vitreous china

MURRO



McGuire - P-Trap



☒ **8872C** Heavy cast brass, Adjustable P-Trap, 292 mm (11-1/2") distance, With cleanout plug, Shallow steel flange, Neoprene gasket, Slipnuts, 17 gauge seamless tubular wall bend, ASME A112.18.2 CSA B125.2, CSA compliant

Watts - Carrier



☒ **WCA-411** Single floor-mounted lavatory carrier with concealed arms, For concealed arm carrier, Plated hardware, required minimum space is 3-5/8" (92 mm)

Note:



C-L-3

MEZZO

Semi-countertop Lavatory
Fine fire clay

To be specified

Delta Commercial - Faucet



☑ **590TF0190-060704A** Automatic no-touch, Counter mounted, Single hole centerset, Metal, Lavatory faucet, Polished chrome finish, 1.32 LPM (0.35 GPM) maximum flowrate, Mid-arc spout, Spray outlet, Hardwired, Less drain, ANSI A117.1 compliant

Delta Commercial - Faucet and Flush Valve Power Kit



☑ **060704A** Power kit, Supplies power for up to five Delta Commercial 590-PAHDF, 590TPA, 591TPA, 620TPA or 630TPA series electronic hardwire units

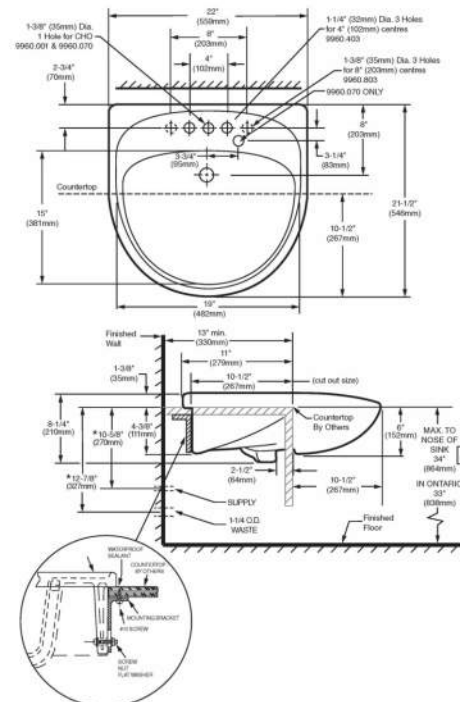
American Standard- Basin

☑ **9960001.020**



Fine fire clay, Counter mounted, Lavatory, White finish, Single hole centerset, 175 mm (6-7/8") deep, 483 mm (19") long, 381 mm (15") wide, 172 mm (6-25/32") high, 546 mm (21-1/2") wide, ANSI A117.1 compliant, With faucet ledge, Rear overflow, No shroud

Refer to the product specification sheet for complete information



Note:



C-L-3

Semi-countertop Lavatory
Fine fire clay

MEZZO

Lawler - Mixing Valve



☒ **570-86820** Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, Nickel plated finish, Lead free brass body construction, 1.9 - 30 LPM (0.5 - 8 GPM) range for flowrate , To adjust the mixed outlet temperature of the valve, remove the cap to gain access to the adjusting spindle. The spindle should be rotated-clockwise to reduce the temperature, counter-clockwise to increase the temperature until the desired set point is reached, The temperature is adjusted with the help of Spindle, 4-7/8" (124 mm) Height, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) outlet, internal checks, ASSE 1070 approved Certified to CSA B125.3 for ASSE 1070 applications, 95-115 °F outlet water temperature range, Offers choice of temperature settings from 95° through 115 °F., 125 PSI max hydrostatic pressure, ±20% pressure variation, 11 LPM (3 GPM) tempered flowrate @ 5 PSI pressure drop, 40-80 °F, 10 °F, 180 °F max, 7 GPM flowrate @ 45 PSI, ±5 °F, Protects against scalding and chilling

McGuire - Fixture Drain



☒ **155WC** Offset drain, offset lavatory strainer, Lavatory, Cast brass, Chrome-plated finish, Inorganic microbial compound, 7/32" (5.5 mm) Ø holes size, Polished chrome, Cast brass elbow, 17 gauge 32 mm (1-1/4") Ø tailpiece, 146 mm (5-3/4") offset

McGuire - Supply



☒ **LFBV170** Lead Free, Supply kit, Chrome-plated finish, Convertible loose key/triangle handle, For commercial applications

Note:



C-L-3

Semi-countertop Lavatory
Fine fire clay

MEZZO

McGuire - P-Trap



☒ **PW8090** Molded Closed cell vinyl (anti-microbial) wrapped cast brass, Glossy White, With Cleanout, ASME A112.18.2, CSA B125.2

Note:



C-L-4

Aqualyn Drop In Sink

Drop-in Lavatory
Vitreous china

To be specified

Delta Commercial - Faucet



☒ **590TF0190-060704A** Automatic no-touch, Counter mounted, Single hole centerset, Metal, Lavatory faucet, Polished chrome finish, 1.32 LPM (0.35 GPM) maximum flowrate, Mid-arc spout, Spray outlet, Hardwired, Less drain, ANSI A117.1 compliant

Lawler - Mixing Valve



☒ **570-86820** Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, Nickel plated finish, Lead free brass body construction, 1.9 - 30 LPM (0.5 - 8 GPM) range for flowrate , To adjust the mixed outlet temperature of the valve, remove the cap to gain access to the adjusting spindle. The spindle should be rotated-clockwise to reduce the temperature, counter-clockwise to increase the temperature until the desired set point is reached, The temperature is adjusted with the help of Spindle, 4-7/8" (124 mm) Height, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) outlet, internal checks, ASSE 1070 approved Certified to CSA B125.3 for ASSE 1070 applications, 95-115 °F outlet water temperature range, Offers choice of temperature settings from 95° through 115 °F., 125 PSI max hydrostatic pressure, ±20% pressure variation, 11 LPM (3 GPM) tempered flowrate @ 5 PSI pressure drop, 40-80 °F, 10 °F, 180 °F max, 7 GPM flowrate @ 45 PSI, ±5 °F, Protects against scalding and chilling

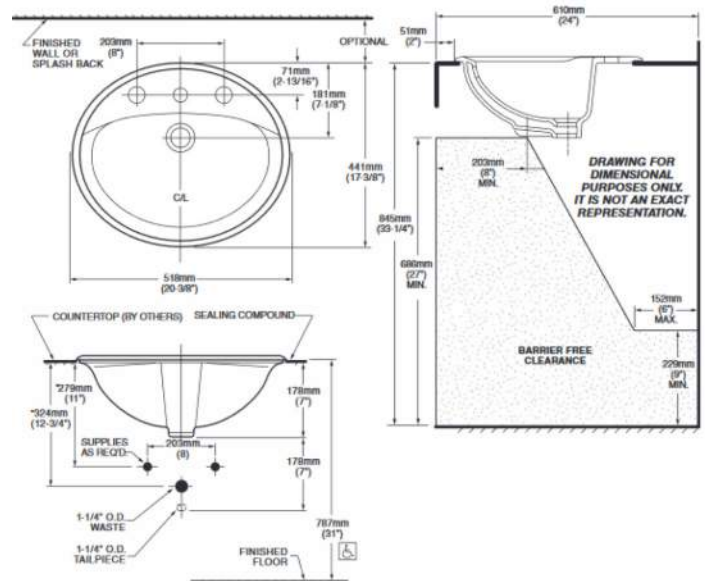
American Standard- Basin

☒ **0475047.020**



Vitreous china, Counter mounted, Lavatory, White finish, Single hole centerset, 143 mm (5-5/8") deep, 406 mm (16") long, 254 mm (10") wide, 178 mm (7") high, 441 mm (17-3/8") wide, With faucet ledge, Front overflow, No shroud

Refer to the product specification sheet for complete information



Note:



C-L-4

**Drop-in Lavatory
Vitreous china**

Aqualyn Drop In Sink

McGuire - Fixture Drain



☒ **155A** Straight drain, Cast brass, Chrome-plated finish, Open grid PO plug, 7/32" (5.5 mm) Ø holes size, 17 gauge 32 mm (1-1/4") Ø tailpiece, 17 gauge 152 mm (6") long

McGuire - Supply



☒ **LFBV170** Lead Free, Supply kit, Chrome-plated finish, Convertible loose key/triangle handle, For commercial applications

McGuire - P-Trap



☒ **8872C** Heavy cast brass, Adjustable P-Trap, 292 mm (11-1/2") distance, With cleanout plug, Shallow steel flange, Neoprene gasket, Slipnuts, 17 gauge seamless tubular wall bend, ASME A112.18.2 CSA B125.2, CSA compliant

Note:



C-L-4

**Drop-in Lavatory
Vitreous china**

Aqualyn Drop In Sink

**Delta Commercial - Faucet and Flush Valve
Power Kit**



☒ **060704A** Power kit, Supplies power for up to five Delta Commercial 590-PAHDF, 590TPA, 591TPA, 620TPA or 630TPA series electronic hardwire units

Note:



C-S-1

- Type 302 Stainless steel

Single compartment -
Counter mounted - Drop-in
Commercial sinks

To be specified

Chicago Faucets - Faucet



☒ **434-ABCP** Manual, Counter mounted, Single hole centerset, ECAST® brass construction, Sink faucet, Polished chrome finish, 5.7 LPM (1.5 GPM) maximum flowrate, Gooseneck spout, Spray outlet, 210 mm (8-1/4") spout reach, 432 mm (17") high, With supply, EPA WaterSense® compliant, Ceramic cartridge with volume control, Less drain, ANSI A117.1 compliant

Lawler - Mixing Valve



☒ **570-86820** Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, Nickel plated finish, Lead free brass body construction, 1.9 - 30 LPM (0.5 - 8 GPM) range for flowrate , To adjust the mixed outlet temperature of the valve, remove the cap to gain access to the adjusting spindle. The spindle should be rotated-clockwise to reduce the temperature, counter-clockwise to increase the temperature until the desired set point is reached, The temperature is adjusted with the help of Spindle, 4-7/8" (124 mm) Height, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) outlet, internal checks, ASSE 1070 approved Certified to CSA B125.3 for ASSE 1070 applications, 95-115 °F outlet water temperature range, Offers choice of temperature settings from 95° through 115 °F., 125 PSI max hydrostatic pressure, ±20% pressure variation, 11 LPM (3 GPM) tempered flowrate @ 5 PSI pressure drop, 40-80 °F, 10 °F, 180 °F max, 7 GPM flowrate @ 45 PSI, ±5 °F, Protects against scalding and chilling

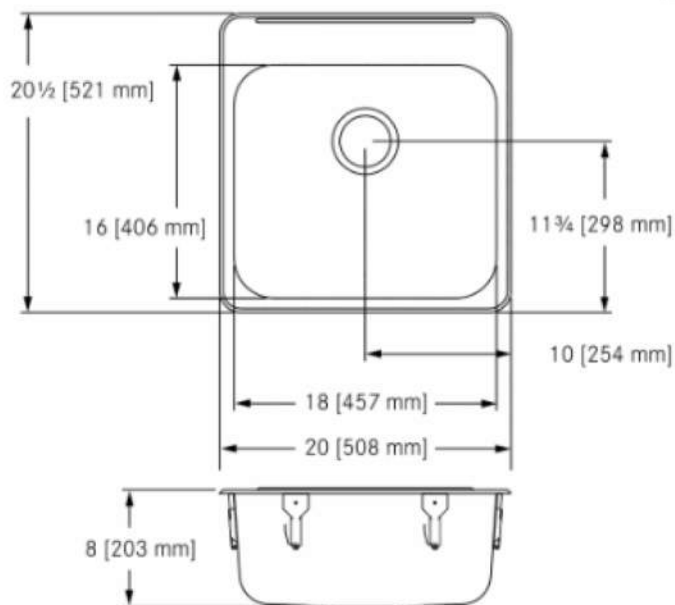
Franke Commercial- Sink

☒ **LBS6808-1-1**



Counter mounted, Stainless steel, Polished to #4 satin finish, Commercial sinks, Single compartment, Single hole centerset, 203 mm (8") deep, Left bowl is 457mm (18") long and right bowl is 305mm (12") long, 406 mm (16") wide, 203 mm (8") high, 521 mm (20-1/2") wide, With faucet ledge, Center back waste location, Factory applied rim seal

Refer to the product specification sheet for complete information



Note:



C-S-1

**Single compartment -
Counter mounted - Drop-in**
Commercial sinks

- Type 302 Stainless steel

McGuire - P-Trap



☒ **8912C** Heavy cast brass, Adjustable P-Trap, 292 mm (11-1/2") length, With cleanout plug, Shallow steel flange, Neoprene gasket, 17 gauge seamless tubular wall bend, Slipnuts

McGuire - Supply



☒ **LFH165LKN3** Lead Free, Supply kit, Chrome-plated finish, Loose key handle

Note:



C-S-2

- Molded stone

Single compartment - Wall-hung -
Laundry sink

To be specified

Delta Commercial - Faucet



☑ **27C4332** Manual, Counter mounted, 102 mm (4") centerset, Brass construction, Sink faucet, Polished chrome finish, 5.7 LPM (1.5 GPM) maximum flowrate, S-type spout, Vandal-resistant aerator, 153 mm (6") projection, 178 mm (7") high, CERTECK 1/4 turn ceramic cartridge, Less drain, ANSI A117.1 compliant

McGuire - P-Trap



☑ **8912C** Heavy cast brass, Adjustable P-Trap, 292 mm (11-1/2") length, With cleanout plug, Shallow steel flange, Neoprene gasket, 17 gauge seamless tubular wall bend, Slipnuts

McGuire - Supply



☑ **LFH165LKN3** Lead Free, Supply kit, Chrome-plated finish, Loose key handle

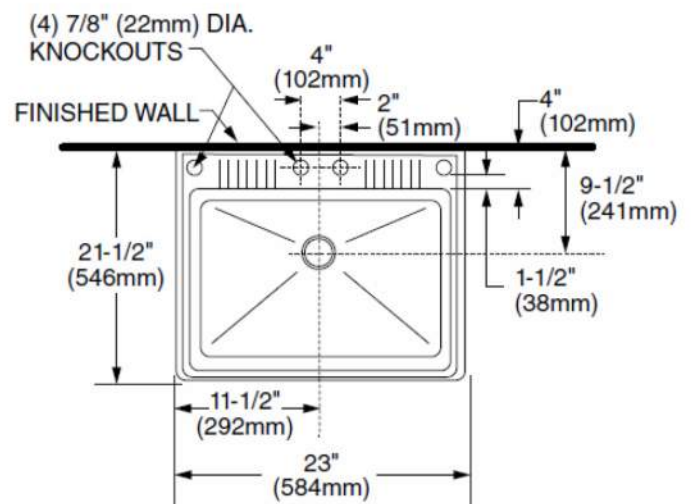
Fiat- Sink

☑ **L1100**



Wall-hung, Molded stone, White finish, Laundry sink, Single compartment, 102 mm (4") knockout center (field drilled), 341 mm (13-7/16") deep, Left bowl is 584 mm (23") long and right bowl is 381 mm (15") long, 445 mm (17-1/2") wide, 341 mm (13-7/16") high, 546 mm (21-1/2") wide, With faucet ledge, White molded plastic polymer side fillers and bottom tub support, assembled in field to the mounting brackets

Refer to the product specification sheet for complete information



Note:



C-S-3

- Type 304 Stainless steel

Double compartment -
Counter mounted - Drop-in
Commercial sinks

To be specified

Chicago Faucets - Faucet



☒ **434-ABCP** Manual, Counter mounted, Single hole centerset, ECAST® brass construction, Sink faucet, Polished chrome finish, 5.7 LPM (1.5 GPM) maximum flowrate, Gooseneck spout, Spray outlet, 210 mm (8-1/4") spout reach, 432 mm (17") high, With supply, EPA WaterSense® compliant, Ceramic cartridge with volume control, Less drain, ANSI A117.1 compliant

Lawler - Mixing Valve



☒ **570-86820** Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, Nickel plated finish, Lead free brass body construction, 1.9 - 30 LPM (0.5 - 8 GPM) range for flowrate , To adjust the mixed outlet temperature of the valve, remove the cap to gain access to the adjusting spindle. The spindle should be rotated-clockwise to reduce the temperature, counter-clockwise to increase the temperature until the desired set point is reached, The temperature is adjusted with the help of Spindle, 4-7/8" (124 mm) Height, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) outlet, internal checks, ASSE 1070 approved Certified to CSA B125.3 for ASSE 1070 applications, 95-115 °F outlet water temperature range, Offers choice of temperature settings from 95° through 115 °F., 125 PSI max hydrostatic pressure, ±20% pressure variation, 11 LPM (3 GPM) tempered flowrate @ 5 PSI pressure drop, 40-80 °F, 10 °F, 180 °F max, 7 GPM flowrate @ 45 PSI, ±5 °F, Protects against scalding and chilling

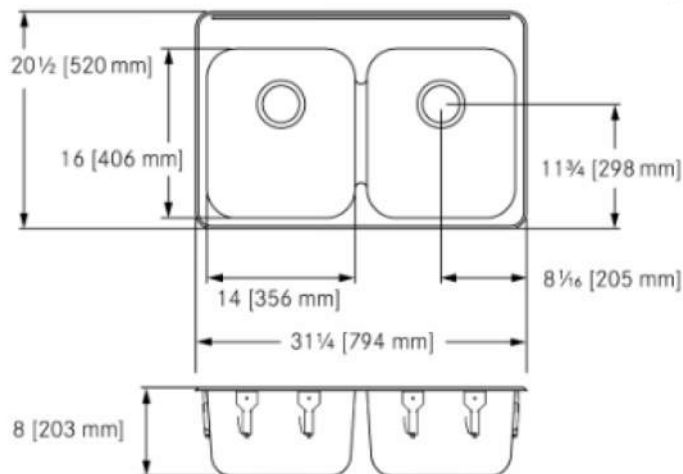
Franke Commercial- Sink

☒ **LBD6408P-1-1**



Counter mounted, Stainless steel, Polished to #4 satin finish, Commercial sinks, Double compartment, Single hole centerset, Left bowl is 203 mm (8") deep and right bowl is 203 mm (8") deep, Left bowl is 356 mm (14") long and right bowl is 356 mm (14") long, Left bowl is 406 mm (16") wide and right bowl is 406 mm (16") wide, 203 mm (8") high, 521 mm (20-1/2") wide, With faucet ledge, Center back waste location, Factory applied rim seal

Refer to the product specification sheet for complete information



Note:



C-S-3

**Double compartment -
Counter mounted - Drop-in**
Commercial sinks

- Type 304 Stainless steel

McGuire - P-Trap



☒ **8912C** Heavy cast brass, Adjustable P-Trap, 292 mm (11-1/2") length, With cleanout plug, Shallow steel flange, Neoprene gasket, 17 gauge seamless tubular wall bend, Slipnuts

McGuire - Supply



☒ **LFH165LKN3** Lead Free, Supply kit, Chrome-plated finish, Loose key handle

Note:



C-S-4

- Type 302 Stainless steel

Triple compartment -
Counter mounted - Drop-in
Commercial sinks

To be specified

Chicago Faucets - Faucet



☒ **919-613XKCAB** Manual, Counter mounted, Single hole centerset, ECAST® brass construction, Pre-rinse fitting, Chrome finish, 3.8 LPM (1.0 GPM) maximum flowrate, Culinary spring spout with metal reinforced hose, Spray outlet, 292 mm (11-1/2") spout reach, 1219 mm (48") high, Less supply risers, Ceramic cartridge, Less drain

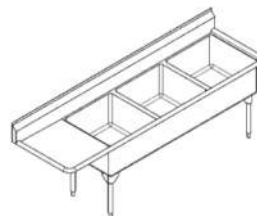
Lawler - Mixing Valve



☒ **570-86820** Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, Nickel plated finish, Lead free brass body construction, 1.9 - 30 LPM (0.5 - 8 GPM) range for flowrate , To adjust the mixed outlet temperature of the valve, remove the cap to gain access to the adjusting spindle. The spindle should be rotated-clockwise to reduce the temperature, counter-clockwise to increase the temperature until the desired set point is reached, The temperature is adjusted with the help of Spindle, 4-7/8" (124 mm) Height, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) outlet, internal checks, ASSE 1070 approved Certified to CSA B125.3 for ASSE 1070 applications, 95-115 °F outlet water temperature range, Offers choice of temperature settings from 95° through 115 °F., 125 PSI max hydrostatic pressure, ±20% pressure variation, 11 LPM (3 GPM) tempered flowrate @ 5 PSI pressure drop, 40-80 °F, 10 °F, 180 °F max, 7 GPM flowrate @ 45 PSI, ±5 °F, Protects against scalding and chilling

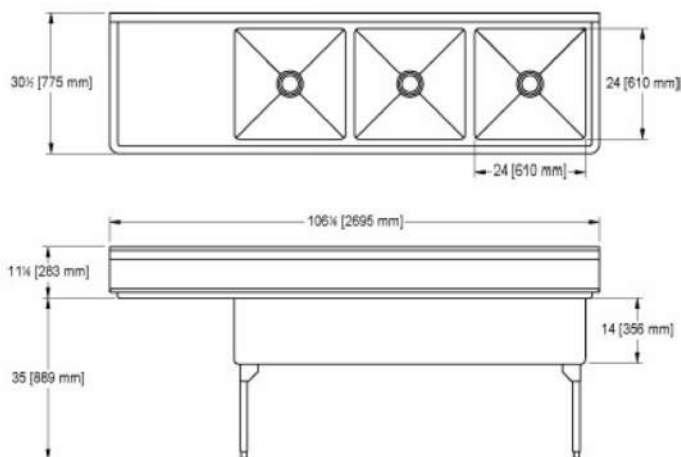
Franke Commercial- Sink

☒ **WTL2472L-1-2**



203 mm (8") centerset, Without faucet ledge, 14 gauge Type 304 Stainless steel Polished to #4 satin finish. Finished with rolled rim, With backsplash, Designed for hygiene and food safety, Drainboard is located to the left of sink bowl, Stainless steel tubular legs with adjustable feet for leveling, Center waste location, 38 mm (1-1/2") (DN38) brass tailpiece, 89 mm (3-1/2") crumb cup strainer, waste fitting included, Compliances and certifications: ASME A112.19.3 compliant, CSA B45.4 compliant, Bowl Dimension: Left bowl is 610 mm (24") long, middle bowl is 610 mm (24") long and right bowl is 610 mm (24") long, Left bowl is 610 mm (24") wide, middle bowl is 610 mm (24") wide and right bowl is 610 mm (24") wide, Left bowl is 356 mm (14") deep, middle bowl is 356 mm (14") deep and right bowl is 356 mm (14") deep, Overall Dimension: 2502 mm (98-1/2") long, 724 mm (28-1/2") wide, 1118 mm (44") high.

Refer to the product specification sheet for complete information



Note:



C-S-4

**Triple compartment -
Counter mounted - Drop-in**
Commercial sinks

- Type 302 Stainless steel

McGuire - P-Trap



☒ **8903C** Heavy cast brass, Adjustable P-Trap, 349 mm (13-3/4") length, With cleanout plug, Shallow steel flange, Seamless tubular brass bend, Slipnuts

McGuire - Supply



☒ **LFH165LKN3** Lead Free, Supply kit, Chrome-plated finish, Loose key handle

Note:



C-S-5

Steel Queen - Stainless steel

Single compartment -
Counter mounted - Drop-in
Kitchen sink

To be specified

Chicago Faucets - Faucet



☒ **434-ABCP** Manual, Counter mounted, Single hole centerset, ECAST® brass construction, Sink faucet, Polished chrome finish, 5.7 LPM (1.5 GPM) maximum flowrate, Gooseneck spout, Spray outlet, 210 mm (8-1/4") spout reach, 432 mm (17") high, With supply, EPA WaterSense® compliant, Ceramic cartridge with volume control, Less drain, ANSI A117.1 compliant

Lawler - Mixing Valve



☒ **570-86820** Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, Nickel plated finish, Lead free brass body construction, 1.9 - 30 LPM (0.5 - 8 GPM) range for flowrate , To adjust the mixed outlet temperature of the valve, remove the cap to gain access to the adjusting spindle. The spindle should be rotated-clockwise to reduce the temperature, counter-clockwise to increase the temperature until the desired set point is reached, The temperature is adjusted with the help of Spindle, 4-7/8" (124 mm) Height, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) outlet, internal checks, ASSE 1070 approved Certified to CSA B125.3 for ASSE 1070 applications, 95-115 °F outlet water temperature range, Offers choice of temperature settings from 95° through 115 °F., 125 PSI max hydrostatic pressure, ±20% pressure variation, 11 LPM (3 GPM) tempered flowrate @ 5 PSI pressure drop, 40-80 °F, 10 °F, 180 °F max, 7 GPM flowrate @ 45 PSI, ±5 °F, Protects against scalding and chilling

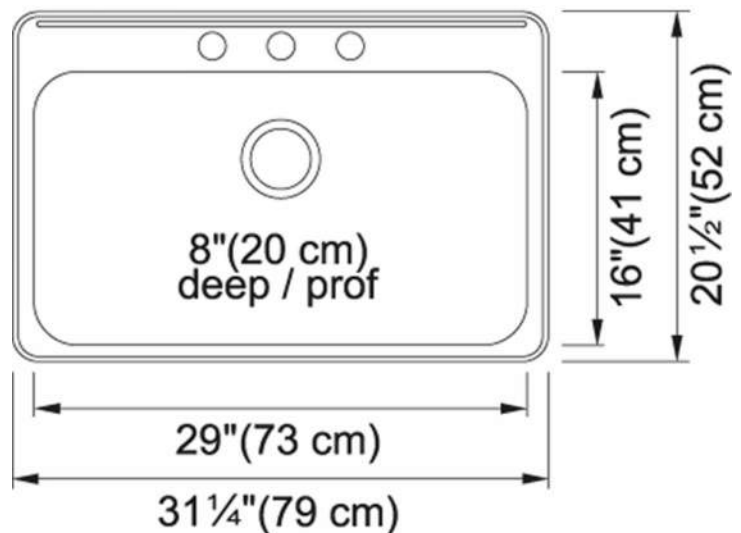
Kindred- Sink

☒ **QSLA2031-8-1**



Steel Queen, Counter mounted, Stainless steel, Satin Finished Bowl with Mirror Finished Rim, Kitchen sink, Single compartment, Single hole centerset, 203 mm (8") deep, 737 mm (29") long, 406 mm (16") wide, 203 mm (8") high, 521 mm (20-1/2") wide, With faucet ledge, Rear waste location

Refer to the product specification sheet for complete information



Note:



C-S-5

Single compartment -
Counter mounted - Drop-in
Kitchen sink

Steel Queen - Stainless steel

McGuire - P-Trap



☒ **8912C** Heavy cast brass, Adjustable P-Trap, 292 mm (11-1/2") length, With cleanout plug, Shallow steel flange, Neoprene gasket, 17 gauge seamless tubular wall bend, Slipnuts

McGuire - Supply



☒ **LFH165LKN3** Lead Free, Supply kit, Chrome-plated finish, Loose key handle

Note:



C-S-6

- Type 316 Stainless steel

Single compartment - Floor
mounted -
Mop service sinks

To be specified

Delta Commercial - Faucet



☒ **28C2364** Manual, Wall-hung, 197 - 210 mm (7-3/4" - 8-1/4") adjustable centerset, Brass construction, Mop sink faucet, Rough chrome finish, No flowrate, 267 mm (10-1/2") long rigid spout with pail hook, No flow control, CER-TECK 1/4 turn ceramic cartridge, Less drain, ANSI A117.1 compliant

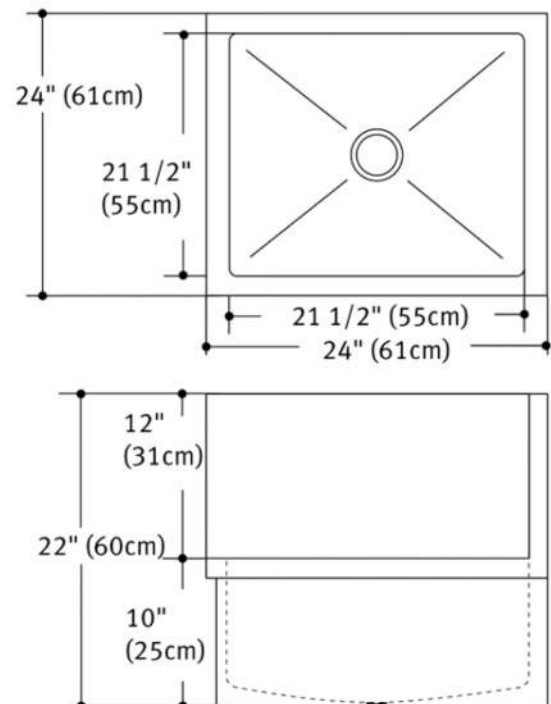
Franke Commercial- Sink

☒ **FSS222210-316-1**



Floor mounted, Stainless steel, Polished to #4 satin finish, Mop service sinks, Single compartment, With 305 mm (12") high backsplash and integral corner splashguard, 254 mm (10") deep, 546 mm (21-1/2") long, 546 mm (21-1/2") wide, 559 mm (22") high, 610 mm (24") wide, Without faucet ledge, Center waste location

Refer to the product specification sheet for complete information



Note:



C-EW-1

Eye wash

Emergency Equipment
Eye wash with stainless
steel bowl

To be specified

Lawler - Mixing Valve



☒ **911E/F-Unit 84908** Emergency mixing valve, Thermostatic High-low master water mixing valve, Rough bronze finish, Temperature adjustment shall be vandal-resistant, 229 x 205 x 127 mm (9" x 8" x 5") , In the event that the liquid motor fails, the control mechanism closes off the hot water port with the reverse seat and fully opens the internal variable bypass to allow cold water flow, The control mechanism shall employ a liquid-filled thermostatic motor to drive the valve without additional power requirements. The control mechanism shall employ a stainless steel sliding piston control device with reverse seat closure and both fixed and variable cold water bypass, 32 mm (1-1/4") NPT inlet, 32 mm (1-1/4") NPT outlet, In the event of interruption of the cold water supply, the control mechanism closes off the hot water port, stopping all flow. Positive hot water shut-off, Listed to ASSE 1071, Outlet Thermometer, 85 F, 70-90 F, 125 PSI max inlet pressure, 120 F Recommended inlet temperature, 65 PSI recommended operating pressure, 7.5 LPM (2 GPM) tempered flowrate @ 5 PSI pressure drop, 11 LPM (3 GPM) tempered flowrate @ 10 PSI pressure drop, 18 LPM (5 GPM) tempered flowrate @ 20 PSI pressure drop, 26 LPM (7 GPM) tempered flowrate @ 20 PSI pressure drop, 38 LPM (10 GPM) tempered flowrate @ 40 PSI pressure drop

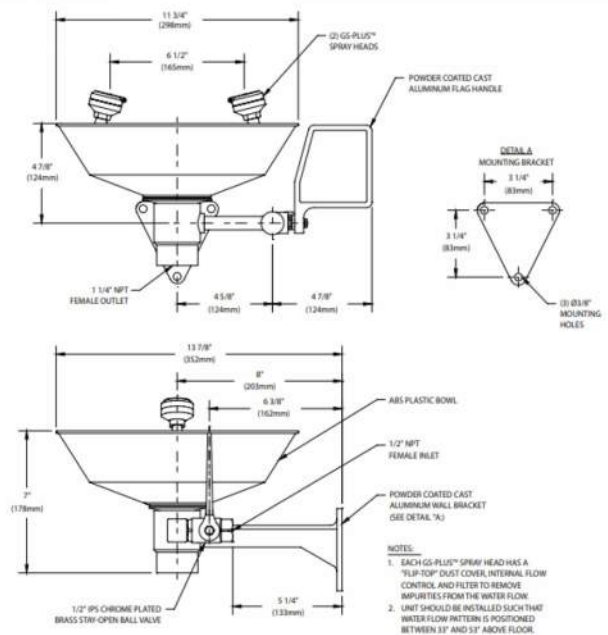
Guardian- Emergency Equipment

☒ **G1814**



Eye wash with stainless steel bowl, Wall-hung, Corrosion resistant powder coated finish, 283 mm (11-1/8") Ø bowl size, Two GS-Plus spray heads with flip top dust cover each, 13 mm (1/2") Ø IPS Chrome plated brass stay open ball valve, Eye wash

Refer to the product specification sheet for complete information



Note:

HYDRANTS (PLUMBING SYSTEMS)

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Submittals

- .1 Submit Shop Drawings and/or catalogue cuts of all items supplied in accordance with requirements of Section 20 05 03 - SHOP DRAWINGS.

PART 2 - PRODUCTS

2.1 Materials

- .1 Hydrants shall be J. R. Smith, Zurn, Mifab, or Watts, equal to the following series.
- .2 Ground hydrants shall be non-freeze, key operated with 19 mm (3/4 in.) hose connection, removable nylon or bronze seat, 19 mm (3/4 in.) IPS female inlet tailpiece, brass lower valve casting and brass hydrant head enclosed in a nickel-bronze surface access box with key operated hinged cover. Depth of bury shall be 1500 mm (5 ft.). Valve shall be encased in gravel from bottom to approximately 300 mm (12 in.) below grade. Carefully determine final grade elevation before setting hydrant. J.R. Smith 5810NB, Zurn ZN1360, Mifab MHY-60, Watts HY-500.
- .3 Provide wall hydrants as follows: non-freeze, key operated with 19 mm (3/4 in.) hose connection, removable nylon or bronze seat, 19 mm (3/4 in.) ground joint union inlet, brass operating parts and nickel bronze access box with polished cover. Provide length of wall sleeve that suits location. J.R. Smith 5509QTNB, Zurn Z1300, Mifab MHY-20, Watts HY-725.
- .4 Interior wall hydrant hose bib: concealed, moderate climate, anti-siphon, narrow wall hydrant for narrow wall installation. Complete with integral vacuum breaker. Bronze head, seat casting, and internal working parts. Complete with loose key. Standard 19 mm (3/4 in.) male hose connection, 90 degree connection with 360 degree swivel with 19 mm (3/4 in.) female / 25 mm (1 in.) male threads. Adjustable nickel bronze box furnished with hinged cover, cylinder lock. WATTS HY-450.
- .5 All hydrants shall be complete with vandal proof vacuum breaker, if backflow preventer is not provided.

PART 3 - EXECUTION

3.1 Not Used

END OF SECTION

REFRIGERATED DRINKING FOUNTAINS AND BOTTLE FILLERS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Submittals

- .1 Submit Shop Drawings and/or catalogue cuts of all items supplied in accordance with requirements of Section 20 05 03 - SHOP DRAWINGS.

PART 2 - PRODUCTS

2.1 Materials

- .1 Provide drinking fountains and bottle fillers equal to Product Specification sheets. Product Specification sheets follow Section 22 42 46 - FIXTURE CARRIERS.

PART 3 - EXECUTION

3.1 Installation

- .1 Provide necessary plates, brackets, cleats, supports, etc., for rigidly securing fixtures in place. Accurately lay out all roughing piping, avoiding offsets.
- .2 Examine fixtures for defects. Remove and replace any fixture which, in the opinion of the Contract Administrator, is damaged. Make necessary adjustments to ensure fixtures function as per manufacturer's operating criteria. Clean and polish all fixtures and trim upon completion.

END OF SECTION

TESTING AND BALANCING PIPING SYSTEMS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Quality Assurance

- .1 The balancing under Section 23 05 93.23 - TESTING AND BALANCING AIR SYSTEMS and this Section shall be performed by the same balancing company.
- .2 Acceptable balancing companies are limited to the following:
 - .1 Air Movement Services Ltd
 - .2 DFC Mechanical Testing & Balancing

PART 2 - PRODUCTS

2.1 Not Used

PART 3 - EXECUTION

3.1 General

- .1 Arrange for walk-through of site during project construction phase, prior to commencement of balancing, to confirm that all valves and appurtenances to fully balance and test the systems are available and accessible. Review Mechanical Subcontractor's proposed access door locations and sizes per Section 20 05 63 – ACCESS DOORS AND ACCESSIBILITY indicated on Shop Drawing and ensure that sufficient access is available.
- .2 A sample of a Test Verification Sheet is provided at the end of the section. Fill out this sheet or a similar one with all pertinent information for all tests called for in the Specification or required by code. Have the sheets signed by the Contractor and the Balancing Company to verify that the data recorded is correct.
- .3 Carry out leakage tests on sections of the Work and identify them by reference number on the test sheet and by description of the piping system. Indicate the reference identification number on the as-built drawings.
- .4 Test and balance the following systems:
 - .1 Refrigeration piping
 - .2 Computer Room A/C units and condensers
 - .3 Chillers and chilled water distribution
 - .4 Boilers and heating systems
 - .5 Water treatment systems
 - .6 Life safety and fire protection systems
 - .7 Plumbing systems
 - .8 All process piping including gas, air nitrogen and vacuum

TESTING AND BALANCING PIPING SYSTEMS

- .5 Read, fully understand and comply with all requirements of the Section 20 08 00 - COMMISSIONING.
- .6 Provide a schedule for all testing and balancing.
- .7 Test all plumbing systems in accordance with all applicable plumbing codes and the requirements of the authority having jurisdiction.
- .8 Test all fire protection systems in accordance with all applicable NFPA codes.
- .9 Test compressed air system to a minimum of 125% and a maximum of 150% of pressure setting of relief valve, using nitrogen for 24 hours and ensure pressure drop does not exceed 10% of the minimum pressure.
- .10 Test for vacuum at 1-1/2 times the operating vacuum.
- .11 For all plumbing systems over 100 psi system pressure and other systems not covered by codes noted above, test and prove tight over a period of 24 hours by a hydrostatic test. Remove vents and gauges and temporarily plug connections.
- .12 Utilize hydrostatic test pressure for steam and water systems as follows:
 - .1 1-1/2 times the system working pressure but not less than 1035 kPa (150 psig), or
 - .2 The maximum working pressure of expansion joints and vibration isolators.
- .13 Repair any leaks or defects and repeat the tests to the satisfaction of the Contract Administrator.
- .14 On all radiant heating systems, provide a tag in accordance with Section 20 05 55 – VALVE TAGS AND CHARTS, securely fixed to the zone balancing valve to indicate the required flow rate. Where balancing valves are not located in the room served, also include on the tag the room(s) / area(s) served and the length of the loop.
- .15 After completion of the testing, rough balance the water systems and ensure all coils, convertors, etc., are operating to approximately design conditions to ensure freezing conditions will not occur anywhere. Adjust the circuits by means of balancing valves.
- .16 Confirm that appropriate balancing valves have been installed on all domestic hot water recirculation branch lines.
- .17 Obtain balance on water lines by inserting thermometers in thermometer wells provided for this purpose or between pipe and insulation at each balancing valve and adjusting flow until all thermometers read the same appropriate system temperature.
- .18 Co-ordinate with the balancing company to ensure all necessary valves for balancing the system are installed.
- .19 Ensure that all cooling coil drain pans drain freely and that no standing water remains.
- .20 Ensure access is provided to all valves and equipment that requires servicing.
- .21 Be responsible for all equipment operating to design conditions and trim impellers, etc., to provide the required conditions.
- .22 Correct any deficiencies in the mechanical systems which prevent balancing the system.
- .23 Do not commence insulation installation until testing report is submitted to Contract Administrator and is reviewed by Contract Administrator without requesting a resubmit.

TESTING AND BALANCING PIPING SYSTEMS

- .24 Balance the entire water system to ensure all heat exchangers, etc., are operating to design conditions. Adjust the circuits by means of the balancing valves and record balance position.
- .25 Check each pump for design, working and shut-off head conditions and trim impeller on any pump that varies by more than 10% from the design conditions until design conditions have been met.
- .26 Balance flow through all heat exchangers, chillers, boilers and other such equipment to ensure that the pressure drop through the equipment is within 10% of the manufacturer's design conditions.
- .27 If the design conditions cannot be met by adjusting the balancing valves throughout the system, then change or trim pump impellers as required.
- .28 As part of initial balancing of coils, ensure that the pressure drops are within 10% of the manufacturer's design conditions. When both the air and water systems are fully operational, take entering air and water and leaving air and water readings as close as possible to the peak design conditions to ensure the coil performance meets the design conditions. Only take coil water working conditions in conjunction with the air flow working conditions for the coil.
- .29 Adjust bleed-off from cooling tower, evaporative condensers, and similar equipment to prevent lime deposits. Record bleed-off rate.
- .30 Do not disconnect any control device. Furnish a list of adjusted set points. Commanding of control valves and entering of adjusted set points into the building automation system for testing and balancing purposes is performed under Section 23 09 00 - BUILDING AUTOMATION SYSTEM (BAS). Co-ordinate with Section 23 09 00 - BUILDING AUTOMATION SYSTEM (BAS)
- .31 Have Balancing Company witness all system tests and sign all test reports. Include one copy of all test reports in each copy of the balancing reports.
- .32 Co-ordinate to ensure that all necessary valves for control and balancing are installed in all locations required.
- .33 Be responsible for balancing the systems to obtain the design conditions, and repeat the balancing until the required conditions have been met.
- .34 At the time of final inspection, recheck in the presence of the Contract Administrator random selections of data recorded in the certified report. Points or areas for recheck will be selected by the Contract Administrator and be approximately 10% of the report data.
- .35 A measured deviation of more than 10% between the verification reading and the reported data shall be considered as failing the verification procedure.
- .36 A failure of more than 10% of the selected verification readings shall result in rejection of the report as unacceptable.
- .37 In the event the report is rejected, rebalance all systems, submit new certified reports and make a re-inspection.
- .38 Following final acceptance of the certified reports by the Contract Administrator, permanently mark the settings of all valves and other adjustable devices so that balance set position can be restored if disturbed at any time. For circuit balancing valves, record the valve position by the number of turns registered on the valve and lock the valve into that position. Do not mark such devices until after final acceptance.

TESTING AND BALANCING PIPING SYSTEMS

- .39 Submit report showing the balanced temperatures at all systems.
- .40 Provide a digital copy of the final testing and balancing reports for review by the Contract Administrator. Include copies of the final testing and balancing reports in the O&M Manuals. Ensure reports are complete with index pages and index tabs, and are certified by the Balancing Company. Prepare all diagrams as single line representation of a Mechanical system specifically prepared for this Project using a CAD system acceptable to Contract Administrator.

TESTING AND BALANCING PIPING SYSTEMS

TEST VERIFICATION SHEET - PIPING

Test Number: Date:

System:

Description and sketch of tested component

Starting test pressure Starting test temperature

Final test pressure Finish test temperature

Duration of test

Test performed by: (signature)

Verified by: (signature)

(Printed name)

(Printed name)

(Company)

(Company)

Test witnessed by: (signature)

Test witnessed by: (signature)

(Printed name)

(Printed name)

(Company)

(Company)

END OF SECTION

TESTING AND BALANCING AIR SYSTEMS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Quality Assurance

- .1 The balancing under Section 23 05 93.13 - TESTING AND BALANCING PIPING SYSTEMS and this Section shall be performed by the same balancing company.
- .2 Acceptable balancing companies are limited to the following:
 - .1 Air Movement Services Ltd
 - .2 DFC Mechanical Testing & Balancing

PART 2 - PRODUCTS

2.1 Not Used

PART 3 - EXECUTION

3.1 General

- .1 Arrange for walk-through of site during project construction phase, prior to commencement of balancing, to confirm that all dampers and balancing devices to fully balance and test the systems are available and accessible. Review Mechanical Subcontractor's proposed access door locations and sizes per Section 20 05 63 – ACCESS DOORS AND ACCESSIBILITY indicated on Shop Drawing and ensure that sufficient access is available.
- .2 A sample of a Test Verification Sheet is provided at the end of the Section. Fill out this sheet or a similar one with all pertinent information for all tests called for in the Specification or required by code. Have the sheets signed by the Contractor and the Balancing Company to verify that the data recorded is correct.
- .3 Carry out leakage tests on Sections of the Work and identify these Sections by reference number on the test sheet and by description of the duct system. Indicate the reference identification number on the as-built drawings.
- .4 Test and balance the following systems:
 - .1 Computer Room A/C Units
 - .2 Air conditioning, ventilation and heating systems
 - .3 Miscellaneous ventilation or exhaust systems
 - .4 Life safety systems
 - .5 Air distribution (supply, return, exhaust, and outdoor air intakes; including calibration reading for each airflow monitoring station)
 - .6 Miscellaneous systems on emergency power
- .5 Read, fully understand and comply with all requirements of the Section 20 08 00 - COMMISSIONING.

TESTING AND BALANCING AIR SYSTEMS

- .6 Provide a schedule for all testing and balancing.
- .7 Duct Pressure Tests
 - .1 Perform pressure tests before ductwork is concealed or insulated.
 - .2 Follow SMACNA HVAC Air Duct Leakage Test Manual procedures.
 - .3 Provide blower and all test equipment.
 - .4 Test the percentage of ductwork indicated in the table below. If a test specimen fails to meet the specified air leakage criteria, modify fabrication methods to bring it into compliance and retest until acceptable duct air leakage is demonstrated. If pressure test fails any sample twice, increase percentage of ductwork tested as indicated in the rightmost column of the table below.
 - .5 Include as a minimum, 5 transverse joints, typical seams, an access door, 2 branch connections and 1 elbow in test samples.
 - .6 Ensure leakage amount does not exceed the allotted amount in the table below for the duct construction pressure class in question.
 - .7 Seal any leaks causing noise.
 - .8 Leakage Class:

Duct Construction Pressure Class	Rectangular Leakage Class	Round Leakage Class	Amount of Ductwork to be Tested	Percentage of Ductwork to be Tested if Test Fails any Sample Twice
10 in. w.g.	4	2	100%	N/A
6 in. w.g.	4	2	100%	N/A
4 in. w.g.	4	2	25%	50 %
3 in. w.g.	8	4	25%	50 %
1/2, 1, and 2 in. w.g.	16	8	10%	20 %

- .9 Submit testing report, including leakage calculations, as a submittal complying with the requirements of Section 20 05 03 – SHOP DRAWINGS.
- .8 Do not commence insulation installation until testing report is submitted to Contract Administrator and is reviewed by Contract Administrator without requesting a resubmit.
- .9 Refer to Section 23 31 13 - DUCTWORK AND SPECIALTIES for pressure ratings of ductwork and systems.
- .10 Test HEPA filter housings by pressure decay (ANSI/ASME N510) and ensure leakage does not exceed 0.2% duct volume/minute at 2500 Pa (10 in. W.G.).
- .11 Test the entire system for noise, tightness of joints and proper functioning of the system. Make noise tests under minimum system pressure drop conditions (highest air velocities and clean filter conditions). Make all necessary alterations and repeat the tests until satisfactory operation is achieved.

TESTING AND BALANCING AIR SYSTEMS

- .12 Adjust minimum outside air controller and adjust return air and exhaust air damper linkages to approximately design air quantities, for both maximum and minimum conditions where required, to ensure freezing conditions will not occur.
- .13 Ensure all necessary manual dampers for balancing the systems are installed.
- .14 Itemize the testing equipment in the test reports. Ensure calibration of the test equipment is current before any tests are undertaken and document calibration dates in test reports.
- .15 Be responsible for all equipment operating to design conditions and change fan sheaves, etc., to provide the required conditions.
- .16 Install new filters for the measuring and balancing process. Provide filters in accordance with Section 23 41 16 - DISPOSABLE FILTERS or as noted in the relevant air handling system Specifications and schedules.
- .17 Ensure that all necessary manual dampers for balancing are installed in all locations required.
- .18 Balance the entire air systems including air volumes and control settings under maximum system pressure drop conditions (filter at replacement condition).
- .19 Measure, make final adjustments and report upon: the air volume at each variable volume box, diffuser, register and grille; the air quantity handled by each fan; the static pressure upstream and downstream of the fan; the fan speed; and the motor current.
- .20 Report upon the air flow at outside, return and exhaust air dampers under conditions of minimum outside air, for maximum and minimum volumes and maximum outside air, exhaust air and return air.
- .21 Only take coil working conditions in conjunction with the fluid flow working conditions for the coil.
- .22 Ensure air volumes measured are within plus or minus 5 % of those shown on Drawings for diffusers, grilles, registers, variable air volume boxes and fans, at both maximum and minimum volumes shown.
 - .1 Take duct traverse readings through the access ports provided. Where no access ports have been provided, make new holes as required. Reseal these holes after final readings with sheet metal cover plates and sealant. Duct tape is not acceptable.
 - .2 Where insulation is damaged, repair it including the vapour barrier in an approved manner. Duct tape is not acceptable.
- .23 Do not disconnect any control device. Command control devices and enter adjusted set points into the building automation system with tools and training that are furnished under Section 23 09 00 - BUILDING AUTOMATION SYSTEM (BAS).
- .24 In all cases where measurements show failure to comply with the Drawings and Specifications, change fan sheaves, etc., as required, and make new balancing measurements.
- .25 Ensure all thermostats and controls are set to give specified conditions and include settings in report.
- .26 For additional information on variable volume boxes, refer to Section 23 36 16 - VARIABLE VOLUME BOXES.

TESTING AND BALANCING AIR SYSTEMS

- .27 Witness all system tests and sign all test reports. Include one copy of all test reports in each copy of the balancing reports.
- .28 Set up fans on all systems to give the minimum discharge pressure required to overcome the resistance of the box, discharge ductwork and diffusers.
- .29 Be responsible for balancing the systems to obtain the design conditions and repeat the balancing until the required conditions have been met.
- .30 At the time of final inspection, recheck in the presence of the Contract Administrator random selections of air quantities and fan data recorded in the certified report. Points or areas for recheck shall be selected by the Contract Administrator and be approximately 10 % of the report data.
- .31 At the time of verification, measure space temperature and humidity in a representative number of rooms to verify performance. Tabulate these results and bind into certified report as an appendix.
 - .1 A measured flow deviation of more than 10% between the verification reading and the reported data shall be considered as failing the verification procedure.
 - .2 A failure of more than 10% of the selected verification readings shall result in rejection of the report as unacceptable.
 - .3 In the event the report is rejected, rebalance all systems, submit new certified reports and make a reinspection, all at no additional cost to The City.
- .32 Following final acceptance of the certified reports by the Contract Administrator, permanently mark the settings of all valves, dampers, and other adjustable devices so that balance set position can be restored if disturbed at any time. Do not mark such devices until after final acceptance.
- .33 Provide a digital copy of the final testing and balancing reports for review by the Contract Administrator. Include 3 copies of the final testing and balancing reports in the O&M Manual. Ensure reports are complete with index pages and index tabs. Prepare any diagram as single line representation of a Mechanical System specifically prepared for this Project using a CAD system acceptable to the Contract Administrator.
 - .1 Submit a sample to the Contract Administrator for review.

TESTING AND BALANCING AIR SYSTEMS

TEST VERIFICATION SHEET - DUCTWORK

Test Number:

Date:

System:

Description and sketch of tested component

Test pressure Surface area of ductwork under test

Duct Leakage (cfm) Allowable duct leakage (cfm)

Duration of test

Test performed by: (signature)

Verified by: (signature)

(Printed name)

(Printed name)

(Company)

(Company)

Test witnessed by: (signature)

Test witnessed by: (signature)

(Printed name)

(Printed name)

(Company)

(Company)

END OF SECTION

BUILDING AUTOMATION SYSTEM (BAS)

PART 1 - GENERAL

1.1 Work Included

- .1 Provide all labour, materials, Products, equipment and services to supply, install, test and commission Building Automation System (BAS) with Direct Digital Control (DDC) for building mechanical and electrical systems and interface with other microprocessor based building subsystems as indicated on Drawings and described herein.
- .2 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .3 Conform to Section 23 09 23 - SEQUENCE OF OPERATION FOR BAS.

1.2 Related Sections

- .1 Section 01 60 00 - BASIC PRODUCT REQUIREMENTS.
- .2 Section 20 05 14 - WIRING AND STARTERS.
- .3 Section 20 05 63 - ACCESS DOORS AND ACCESSIBILITY.
- .4 Section 20 08 00 - COMMISSIONING.
- .5 Section 26 05 01 - ELECTRICAL GENERAL REQUIREMENTS.

1.3 System Outline

- .1 General
 - .1 The documentation contained in this section and other Contract Documents pertaining to Building Automation System (BAS) is schematic in nature. The Contractor shall provide all required hardware and software necessary to implement the functions shown or implied in the Contract Documents.
 - .2 Control system to consist of high-speed, peer-to-peer network of microprocessor based DDC controllers and web-based operator interface.
 - .3 Control system to consist of microprocessor based DDC controllers.
 - .4 DDC controllers shall be based on open type protocols, BACnet as defined by ANSI/ASHRAE Standard 135 for potential future connection to Building Automation System (BAS).
 - .5 Control system to consist of high-speed, peer-to-peer network of microprocessor based DDC controllers and integrate with existing BAS.
 - .6 Each system, building floor plan and control device shall be displayed through point-and-click graphics.
 - .7 The City shall receive all Administrator level login and passwords for engineering toolset at first training session. The City shall have full licensing and full access rights for all network management, operating system server, passwords, engineering and programming software required for the ongoing maintenance and operation of the BMS.
 - .8 BAS shall provide support for smart phones & portable devices via one or more of the current common standards: Apple iOS (iPhone, iPad), Android Open Source Project (Android devices), Windows Mobile Devices.
 - .9 BAS to operate on building LAN communication infrastructure.

BUILDING AUTOMATION SYSTEM (BAS)

.2 Functional Principals

- .1 BAS to control mechanical and electrical equipment as specified in CONTROL SEQUENCES, SCHEMATICS AND EQUIPMENT SCHEDULES.
- .2 Controls to control mechanical and electrical equipment as specified in CONTROL SEQUENCES.
- .3 System architecture to be modular permitting expansion of application software, system peripherals and field hardware.
- .4 Each controller to operate independently by performing its own specified control, alarm management, operator I/O and historical data collection receiving information from input field devices and controlling output field devices to perform the control sequences.
- .5 DDC controller may control more than one system provided that points associated with those systems are connected to that same controller.
- .6 DDC controllers to be configured so that main inputs and outputs from any control loop are located in that same controller.
- .7 Global points used for control loop reset such as outdoor air temperature are exempt from this requirement.
- .8 DDC controllers to be capable of operating with local closed loop programming, independent from the server if communication is interrupted.
- .9 Where PID control loops are called for in the sequences, they are to be implemented within the controller.

1.4 Base Building BAS Provider

- .1 Approved Suppliers And Manufacturers:
 - .1 Rec Centre: Johnson Controls Incorporated – Metasys
 - .2 Child Care: Automated Logic or Reliable Controls
- .2 City of Winnipeg Requirements
 - .1 The Contractor shall provide and install all essential hardware and software to interface to the existing City of Winnipeg Extended Application and Data Server (ADX).
 - .2 The Contractor shall design the Metasys User Interface (MUI), to match the existing system. MUI graphics shall use the City of Winnipeg templates.
 - .3 The Contractor will not have access to the City of Winnipeg SCT server. All MUI files shall be provided by the BMS contractor in the correct format for merging into the existing system with support from the City of Winnipeg.
 - .4 The Contractor shall create or add MUI user views to match existing structure.
 - .5 There is an existing central monitoring system in place. All Direct Digital Controller (DDC) points are identified as centrally monitored points.
 - .6 All new controls shall be the Series Network Engine (SNE-XX000) supervisory controller which will utilize BACnet/IP and \ or MS/TP field controllers. The Contractor is required to meet with the City of Winnipeg for additional requests if the SNE-XX000 is not in the projects design or additional requirements are required. See note #2 and 3.

BUILDING AUTOMATION SYSTEM (BAS)

- .7 Field Controllers shall communicate through BACnet/IP or MSTP bus to a SNE-XX000 supervisory controller. See note #1, and 2.
- .8 No LON protocols are to be accepted.
- .9 The Contractor to provide commissioning sheets for all points on field devices.
- .10 The Contractor to communicate with equipment provider to ensure proper field point integration as well as controllability of the equipment, if not package controls.
- .11 If Other vendor (non-JCI) controls are to be used then a seamless integration must be proven before approval will be given. See note #1 and 4.

Notes:

- .1 The term BACnet refers to an industry standard protocol which complies with ASHRAE, and must be listed with the BACnet International / BACnet Testing Laboratories (BI/BTL). Basically, states that all devices using the BACnet technology will be able to communicate to each other. The controls contractor performing the controller installation should confirm that all devices specified are able to communicate to the proposed devices. Then supply documentation such that all devices supplied will communicate to each other as required for proper operation of the system (PICS Statement, BI/BTL Listing, and ASHRAE listings).
- .2 If the Metasys Series Network Engine (SNE) are to be installed on the project then the version of these devices and their software must be such that the City of Winnipeg does not be required to update/upgrade the existing ADX server in order for all user views, alarms, and point monitoring to occur. The contractor must co-ordinate with City staff to determine the correct version to be installed.
- .3 If the Metasys Series Network Engine (SNE) is existing, the contractor is required to meet with the City of Winnipeg for additional directions.
- .4 All points must be integrated back to the City of Winnipeg ADX server.
Important: The only way to bring points into the ADX server is to route them through a Johnson Controls supervisory device.

1.5 Quality Assurance

- .1 Supplier will have successfully completed training provided by the control system manufacturer on the manufacturer's product line. Training will have included design, programming and testing of control systems incorporating the manufacturer's product line. Submit with the Bid Documents a copy of the certificate of completed training and indicate the hours of instruction and course outlines.

1.6 Codes And Standards

- .1 Comply with rules and regulations of codes and ordinances of local, provincial, and federal authorities; such codes and ordinances, when more restrictive, take precedence over the Contract Documents.
- .2 Provide Products listed and classified by the testing firm acceptable to the authority having jurisdiction as suitable for the purpose indicated and specified.

BUILDING AUTOMATION SYSTEM (BAS)

1.7 Standard Of Equipment

- .1 Use only new Products and software that manufacturer is currently stocking and selling for use in new installations.
- .2 Do not use this installation as Product test site unless explicitly approved in writing.
- .3 Spare parts, software and technical support to be available for at least ten years after acceptance is certified.
- .4 All user accessible controls devices shall be of the same manufacturer.

1.8 Open Protocol Standard

- .1 Intention of this Specification is to provide an integrated, open protocol BAS, BACnet as defined by ANSI/ASHRAE Standard 135.
- .2 BACnet devices on the lower tier network to support all BACnet functional groups, standard application services and standard object types necessary, but not limited to provide reading and writing functionality of all analog and binary inputs and outputs and change-of-value initiation and reporting between BACnet devices on the network.
- .3 All BACnet devices to be BTL tested. Provide Protocol Implementation Conformance Statement (PICS) for all BACnet devices.

1.9 System Communication Architecture

- .1 The first tier of the BAS network shall be based on Ethernet (ISO 8802-3/IEEE 802-3) communications, providing a high-speed local area network for reliable peer-to-peer communications. Future connected systems shall have compatibility specifications to provide communication with the first tier LAN. The operator workstations shall also be supported on the high speed LAN Tier 1. Communication speed on first tier network shall be at rate of 10Mbps or higher.
- .2 Tier 1 to be integrated into the IP Network. Coordinate with The City and communication service provider for required number of IP addresses, required number and location of Ethernet ports and subnets; identification of Internet socket port number requirements for external communication through The City firewall.
- .3 Typical office floors field controllers, including but not limited to VAV, CAV, FCU, etc., shall be set up in a Star Home Run configuration. Typical floor network shall not traverse floors.
- .4 DDC controllers shall have communication port for temporary connection to laptop computer or operator interface device to allow downloads, uploads and other commissioning and troubleshooting operations.

1.10 Equipment Supplied For Installation Under Other Sections

- .1 Automatic control valves except otherwise noted.
- .2 Temperature sensor wells.
- .3 Terminal unit controllers including transformers. Ship to terminal unit manufacturer's facility for factory installation.
- .4 Motorized Dampers except otherwise noted. Verify damper sizes and connection type with Sheet Metal Contractor prior to ordering.
- .5 Dampers except otherwise noted. Verify damper sizes and connection type with Sheet Metal Contractor prior to ordering.

BUILDING AUTOMATION SYSTEM (BAS)

1.11 BAS Performance

- .1 Graphic Display: Display the selected graphic representation at Operator Interfaces with current point object data at a minimum rate of twenty points in five seconds.
- .2 Graphic Refresh: Update the selected graphic representation at Operator Interfaces with current point object data at a minimum rate of twenty points in five seconds.
- .3 Data Scan: Update point object data at controllers and Operator Interfaces with current point object data at a minimum rate of once every second.
- .4 Binary Object Command: Controlled device will react within five seconds of an operator initiated command on a binary point object.
- .5 Analog Object Command: Controlled device will start to react within five seconds of an operator initiated command on an analog point object.
- .6 Alarmed Object Display: Alarm will annunciate visually and audibly at Operator Interfaces within five seconds from the time the object entered the alarmed state.
- .7 Program Execution Rate: Provide ability to execute programs at a minimum rate of once every five seconds. Provide execution rates suitable for processes controlled.
- .8 PID Execution Rate: Provide adjustable execution rates for proportional-integral-derivative (PID) loops; update the controlled variable and command the controlled device at this same rate. Provide execution rates suitable for processes controlled.
- .9 Display and Report Accuracy: Provide minimum accuracy for point object data displayed at Operator Interfaces, reported to printers, reported to data files to Table 1: Display and Report Accuracy.

Table 1: Display and Report Accuracy.	
Point Object	Accuracy
Room Air Temperature	+/-0.2 deg. C (+/-0.36 deg. F) from actual
Duct Air Temperature	+/-0.2 deg. C (+/-0.36 deg. F) from actual
Outside Air Temperature	+/-0.2 deg. C (+/-0.36 deg. F) from actual
Dew Point Temperature	+/-1.5 deg. C (+/-2.7 deg. F) from actual
Water Temperature	+/-0.2 deg. C (+/-0.36 deg. F) from actual
Relative Humidity	+/-2% of actual for 20% to 80% RH at 25 deg. C (77 deg. F)
Water Flow	+/-1.2% of actual for 3.0 to 30.0 ft/s
Air Flow, Terminal Unit	+/-5.0% of actual
Air Flow, Fan Bell and Duct	+/-5.0% of actual
Air Flow, Pressurized Space	+/-3.0% of actual
Air Pressure, Duct	+/-0.45% of scale length
Air Pressure, Room	+/-0.45% of scale length
Fluid Pressure (other than air)	+/-0.45% of scale length (see Note 1)
Electrical (current, voltage, power)	+/-1.2% of actual (see Note 2)
Carbon Monoxide	+/-3.2% of actual
Carbon Dioxide	+/-3.2 % of actual
Note 1: For both absolute and differential pressure.	
Note 2: Does not include utility grade meters.	

BUILDING AUTOMATION SYSTEM (BAS)

- .10 Control Tolerance: Maintain controlled variable to control tolerance from set point to Table 2: Control Tolerance.

Table 2: Control Tolerance.		
Controlled Variable	Range	Control Tolerance from Set Point
Room Temperature		+/-0.6 deg. C (+/-1.1 deg. F)
Duct Temperature		+/-0.6 deg. C (+/-1.1 deg. F)
Humidity		+/-5 % RH
Air Flow		+/-1.0 % of scale length
Air Pressure	0-1500 Pa (0-6 in. w.g.)	+/-1.0 % of scale length
	-25 to 25 Pa (-0.1 to 0.1 in. w.g.)	+/- 10.0 % of scale length
Fluid Pressure (other than air)		+/- 1.0 % of scale length

1.12 Submittals

- .1 Product Data and Shop Drawings:
- .1 Within 30 days of award of contract, before start of construction, submit completely engineered and coordinated shop drawing package.
 - .2 Before start of construction, submit completely engineered and coordinated shop drawing package including graphics samples
 - .3 Submittals in printed format and as amended below.
 - .4 Provide drawing files through Electronic File Transfer.
 - .5 Riser Diagrams: Indicate: communication wire paths and connections to network devices; power wire and ground wire connections to Operator Interfaces and network devices; wire types and port types with manufacturer's model numbers; communication protocol and communication speed for network segments; power panel and breaker designations; wire terminal designations; addresses for network devices; room designations.
 - .6 Specifications and Instructions: Indicate: dimensions, capacities, electrical characteristics, mechanical characteristics, environmental characteristics, performance characteristics, finishes. Circle model number for Products provided or furnished. General catalogue sheets are not acceptable. Provide installation instructions.

BUILDING AUTOMATION SYSTEM (BAS)

- .7 System Flow Diagrams: Indicate: control devices, control device designation, control device range, control device fail-safe position, point object type, point object name, point object address. Indicate flow directions for gases and liquids relevant to the controlled process. Indicate hardwired interlocks between control devices and equipment. Indicate the location of field control devices.
 - .8 Products Schedule: Indicate: Product designation, Product name, Product manufacturer, Product model number, Product data sheet reference number, quantities. Provide quantities required under the Work.
 - .9 Valve Schedule: Indicate: system designation, service, medium, quantity, reference drawing, valve type, pipe configuration, fail position, pipe size, valve body size, valve design flow, valve design pressure drop, actual valve pressure drop, design Cv, valve Cv, design close-off, valve close-off, control type, control signal, connection type, valve model number.
 - .10 Damper Schedule: Indicate: system designation, control device designation, duct dimensions, blade width, blade type, damper model number, calculated torque, actuator torque, actuator model number, actuator quantity, actuator fail-safe position, provisions for edge and blade seals and actuator mounting configuration.
 - .11 Room Schedule: Indicate: controller object name, controller address, controller model number, application designation, room designation, VAV air volume set points, and sensor model numbers.
 - .12 Cabinet Layouts: Interior: Indicate: orientation of contents including controllers, transformers, cable trays, terminal strips, relays, control devices, labels. Exterior: Indicate: orientation of gauges, displays, switches, labels.
 - .13 Wire Details: Indicate: connections between control devices, controllers and equipment; connections to sources of power and grounds; control device designations, control device terminal designations, control device location; equipment terminal designations; cabinet terminal strip designations; wire designations. For control devices shown on multiple Drawings, indicate the control device with the same designation on all Drawings. Differentiate between manufacturer installed wire and field installed wire.
 - .14 Sequence of Operation: Provide a complete description of operation to Section 23 09 23 - SEQUENCE OF OPERATION FOR BAS. Provide description of operation for interlocks that directly connect to the Work. Indicate references to the system flow diagram by control device designation or point object name.
 - .15 Custom Application Programs (Algorithms): Provide in printed format to Section 23 09 23 - SEQUENCE OF OPERATION FOR BAS. Provide comments that describe the details of program functions.
 - .16 Flow Diagrams for Custom Application Programs (Algorithms): Provide in printed format to Section 23 09 23 - SEQUENCE OF OPERATION FOR BAS.
 - .17 Points Schedule: Indicate: input points, output points and virtual points for each controller. Indicate: point object address, point object name, point object description, point object alarm limits. List points in ascending order based on point object address.
 - .18 Submit floor plan drawing indicating the coverage of Thermostats sensors where applicable or a spreadsheet to convey the same information.
- .2 Samples:

BUILDING AUTOMATION SYSTEM (BAS)

- .1 Provide with submittal under Part 1: Product Data and Shop Drawings for approval by The City and/or Contract Administrator:
 - .1 Graphic Representations: Conceptual layouts in printed format of images and point objects for systems under Part 3: Execution, Operator Interface. Indicate or explain which other graphic representations are directly accessed.
 - .1 Typical terminal unit floor plan graphic that shows conditions on occupied floor.
 - .2 Typical equipment room floor graphic.
 - .3 Typical graphic for each system and terminal unit.
 - .4 Typical navigation menu.
 - .5 One sample graphic for each equipment type.
 - .6 One sample graphic for chilled water system.
 - .7 One sample graphic for hot water system.
 - .2 Test Forms: In printed format for test forms under Part 3: Execution, Testing and Commissioning.
 - .3 Products: As specified under Part 3: Execution, Control Devices.
- .3 Work Schedule:
 - .1 Provide a schedule of the Work within four weeks of contract award. Indicate: intended sequence of tasks, start dates, task durations, and delivery dates for material and equipment requiring long lead times, restraints on Work by other trades or situations.
 - .2 Provide monthly updated Work Schedule indicating percentage complete and revisions to expected delivery dates.
- .4 Values Schedule:
 - .1 Provide a schedule of separate system prices that comprises the price of the Work of this Section within four weeks of contract award. In addition to the system price, indicate material and labour prices separately for the system. Indicate each mechanical and electrical system as a separate price. Indicate terminal unit systems of the same type on a floor as a separate system price for the respective floor. Include the price for communication networks and power networks allocated proportionately to the separate system prices. Indicate the Operator Interfaces as a separate system price. Include all costs associated with the Work of the system in the separate system price.
 - .2 The Values Schedule provides the basis for progress payments.
- .5 Project as-built documents:
 - .1 Operation and Maintenance Manuals:
 - .1 Provide one copies in digital format for review by the Contract Administrator at least ten weeks before the projected Substantial Completion date.
 - .2 Provide four copies of corrected manuals in printed format and four copies on Electronic Fire Transfer within three weeks following completion of Acceptance Test under Part 3: Execution. Provide manuals in hard cover three-ring binders with index page and indexing tab per section.
 - .3 Sections:

BUILDING AUTOMATION SYSTEM (BAS)

- .1 Contact Information: Provide names, addresses, 24-hour telephone numbers of service representatives and installing Subcontractors.
 - .2 Operation: Provide The City operating manuals for Operator Interfaces, Controller Resident Software, DDC Controllers, Advanced Application Controllers, Specific Application Controllers, control devices, compressed air system. For Custom Application Programs (Algorithms) Editor, provide a reference manual for the language syntax that describes each function.
 - .3 Engineering, Installation and Maintenance: Provide manuals for design and installation of point objects, controllers, and control devices. Provide instructions for calibrating, troubleshooting and replacing controllers and control devices.
 - .4 Software: Provide complete original issue media and release notes for Operator Interfaces.
 - .5 Preventive Maintenance Procedures: Provide for Operator Interfaces, controllers, control devices. Provide a schedule of tasks; indicate dates for inspection, maintenance and calibration; indicate the pages in the engineering, installation and maintenance manuals that list the procedures.
 - .6 Replacement Parts List: Indicate: manufacturer name, manufacturer model number, Supplier name, Supplier address, Supplier telephone number.
 - .7 Certificates: Provide original issue certificates for installation, maintenance and calibration.
 - .8 Test Forms: Provide copies of test forms completed under Part 3: Execution, Testing and Commissioning.
 - .9 Provide certificate of pressure test under Part 3: Execution, Control Air Tubing.
 - .10 Provide licenses, guarantees and warranty documents for Products and systems.
- .2 As-built Product data and Shop Drawings:
- .1 Provide drawing files through Electronic File Transfer
 - .2 Provide three copies in printed format for approval by the Contract Administrator within three weeks following the successful completion of Acceptance Test under Part 3: Execution.
 - .3 Provide three copies in printed format and three copies in CD for approval by the Contract Administrator within three weeks following the successful completion of Demonstration under Part 3: Execution.
 - .4 Provide 1 copy on Electronic File Transfer.

BUILDING AUTOMATION SYSTEM (BAS)

- .5 Points Schedule: For points schedule generated under Part 1: Submittals, Product Data and Shop Drawings, indicate operating conditions for point object data; list point objects by system designation and alphabetically by point object name.
- .6 Time-of-Day (TOD) Schedules: Indicate: objects assigned to the TOD Schedule, Occupied Mode times.
- .3 As-built Floor Plans:
 - .1 Maintain on the Project site as-built conditions on one full-size set of Contract Drawings, referred to as marked-up drawings; indicate on these drawings as-built locations for: control devices, cabinets, network devices with network address, communication networks by type and address, connection points to communication networks for Operator Interfaces, power networks, conduit paths, junction boxes, Operator Interfaces.
 - .2 Submit three copies of marked-up drawings to Contract Administrator for review within three weeks following successful completion of Acceptance Test under Part 3: Execution. Revise Contract Drawings to match the approved marked-up drawings; revise using AUTOCAD Release 12 or higher format and submit three copies as full-size in printed format and two copies electronically in a means discussed in as-built product data and Shop Drawings.
- .4 Software Backup:
 - .1 Provide with as-built Product data and Shop Drawings.
 - .2 Provide three copies of complete BAS databases on Electronic File Transfer.
- .5 Training Manuals:
 - .1 Provide a course outline, and one copy in printed format of training manuals provided under Part 3: Execution, Instruction and Training at least six weeks prior to the first class. Modify the course outline and training materials to suit The City's requirements and as requested by the Contract Administrator.

1.13 Warranty

- .1 Warrant the Work free from defects for a period of 12 months and in accordance with the General Conditions and as amended below.
- .2 Warranty start date will be the date the Work is accepted under Part 3: Execution, Acceptance Test.
- .3 Warranty start date will be the date the Work is accepted under Part 3: Execution, Demonstration.
- .4 Provide a single warranty start date even when The City has received beneficial use prior to acceptance of the Work. For Work split into multiple contracts or for a multi-phase contract, provide a separate warranty start date and period for each contract or phase.
- .5 Adjust, repair or replace defects and failures in the Work at no additional cost during the warranty period and without reduction in service to The City. Provide warranty service during normal business hours and within 24 hours of The City's request for service.
- .6 Provide warranty service by factory trained service representatives of the Supplier.

BUILDING AUTOMATION SYSTEM (BAS)

- .7 Replace Operator Interface software, Controller Resident Software, controller firmware and database files with revisions that correct deficiencies or defects during the warranty period at no charge to The City. Notify The City of changes and schedule the installation. Update Operation and Maintenance Manuals with firmware release notes.
- .8 Prior to testing date under Part 3: Execution, Acceptance Test, update firmware in controllers to latest revisions at no additional cost to The City; update Operation and Maintenance Manuals with firmware release notes.
- .9 During the warranty period check the tuning of each control loop once during heating season and once during cooling season; notify the The City when this Work is to occur. Forward to the Contract Administrator documentation indicating observations and adjustments made.

1.14 The Cityship Of Proprietary Material

- .1 Software and documentation supplied and generated under the Work or required for ongoing system operation, maintenance and modification becomes the property of The City, including and not limited to graphic files, database files, Custom Application Programs, Project as-built documents and training manuals.
- .2 The City shall receive all Administrator level login and passwords for engineering toolset at first session. The City shall have full licensing and full access rights for all network management, operating system server, engineering and programming software required for the ongoing maintenance and operation of the BMS.
- .3 Vendor to provide unlimited number of Licensing and user profile accounts for the BAS without additional fees.
- .4 As of last day of the warranty period, all software to be upgraded to most current recommended version of manufacturer's release.

PART 2 - PRODUCTS

2.1 Materials

- .1 New Products: Non-beta versions currently under manufacture and have been applied in similar installations for a minimum period of one year.
- .2 Revisions: Latest available revision for Operator Software, Controller Resident Software and controller firmware at start of Warranty.
- .3 Revisions: Latest available revision for Controller Resident Software and controller firmware at start of Warranty.
- .4 Replacement Parts: Readily available and not scheduled for discontinuation at time of Total Project Completion.
- .5 Expansion: Expandable through additional inputs and outputs and to card access, security, fire alarm, lighting control systems and other building systems.

BUILDING AUTOMATION SYSTEM (BAS)

2.2 Network

2.3 BAS

- .1 Provide a network that exceed the following capabilities:
 - .1 Data transfer rate of at least 10 Mbit/s for alarm reporting, point log reporting and uploading/downloading of programs.
 - .2 Single or multiple node failure reporting.
 - .3 Error detection, correction and re-transmission to ensure data integrity.
 - .4 Synchronization of the real time clocks in the Building Controllers and Advanced Application Controllers.
 - .5 Message and alarm buffering to prevent data loss shall be provided within the IP controllers.
 - .6 Coordinate with base building local area network provider to ensure connectivity of all BAS devices and allocation of network ports.
 - .7 A failure of any component or controller on the base building local area network shall not interrupt the execution of communication on this network.
 - .8 Provide full communication capability across all systems including the base building local area network so that all BAS specified downloading, uploading, data transmission, control commanding, alarm handling and programming is achieved smoothly and transparently.
 - .9 Review location and quantity of communication hub ports required for connection of lower tier networks to the Tier 1 network. Coordinate and arrange use of ports with Base Building Local Area Network Contractor.
 - .10 BAS Network shall have an extra 25% capacity for future expansion on all tiers.

2.4 Operator Interface

- .1 Operator Software:
 - .1 Alarms and Events:
 - .1 Definition: Alarm limits, alarm limit differentials, states and reactions shall be adjustable.
 - .2 Processing: Alarm and event messages are independently configured to route to network devices. Enable and disable alarms and events manually by the operator.
 - .3 Storage: Store alarm and event messages to the Server.
 - .2 Trends:
 - .1 Definition: Create, delete and modify trends. Title blocks, legends sampling interval and start and stop time shall be configurable.
 - .2 Storage: Store trend data in The City's server. Maintain twelve consecutive months of trend data on the Server for benchmark data. Store Analog data at 15 minute intervals and digital data when there is a change of value.
 - .3 Reports:

BUILDING AUTOMATION SYSTEM (BAS)

- .1 Definition: Create, delete and modify reports. Report data shall include date and time stamps. Title blocks and legends shall be configurable.
- .2 Storage: Reports are stored to the Server automatically and by operator command. Report data shall be available for use in spreadsheets and database programs.

2.5 3rd Party Manufacturer Interface.

- .1 3rd party manufacturer controllers included but not limited to chillers, boilers, variable frequency drives, power monitoring, medical gasses to be based on the open system communication (BACnet) for seamless integration with BAS. Include network connection from BAS to 3rd party manufacturer controllers.
- .2 If 3rd party manufacturer controllers are based on different open system standard than BAS, it is the responsibility of BAS Contractor to provide the appropriate interface for integration of that 3rd party manufacturer controller to BAS.
- .3 If open system controllers are not available, include all appropriate hardware equipment and software to allow bi-directional data communication between the BAS and 3rd party manufacturers' control panels.

2.6 Controller Resident Software

- .1 The software resides in Building Controllers and Advanced Application Controllers and is edited by means of the Operator Interface.
- .2 Security:
 - .1 Definition: Multiple operators are assigned access levels, and independent user login names and passwords are configurable.
 - .2 Processing: Automatically log off operator after an adjustable period of inactivity.
- .3 Alarms and Events:
 - .1 Definition: Alarm limits, alarm limit differentials, states and reactions shall be adjustable.
 - .2 Processing: Alarm and event messages are independently configured to route to network devices. Enable and disable alarms and events manually by the operator and automatically through Custom Application Programs.
- .4 Trends:
 - .1 Definition: Create, delete and modify trends. Title blocks, legends, sampling interval and start and stop time shall be configurable.
 - .2 Storage: Trend data is retrieved by the Operator Interface.
 - .3 Create trend logs for all AI/AO/BI/BO of the BAS. Analog points to be at 15 minute intervals and Digital points to be at Change of Value.
- .5 Time-of-Day (TOD) Schedules:
 - .1 Definition: Create, delete and modify TOD Schedules. Assign objects to TOD Schedules based on function and location.
- .6 Custom Application Programs (Algorithms):
 - .1 Definition: Create, delete and modify programs and program statements.

BUILDING AUTOMATION SYSTEM (BAS)

- .2 Syntax Capabilities:
 - .1 Analog and binary point objects.
 - .2 Conditional statements (IF, THEN, ELSE, ELSE IF) using compound Boolean relations (AND, OR and NOT) and comparisons (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL).
 - .3 Floating-point arithmetic using operators for addition, subtraction, division, multiplication and square root; absolute value and minimum/maximum value arithmetic functions.
 - .4 Predefined objects representing date, time of day, day of week, month of year and elapsed time.
 - .5 Create, delete and modify custom function blocks.
- .7 Maintenance Messages: Display at Operator Workstations. Indicate equipment name and maintenance required based on equipment run time, starts, and calendar date limits..
- .8 PID Control: PID (proportional-integral-derivative), PI and P algorithms for direct acting and reverse acting. Analog output is time-varying. Output control device is adjustable by the operator. Set point and gains are adjustable.
- .9 Optimal Start/Stop: Delay equipment start-up to latest possible time which will allow building space to reach target conditions by occupancy time. Advance shut-down of equipment to earliest possible time and maintain space target conditions until the end of occupancy time.
- .10 Enthalpy Economizer Control: Control outside, return and exhaust dampers based on inside and outside enthalpy comparisons.
- .11 Electrical Demand Management: Manage electrical demand by monitoring power consumption. If consumption exceeds operator adjustable level system to be capable of adjusting set-points, de-energizing low priority equipment and taking other pre-programmed actions as described in SEQUENCES OF OPERATION.
- .12 Chiller Optimization: sequence chillers and other chilled water plant equipment and reset chilled water and condenser water control set points, to provide cooling at minimum cost.
- .13 Load Reset: use the zone with the greatest load to reset the set-point of heating or cooling source.
- .14 Morning Warm-Up: compare outside and space temperatures and if outside air temperature is less than desired space temperature, run the system before occupancy with fully closed outside dampers until space temperature is satisfied.
- .15 Night Cool Down: compare outside and space temperatures and if outside air temperature is less than desired space temperature, run the system during unoccupied hours with outside dampers fully opened until space temperature is satisfied.
- .16 Equipment Sequencing: Sequence equipment with lead - leg, duty - standby and priority assignment based upon runtime or operator command as described in SEQUENCES OF OPERATION.
- .17 Staged Starts: Operator selectable time delays between starts for equipment on power restoration or scheduled start.
- .18 Anti-Short Cycling: Minimum on and minimum off times for equipment.

BUILDING AUTOMATION SYSTEM (BAS)

- .19 Dead-band Switch: Cycle a binary point object based on controlled point object and set point for direct acting and reverse acting. Differentials are adjustable.
- .20 Equipment Run Time Totalization: Accumulated run time expressed in unit hours and operator adjustable high runtime alarms.

2.7 DDC CONTROLLERS

- .1 General
 - .1 Input/Output Interface
 - .1 Minimum Spare I/O Capacity: Controllers to have minimum 20% spare capacity or at least one of each type of I/O available on the controller. This does not apply to Application Specific Controllers
 - .2 For tenant Projects: delete this requirement if not available with base building controllers to be swappable without disconnecting the wiring
 - .3 Controllers to continue to provide control functions in event of network communications failure.

2.8 DDC Controllers

- .1 General
 - .1 Input/Output Interface:
 - .1 Analog Inputs:
 - .1 Signal: 4 to 20 mA, 0 to 10 VDC, thermistor, RTD.
 - .2 Binary Inputs:
 - .1 Detect dry contact closure.
 - .2 Wetting Current: Supplied by the controller.
 - .3 Pulsed Inputs:
 - .1 Detect pulse of dry contact closure.
 - .2 Pulse Frequency: Compatible with input device.
 - .3 Wetting Current: Supplied by the controller.
 - .4 Analog Outputs:
 - .1 Signal: 4 to 20 mA, 0 to 10 VDC. Provide range and zero adjustment.
 - .2 Accuracy Rating: +/- 1% of scale length.
 - .5 Binary Outputs:
 - .1 Triac: Rated for 0.5 A at 24 VAC
 - .2 Relay: NO or NC configuration, rated for 3 A at 24 VAC
 - .3 Provide secondary relay for higher loads.
 - .6 Minimum Spare I/O Capacity: Controllers to have minimum 20% spare capacity or at least one of each type of I/O available on the controller. This does not apply to Application Specific Controllers.
 - .2 Controllers that perform scheduling operations to have on board real-time clock.

BUILDING AUTOMATION SYSTEM (BAS)

- .3 Controllers to continue to provide control functions in event of network communication failure.
- .4 Controllers to be swappable without disconnecting the wiring.
- .5 Immunity to Power: Rated for 90% to 110% of nominal voltage.
- .2 Building Controllers (BC):
 - .1 Independent, networked, microprocessor-based for all internetwork control strategies.
 - .2 Reside on Ethernet Tier 1 BAS network.
 - .3 Manage connected input and output control devices; transmit real and virtual point object data to distributed controllers and Operator Interfaces and provide global strategy and direction.
 - .4 Continuous monitoring of processor, memory and communication circuits; assume a predetermined failure mode for abnormal conditions; assume a failsafe operating mode for failed communication with objects.
 - .5 Communicates to card access, security, fire alarm, lighting control systems.
 - .6 Service communication port for communication with Portable Operator Terminals.
 - .7 Memory: Non-volatile EEPROM for firmware. Seventy-two hours battery backed memory for object database and custom application programs.
 - .8 Each BC to support firmware upgrades without need to replace hardware.
 - .9 Environment: Suitable for anticipated ambient conditions.
 - .10 Serviceability: LEDs for power, communication and processor status.
- .3 Advanced Application Controllers (AAC):
 - .1 Independent, networked, microprocessor-based.
 - .2 Reside on lower tier BAS network (BACNet or LON).
 - .3 Manage connected input and output control devices; transmit real and virtual point object data to distributed controllers and Operator Interfaces.
 - .4 Continuous monitoring of processor, memory and communication circuits; assume a predetermined failure mode for abnormal conditions; assume a failsafe operating mode for failed communication with objects.
 - .5 Service communication port for communication with Portable Operator Terminals.
 - .6 Memory: Non-volatile EEPROM for firmware. Seventy-two hours of battery backed memory for object database and custom application programs.
 - .7 Each AAC to support firmware upgrades without need to replace hardware.
 - .8 Environment: Suitable for anticipated ambient conditions.
 - .9 Serviceability: LEDs for power, communication and processor status.
- .4 Application Specific Controllers (ASC):
 - .1 Microprocessor-based networked. Non-adjustable programs with operator adjustable settings for customized operation within equipment design limits.
 - .2 Reside on lower tier BAS network (BACNet or LON).

BUILDING AUTOMATION SYSTEM (BAS)

- .3 Service communication port for communication with Portable Operator Terminals.
- .4 Memory: Non-volatile EEPROM memory for firmware and program data.
- .5 Environment: Suitable for anticipated ambient conditions.
- .6 Serviceability: LEDs for power, communication and processor status.

2.9 Power Supplies And Line Filtering

- .1 Provide a separate power supply for every Building Controller, Advanced Application Controller and Application Specific Controller for terminal units.
- .2 Power Supply Voltage: 24 V, unless indicated otherwise on Drawings.
- .3 Power Supplies:
- .4 Type: Enclosed; Class 2 current-limiting, or over-current protection in primary and secondary circuits for Class 2 service to the National Electrical Code.
- .5 Applied Loads: To 80% of rated capacity.
- .6 DC Power Supplies: Regulated output.
- .7 Built in over voltage and over current protection.
- .8 Able to withstand 150% current overload for at least 3 seconds without trip or failure.
- .9 Power Line Filtering: Provide internal or external transient voltage and surge suppression for workstations and controllers.

2.10 Cabinets

- .1 Type: NEMA rated and suitable for installed environment.
- .2 Door: Hinged with key-lock latch with common key for all cabinets; provide duplicate keys; for Application Specific Controllers provide screwed tight slide-off cover.
- .3 Controllers, transducers and relays mounted on backing board or DIN rails within inner section behind hinged doors.

2.11 Control Devices

- .1 Motorized Control Dampers:
 - .1 Sizing:
 - .1 Dimensions: As indicated. Maximum damper section size: 1200 mm x 1500 mm (48 in. x 60 in.). For dampers larger than the section maximum, use an assembly of multiple, equally sized sections.
 - .2 Two-position: Parallel blade.
 - .3 Modulating: Opposed blade. Parallel blade dampers may be used for return air and bypass applications.
 - .2 Frame: 125 mm x 25 mm x 3 mm (5 in. x 1 in. x 0.125 in.) 6063T5 extruded aluminum with mounting flanges on both sides.
 - .3 Blades: Airfoil shape, 6063T5 extruded aluminum, maximum 150 mm (6 in.) depth.
 - .4 Seals:

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- .1 Blade Edge: Extruded thermoplastic rubber (TPR) suitable for -58 deg. C to 135 deg. C (-72 deg. F to 275 deg. F), mechanically locked in place and easily replaceable in the field.
- .2 Blade Jamb: Spring-loaded stainless steel.
- .5 Bearings: Molded synthetic.
- .6 Linkage: Corrosion resistant steel and concealed in the frame.
- .7 Drive Shaft: Corrosion resistant steel of square or hexagon shape.
- .8 Axle: Corrosion resistant steel.
- .9 Leakage: Maximum 40.6 L/s/sq m (8 CFM/sq ft) at 1.0 kPa (4 in. w.g.) of differential pressure across fully closed damper when tested to AMCA Standard 511.
- .10 Make and Model: Ruskin CD-50 or equivalent.
- .2 Motorized Control Dampers (Thermally Insulated):
 - .1 Sizing:
 - .1 Dimensions: As indicated. Maximum damper section size: 1524 mm x 1829 mm (60 in. x 72 in.). For dampers larger than the section maximum, use an assembly of multiple, equally sized sections.
 - .2 Two-position: Parallel blade.
 - .3 Modulating: Opposed blade. Parallel blade dampers may be used for return air and bypass applications.
 - .2 Frame: 125 mm x 25 mm x 3 mm (5 in. x 1 in. x 0.125 in.) 6063T6 extruded aluminum with mounting flanges on both sides.
 - .3 Blades: Airfoil shape, 6063T6 extruded aluminum, maximum 150 mm (6 in.) depth, injected with high density polyurethane foam insulation with thermal isolation gap.
 - .4 Seals:
 - .1 Blade Edge: Mechanically fastened extruded Ruskiprene, suitable for -43 deg. C to 85 deg. C (-45 deg. F to 185 deg. F), and easily replaceable in the field.
 - .2 Blade Jamb: Ribbed extruded Ruskiprene.
 - .5 Thermal Efficiency Ratio: 345% or higher.
 - .6 Linkage: Corrosion resistant steel and concealed in the frame.
 - .7 Drive Shaft: Corrosion resistant steel of square or hexagon shape.
 - .8 Axle: Corrosion resistant steel.
 - .9 Leakage: Maximum 40.6 L/s/sq m (8 CFM/sq ft) at 1.0 kPa (4 in. w.g.) of differential pressure across fully closed damper when tested to AMCA Standard 511.
 - .10 Make and Model: Ruskin TED-50 or equivalent.
- .3 Actuators For Dampers, Electronic:
 - .1 Actuator Type: Modulating, except as indicated below for VAVs.

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- .2 Control Signal: Compatible with BC, AAC and ASC.
- .3 Floating control signal is acceptable only for VAV damper application.
- .4 Operating Time: Maximum 120 seconds throughout the full rotation or fast acting 75 seconds for critical systems with 2 position control.
- .5 Angle of Rotation: Adjustable between 0° to 90°.
- .6 Stall protection: Mechanical or electronic.
- .7 Actuators shall have electronic overload protection or digital rotation sensing circuitry to prevent actuator damage throughout the entire rotation.
- .8 Failsafe: Fail in place for VAV terminals; spring return for other applications. Spring return to normal position within 15 seconds or less than 10 seconds for critical systems with 2 position control.
- .9 Manual Override: Crank type. External gear release for fail in place actuators.
- .10 Position Indicator: Reversible for clockwise or counter-clockwise rotation; set the 0 degrees mark to the failsafe position.
- .11 Torque: To damper manufacturer's requirements to provide complete compression of seals between frame and blades and for smooth control.
- .12 Provide 2 SPDT auxiliary switches for critical systems dampers to prove open-closed.
- .4 Control Valves:
 - .1 Characteristics, materials and pressure ratings suitable for the application; refer to schedules.
 - .2 Flow Characteristic:
 - .1 Water:
 - .1 Two-way: Equal percentage.
 - .2 Three-way: A Port: Equal percentage. B Port: Linear or modified linear.
 - .2 Steam: Linear.
 - .3 Sizing Water Valves:
 - .1 Two-position: Line size with full ports.
 - .2 Two-way Modulating: Non Radiation: Pressure drop equal to the pressure drop through the coil or 27 kPa (4 psi), whichever is greater. Radiation: Pressure drop equal to 7 kPa (1 psi).
 - .3 Three-way Modulating: Non Radiation: Pressure drop equal to the pressure drop through the coil or 27 kPa (4 psi), whichever is greater. Radiation: Pressure drop equal to 7 kPa (1 psi).
 - .4 Butterfly Valves:
 - .1 Type: High-performance (HPBV).
 - .2 Make and Model: Dezurik BHP or equivalent.
 - .3 Tee-fitting: Provide for three-way application; with motor mounting bracket and linkage hardware.

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- .5 Valves 12 mm (1/2 in.) through 50 mm (2 in.):
 - .1 Screwed ANSI Class 250 bronze body.
- .6 Valves 62 mm (2-1/2 in.) and Larger:
 - .1 Water temperature less than 121 deg. C (250 deg. F) at 1035 kPa (150 psi) or less than 93.2 deg. C (200 deg. F) at 1139 kPa (165 psi): Flanged ANSI Class 125 cast iron body.
 - .2 Water temperature greater than 121 deg. C (250 deg. F) at 1035 kPa (150 psi) or greater than 93.9 deg. C (200 deg. F) at 1138 kPa (165 psi): Flanged ANSI Class 250 cast iron body or ANSI Class 300 cast steel body.
- .4 Sizing Steam Valves:
 - .1 Two-position: Pressure drop equal to 10% to 20% of inlet pressure.
 - .2 Modulating: Pressure drop equal to 50% of inlet pressure.
 - .3 Leakage: ANSI Class IV.
 - .4 Materials:
 - .1 Stems: Stainless steel.
 - .2 Plugs and Seats: Brass or steel.
 - .3 Packing: PTFE for steam.
 - .5 Rangeability: 40:1 minimum.
- .5 Pressure Independent Control Valves:
 - .1 Factory fabricated of type, body material, and pressure class based on maximum pressure and temperature rating of the piping system, unless otherwise indicated.
 - .2 Calibrated Balancing Valves and Automatic Flow-Control Valves shall not be required on devices where pressure independent control valves are installed.
 - .3 The control valves shall accurately control the flow from 0 to 100% full rated flow with an equal percentage flow characteristic.
 - .4 Each control valve shall be individually flow tested and factory verified to deviate no more than $\pm 5\%$ through the operating pressure range. A calibrated performance tag shall be provided with each valve (optional for 1/2" [15mm]) listing the measured flow rate in 10° rotation increments.
 - .5 Valve bodies 2" [50mm] and smaller shall be brass. Valve bodies 3" [75mm] thru 8" [200mm] shall be ductile iron. All internal parts shall be brass, carbon steel, stainless steel or Teflon®. Plastic internal parts are not acceptable.
 - .6 Control valve rangeability shall be 100:1 minimum.
 - .7 The manufacturer shall warrant all components for a period of 5 years from the date of production.
 - .8 The actuator shall be the same manufacturer as the valve, integrally mounted to the valve at the factory, or shall be provided with universal mounting plate to

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- allow installation of actuators meeting system electrical and valve torque requirements.
- .9 If valves have additional features such as energy management or temperature monitoring, these aspects are to be fully integrated into BAS using BACnet IP or MS/TP. All available information to be communicated to BAS.
- .10 All necessary low-voltage power requirements for the valves should be provided.
- .6 Actuators for Control Valves, Electronic:
 - .1 Type: Modulating, proportional flow control.
 - .2 Control Signal: Compatible with BC, AAC and ASC.
 - .3 Floating control signal is not acceptable.
 - .4 Operating Time: Maximum 120 seconds throughout the full rotation.
 - .5 Mounting: Corrosion resistant hardware.
 - .6 Stall Protection: Electronic overload or digital rotation sensing.
 - .7 Failsafe: Fail in place for terminal reheat coils; fail open for all other heating valves; fail open for critical cooling valves (e.g. server or IT rooms), fail closed for all other cooling valves. Spring return to fail position within 15 seconds. Battery or capacitor return are not acceptable. Refer to Sequence Of Operation for alternate fail positions as may be required.
 - .8 Manual Override: Crank type. External gear release for fail in place actuators.
 - .9 Position Indicator: Provide. Indicate valve open and closed positions.
 - .10 Sound level: Provide actuator with 30 dBA maximum sound level where valves are located within or near bedrooms. Provide additional acoustic cover as may be required to meet acoustic requirements in these areas. Confirm acoustic cover will not result in overheating of actuator. Coordinate cover to fit within radiator cabinets as may be required. delete if no sleeping areas in project.
 - .11 Close-off Pressure:
 - .1 Water:
 - .1 Two-way: 150% of total system head.
 - .2 Three-way: 300% of the pressure differential between ports A and B at design flow, or 100% of total system head.
 - .2 Steam: 150% of inlet pressure.
- .7 Electric Relays:
 - .1 Type: General purpose; enclosed coil; diodes provided for inductive switched loads; override button; LED "energized" indicator; plug-in type base.
 - .2 Contact rating, configuration and coil voltage suitable for application.
 - .3 Regulatory: UL listed.
- .8 Damper End Switches:
 - .1 Type: Lever operated activated by blade position.
 - .2 Electrical Contacts: Rated for 10 A resistive, 6 FLA at 120 VAC.

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- .3 Regulatory: UL listed.
- .9 Level Switches:
 - .1 Type: Float.
 - .2 Electrical Contacts: Rated for 10 A resistive, 6 FLA at 120 VAC.
 - .3 Mounting: Outside of measured fluid.
 - .4 Enclosure: NEMA rated for the application.
- .10 Ultrasonic Level Transmitter:
 - .1 Service: Compatible fluids. Not for use with powder and bulk solids.
 - .2 Accuracy: $\pm 0.2\%$ of maximum range.
 - .3 Resolution: 0.079" (2 mm).
 - .4 Output Signal: 4 to 20 mA (Two-wire).
 - .5 Temperature Compensation: Automatic.
 - .6 Enclosure Rating: NEMA rated for the application.
 - .7 Failsafe: On lost echo after 30 seconds, user selectable to 4, 20, 21, 22 mA or last signal.
 - .8 Display: 6 character LCD.
 - .9 Agency Approvals: CE compliance, FM approved.
- .11 Low Limit Electromechanical Thermostat:
 - .1 Type: Vapour Pressure; minimum 6000 mm (20 ft.) of capillary; actuated by any 300 mm (12 in.) of capillary element; manual reset upon activation.
 - .2 Electrical Contacts: Double-pole double-throw (DPDT), snap-acting; rated for 10A resistive, 6 FLA at 120 VAC.
 - .3 Adjustable Set Point: Range: -1 deg. C to 13 deg. C (30 deg. F to 55 deg. F) and set to 1.67 deg. C (35 deg. F).
 - .4 Regulatory: UL listed.
- .12 High Limit Electromechanical Thermostat:
 - .1 Type: Bimetallic sensing; manual reset upon activation.
 - .2 Mounting: Air stream.
 - .3 Electrical Contacts: Single-pole single-throw (SPST), normally closed, snap-acting; rated for 10 A resistive, 6 FLA at 120 VAC.
 - .4 Adjustable Set Point: Range: 38 deg. C to 66 deg. C (100 deg. F to 150 deg. F) and set to 57 deg. C (135 deg. F).
- .13 Electromechanical Thermostat:
 - .1 Wall Mount:
 - .1 Provide samples of covers to Part 1: Submittals, Samples.
 - .2 Low Voltage:
 - .1 Type: 24 VAC, bimetal-operated; vented ABS plastic concealed cover.

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- .2 Set Point: Range: 13 deg. C to 30 deg. C (55 deg. F to 85 deg. F);
1 deg. C (2 deg. F) maximum differential.
- .2 Line Voltage:
 - .1 Type: Bimetal-actuated open contact, or bellow-actuated enclosed snap-switch type, or equivalent solid state type; anticipation heater; vented metal concealed cover.
 - .2 Electrical Contacts: Rated for 10 A resistive, 6 A FLA at 120 VAC.
 - .3 Set Point: Range: 13 deg. C to 30 deg. C (55 deg. F to 85 deg. F); 1 deg. C (2 deg. F) maximum differential.
 - .4 Regulatory: UL listed.
- .14 Digital Thermostat:
 - .1 Digital thermostats shall be 7-day programmable digital type suited for the application.
 - .2 Standalone terminal units shall utilize a digital thermostat where shown on Drawings.
 - .3 Digital thermostat shall have user selectable engineering units (F or C) and set point adjustment.
 - .4 Digital thermostat shall support automatic daylight savings time switchover.
 - .5 Digital thermostat shall support automatic and manual heat/cool changeover when applicable.
 - .6 Digital thermostat shall support temporary set point adjustment with automatic return to normal operation.

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.15 Temperature Sensors:

.1 General Requirements:

- .1 Temperature sensors shall be of the resistance type, two-wire 1000 ohm nickel RTD, two-wire 1000 ohm platinum RTD or two-wire 10,000 ohm thermistor.

.2 Space Temperature Sensors:

- .1 Stainless Steel plate sensors or white-plate sensors For installation throughout the facility where local control is not required (such as corridors or lobby) unless otherwise noted.

.3 Space Temperature Sensors With Adjustable Set-Point, Override and Display:

- .1 Key pad or slider for temperature set-point adjustment.
- .2 LED display.
- .3 Timed override request push button with LED status for activation of after-hours operation.
- .4 For installation only where indicated on Drawings, controls diagrams or sequences of operations.

.4 Covers for Wall Mount Sensors:

- .1 Overrides: Exposed set point adjustment and override button.
- .2 Communication Port: For communication between Portable Operator Terminals and ASC controllers.

.5 Averaging Temperature Sensors:

- .1 Minimum 1.5 m (5 ft) of capillary per 1 sq m (10 sq ft) of duct cross-section.
- .2 Provide multiple sensors where single averaging element is unable to be positioned to provide complete duct or plenum traverse.

.6 Outside Air Temperature Sensors:

- .1 Outside air temperature sensors shall be designed to withstand the environmental conditions to which they will be exposed.
- .2 The sensors shall be provided with a solar shield.
- .3 Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.

.7 Duct Temperature Sensors:

- .1 Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
- .2 Probe length shall be no less than 1/3 of the duct width or diameter.
- .3 For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.

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- .8 Thermowells:
 - .1 Brass or Type 316 stainless steel suitable for the application.
 - .2 Heat transfer compound compatible with sensing element.
- .9 Guards for Sensors and Thermostats:
 - .1 Materials: Heavy gauge steel.
- .16 Relative Humidity Sensors:
 - .1 Sensors shall be calibrated to NIST standards.
 - .2 Sensing Element:
 - .1 Type: Thin film capacitance.
 - .3 Transmitter:
 - .2 Range: 0 to 100% RH.
 - .3 Signal: 4 to 20 mA or 0-10 VDC with span and zero adjustment.
 - .4 Accuracy Rating: +/- 2% of output reading.
 - .5 Outside air relative humidity sensors shall be installed with a rain proof, perforated cover. The transmitter shall be installed in a NEMA 3R enclosure.
 - .6 Duct type sensing probes shall be constructed of 304 stainless steel, and shall be equipped with a neoprene grommet, bushings, and a mounting bracket.
- .17 Pressure Sensors:
 - .1 General:
 - .1 Sensing Element:
 - .1 Type: Capacitance sensing.
 - .2 Materials: Suitable for continuous contact with measured medium.
 - .2 Transmitter:
 - .1 Range: Not to exceed two times the operating pressure.
 - .2 Signal: 4 to 20 mA or 0-10 VDC; with zero and span adjustment.
 - .3 Accuracy Rating: +/- 1.0% of full scale.
 - .4 Response Time: Maximum 0.5 seconds.
 - .3 Isolation Valve: Between process connection and sensor.
 - .1 Capable of withstanding 100% overpressure without damage
 - .4 Air Static Pressure Sensors:
 - .1 Sensing Element:
 - .1 Type: Capacitance sensing with pitot tube sensing tips screwed securely to duct.

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.18 Submersible Pressure Sensor:

- .1 The sensor housing shall be made from high strength stainless steel or titanium for pressure ranges 1.25 times the maximum system pressure and compatible with a wide range of liquids.
- .2 The sensor shall be vented through the cable to correct for barometric pressure changes.
- .3 Sensor over range protection shall be two times rated pressure.
- .4 Accuracy shall be +/- 0.25% of the full scale or better.
- .5 Available control signals shall be 2-10 VDC or 4-20 mA.

.19 AC Current Sensing Switches:

- .1 Type: Self-powered solid-state with split-core.
- .2 Electrical Contacts: Rated for 1 A resistive at 30 VAC/DC.
- .3 Insulation Rating: 600 VAC.
- .4 Adjustable trip point with LED status indicator.

.20 AC Current Transducers:

- .1 Type: Self-powered or loop-powered solid-state with split-core.
- .2 Amperage Range: Motors: Factory calibrated to LRA; Switchgears: Factory calibrated to design load.
- .3 Insulation Rating: 600 VAC.
- .4 Signal: 4 to 20 mA or 0-10 VDC; internal zero and span adjustment.
- .5 Accuracy Rating: +/- 2% of full scale.
- .6 Regulatory: UL listed or CSA approved.

.21 CO2 Sensors:

- .1 Sensor shall employ non-dispersive infrared technology (NDIR).
- .2 Accuracy shall be +/- 75 ppm over 0-1500 ppm range.
 - .1 All CO2 sensors reading below 350 ppm shall be re-calibrated or replaced to provide an accurate reading.
- .3 Response time shall be less than 1 minute.
- .4 Sensor shall have field selectable 0-10 VDC and 4-20 mA outputs.
- .5 Power voltage shall be 20-30 VDC/AC.
- .6 Operating temperature range shall be 0 to 50 deg. C.
- .7 The sensor shall be wall mount.

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.22 Gas Detection System:

.1 Gas Detection Controller:

- .1 Use: Centralized gas detection monitoring with real-time gas reading, selective alarm activation
- .2 Enclosure: NEMA 4X Polycarbonate - ABS
- .3 Power Requirement: 17-27 Vac, 24-38 Vdc, 500 mA
- .4 Network: Three Modbus channels for up to 96 transmitters and an optional BACnet/LON/IP output; Communication Line Up to 609 m (2000 ft.) per channel
- .5 Alarm Levels: fully programmable alarm levels; Time Delays 0, 30 sec., 45 sec., 1-99 minutes before and after alarm
- .6 Outputs: 4 DPDT relays (alarms and/or fault) at 5 A, 30 Vdc or 250 Vac (resistive load); 65dBA buzzer
- .7 Display: 122 x 32 dot matrix LCD display
- .8 Operating Humidity Range: 0-95% RH, non-condensing
- .9 Operating Temperature Range: -20 to 50 deg. C (-4 to 122 deg. F)
- .10 Certifications: CAN/CSA C22.2 No 61010-1
- .11 Conforms to: ANSI/UL 61010-1; IEC 61010-1 Including Amendments A1:1992 + A2:1995 and National Deviations (Canada, US)
- .12 Make and Model: Honeywell 301C, or Belimo Opera Model 6000, or equivalent.

.2 Wired or Stand-Alone Gas Transmitter:

- .1 Use: Wall mounted, wired gas detector transmitter used in conjunction with controller
- .2 Power Requirement: 24 Vac nominal (17-27), 50/60 Hz, 0.35A; 24 Vdc nominal (20-38Vdc)
- .3 Network: Modbus RS-485; BACnet MS/TP master
- .4 Display: 8 character, 2 line backlit LCD
- .5 Visual Indicators: Green LED; Power, Amber LED 1: Alarm/ Fault, Amber LED 2: Alarm/ Fault
- .6 Audible Alarm: >85 dbA at 3m (10ft)
- .7 Relay Output: Network 1 DPDT relay, 5A @ 250Vac; 5A @ 30 Vdc; Stand Alone 2x DPDT relay, 5A @ 250Vac; 5A @ 30 Vdc
- .8 Sensing Technology: Toxic = Electrochemical; Combustibles = Catalytic; Oxygen = Diffusion fuel cell
- .9 Accuracy: Toxic, Combustibles, Oxygen = +/- 3%
- .10 Detection Range: Carbon Monoxide = 0 - 250 ppm; Nitrogen Dioxide (NO2) = 0-10 ppm; Oxygen = 0-1 ppm; Combustibles = 0-100% LEL;
- .11 Certified to: CAN/CSA C22.2 No. 61010-1

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- .12 Conforms to: ANSI/UL 61010-1
- .13 Sensors Make and Model: Honeywell E3 Point, Belimo Opera Model 6000, or equivalent.
- .23 Refrigerant Gas Detection System:
 - .1 Gas Detection Controller /Expansion Module - Inside Mechanical Room
 - .1 Use: Centralized Stand Alone refrigerant gas detection monitoring main controller with real-time gas reading, selective alarm activation
 - .2 Power Requirement: 22-27 Vac, 29-38 Vdc, 2A max @ 29Vdc
 - .3 Up to 20 gas transmitters, Digital Communication Modbus RS-485 Line, Up to 61 m (200 ft.) from the controller.
 - .4 Alarm Levels: 3 fully programmable alarm levels
 - .5 Outputs: 4 DPDT form C relays (alarms and/or fault) at 5 A, 30 Vdc or 250 Vac (resistive load); 65dBA buzzer, 3 Outputs at 24 Vdc @ 250 mA each
 - .6 Integral Strobe/Horn: STAS flashing LED/105dBA, 4-28V, 2800Hz (RFSA)
 - .7 Display: 122 x 32 dot matrix backlit LCD display
 - .8 Visual Indicators: - Green LED - Normal Operation
 - .9 Red LED Gas Alarm A, B, and C
 - .10 Yellow LED: Fault/Service
 - .11 The Controller/expansion module must provide all the functionalities necessary to comply with current ASHRAE 15 guidelines and CSA B-52 Mechanical Codes.
 - .12 Manual Fan Start/Stop operation
 - .13 Audible Alarm with a silence key to acknowledge
 - .14 Visible Alarm
 - .15 Operating Humidity Range: 0-95% RH, non-condensing
 - .16 Operating Temperature Range: 0 to 40 deg. C (32 to 100 deg. F)
 - .17 Enclosure rating: NEMA 4X, ABS - Polycarbonate - indoor
 - .18 Certifications: CAN/CSA C22.2 No 61010-1
 - .19 Conforms to: ANSI/UL 61010-1; IEC 61010-1 Including Amendments A1:1992 + A2:1995 and National Deviations (Canada, US)
 - .2 Make and Model: Honeywell 301EM RFSA or equivalent Gas Detection Remote Annunciator Panel: Outside Mechanical Room
 - .1 Use: Remote Annunciator / Slave display panel located outside each entrance to Mechanical room
 - .2 Power Requirement: 22-27 Vac, 50 or 60 Hz, 29-38Vdc, 2.0 A max @ 24 Vdc
 - .3 Up to 10 remote Annunciator panels can be connected to the main refrigerant gas detection Controller; Digital Communication Modbus RS-485 up to 304 m (1000 ft).

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- .4 The remote annunciator panel must provide all the functionalities necessary to comply with Current ASHRAE 15 and CSA B-52 Mechanical Codes. This includes a key for manual "fan start" only operation, strobe/horn audible visual alarm on top of the unit
- .5 Display 122 x 32 dot matrix backlit LCD display
- .6 Visual Indicators: - Green LED - Normal Operation
- .7 Red LED Gas Alarm A, B, and C
- .8 Yellow LED: Fault/Service
- .9 The Remote annunciator panel will indicate the exact concentration of refrigerant gas as displayed on the 301EMRFSA Main Controller and the refrigerant gas detected. The LCD display screen will indicate multiple alarm levels for each sensing point.
- .10 Operating Temperature Range: 0 to 40 deg. C (32 to 100 deg. F)
- .11 Enclosure rating: NEMA 4X, ABS - Polycarbonate - indoor
- .12 Certifications: CAN/CSA C22.2 No 61010-1
- .13 Conforms to: ANSI/UL 61010-1; IEC 61010-1 Including Amendments A1:1992 + A2:1995 and National Deviations (Canada, US)
- .14 Make and Model: Honeywell 301EM RP RFSA or equivalent
- .3 Wired Refrigerant Gas Transmitter:
 - .1 Use: Wall mounted, wired refrigerant gas detector transmitter used in conjunction with 301EMRFSA controller, Diffusion Type with no internal sample pump or filter maintenance required
 - .2 Power Requirement: 8.5 - 12.5 Vdc, 1A@10 Vdc Maximum
 - .3 Network: Modbus RS-485
 - .4 Sensing Technology: NDIR (Non Dispersive Infrared)
 - .5 Accuracy: ± 10 ppm @ 50 ppm / ± 40 ppm @ 500 ppm
 - .6 Detection Range: Refrigerants 0-1000 ppm
 - .7 R11, R12, R13B1, R22, R114, R123, R125, R134a, R227, R245A, R404A, R407C, R410A, R507, R508b
 - .8 Resolution: 1 ppm
 - .9 Response Time (T90) 60 seconds
 - .10 Operating Temperature Range: 0 to 40 deg. C (32 to 100 deg. F)
 - .11 0 to 95% RH (non-condensing)
 - .12 Enclosure NEMA 4X ABS/Polycarbonate - Indoor
 - .13 Certified to: CAN/CSA C22.2 No. 61010-1
 - .14 Conforms to: ANSI/UL 61010-1
 - .15 Make and Model: Honeywell 301IRFS sensors or equivalent.

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.24 Water Flow Meters:

- .1 Provide an Electromagnetic Flow Meter complete with integral or remote transmitter.
- .2 The transmitter shall include a backlit graphic display and keypad. Output signals shall be 4-20 mA and programmable pulse.
- .3 The flow meter shall be installed either in the supply or return pipe of the system to be measured following the manufacturer's written instructions. The flow meter size shall be selected based on the minimum and maximum flow range for the application.
- .4 Connections to the piping shall be ANSI class 150 flanges (ANSI class 300 where required).
- .5 The flow tube shall be epoxy coated steel; the sensing electrodes shall be 316SS; the liner shall be polypropylene or ebonite for low temperature service, PTFE for hot water service (302 F maximum).
- .6 Each flow meter shall be individually wet-calibrated and accurate to within $\pm 0.2\%$ of reading from 3 to 33 feet per second velocity. A certificate of calibration shall be provided with each flow meter.
- .7 The flow meter shall be capable of measuring bi-directional flow.
- .8 For installations in non-metallic pipe, an internal grounding electrode shall be provided which eliminates the need for external grounding rings.
- .9 Each flow meter shall be factory programmed for its specific application, and shall be re-programmable using the integral keypad on the converter (no special interface device or computer required).
- .10 Make and Model: ONICON F-3000 Series Electromagnetic Flow Meter or equivalent.

.25 BTU Meters:

- .1 The entire BTU metering system shall be built and calibrated by a single manufacturer and shall consist of a flow meter, two temperature sensors, a Btu meter, temperature thermo wells, and all required mechanical installation hardware. A certificate of NIST (U.S. National Institute of Standards and Technology) traceable calibration shall be provided with each system. All equipment shall be covered by the manufacturer's two year warranty.
- .2 The Btu meter shall provide the following information via both an integral LCD, and via network communications (protocol conforming to BACnet or LON): Energy Total, Energy Rate, Flow Total, Flow Rate, Supply Temperature and Return Temperature. Each Btu meter shall be factory programmed for its specific application, and shall be re-programmable using the front panel keypad (no special interface device or computer required).

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- .3 Insertion type flow meters shall be provided complete with all installation hardware necessary to enable insertion and removal of the meter without system shutdown, and be hand-insertable up to 400 psi. Inline meters shall be installed with isolation valves to allow installation or removal of the flow meter without a system shutdown. Turbine rotation shall be detected by electronic impedance-based sensing (non-magnetic). Each flow meter shall be individually wet-calibrated against a primary volumetric standard that is accurate to within 0.1% and traceable to NIST. A certificate of calibration shall be provided with each flow meter. Accuracy shall be within $\pm 0.5\%$ of rate at the calibrated velocity, within $\pm 1\%$ of rate over a 10:1 turndown (3.0 to 30 ft./s) and within $\pm 2\%$ of rate over a 50:1 turndown (from 0.4 to 20 ft/s). The flow meter shall include an integral 0-15V square wave output as an input to the Btu Meter.
- .4 Temperature sensors shall be loop-powered current based (mA) sensors and shall be bath-calibrated and matched (NIST traceable) for the specific temperature range for each application. The calculated differential temperature used in the energy calculation shall be accurate to within $+0.150^{\circ}\text{F}$ (including the error from individual temperature sensors, sensor matching, input offsets, and calculations).
- .5 Make and Model: ONICON System-10 BTU Meter or equivalent.
- .26 Energy Meters:
 - .1 The energy meter shall conform to ANSI C12.1 metering accuracy standards.
 - .2 The energy meter shall consist of a meter and CTs calibrated together as a system.
 - .3 Accuracy shall be $\pm 1\%$ from 2-100% of rated current.
 - .4 The energy meter shall not require annual recalibration.
 - .5 The energy meter shall derive operating power from its metering connection and shall not require separate control power connection.
 - .6 The energy meter electronics shall automatically correct for CT phase reversal.
 - .7 LCD display shall show accumulated kWh, Amps, Voltage.
 - .8 The energy meter shall have a pulse output with selectable pulse output rates.
 - .9 The energy meter shall meet UL and cUL specifications.
- .27 Air Flow Stations (Fan Bell Mouth):
 - .1 The measuring device shall consist of air flow traverse probes mounted on the fan bell mouth. The probes shall contain multiple total and static pressure sensors placed at concentric area centers along the exterior surface of the cylindrical probe and internally connected to their respective averaging manifolds. Sensors shall not protrude beyond the surface of the probe, not be adversely affected by particle contamination normally present in building system airflows. The fan inlet air flow traverse probes (two per inlet) shall have dual end support swivel brackets suitable for mounting in the fan inlet bell and symmetrical averaging signal takeoffs and fittings and shall be of aluminum construction with hard anodized finish. The fan inlet airflow traverse probes shall not induce a measurable pressure drop, nor shall the sound level with the system be amplified by its presence in the fan inlet bell. The probes shall be capable of producing steady, non-pulsating signals of total and static pressure, without need for flow

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- corrections or factors, with an accuracy of +/- 3% of actual flow over a fan operating range of 6 to 1 capacity turndown.
- .2 Velocity pressure transmitter shall be selected to suit the system working pressures and shall meet the following performance requirements:
 - .1 Calibrated accuracy within +/- 0.25% of span.
 - .2 Repeatability within 0.05% of output.
 - .3 Dead band & hysteresis not detectable or measurable.
 - .3 Square root extractor and multiplier shall meet the following performance requirements:
 - .1 Calibrated Accuracy: +/- 0.5% of flow.
 - .2 Hysteresis: Not detectable.
 - .3 Repeatability: 0.05% of output.
 - .4 Response: 0.5 seconds.
 - .5 Multiplier: Adjustable 0.3 to 2.8.
 - .4 Provide a control panel that shall contain all control equipment. Each panel shall have a hinged door, latch and lock.
 - .5 Transmitter shall provide a 4 to 20 mA or 0 to 10 VDC signal proportional to flow to the BAS. The signal shall be converted to L/S (CFM) by the BAS.
 - .6 The fan inlet airflow traverse probes and velocity pressure transmitter shall be Air Monitor Corporation VOLU-probe/FI and Veltron II.
 - .7 Acceptable equal shall be Ebtron Gold Series:
 - .1 The air sensors shall be self heated thermistors and epoxy encapsulated temperature sensors. The heated element shall determine velocity and the other shall provide a reference temperature signal to the velocity sensor to compensate for temperature changes in the air flow. There shall be a minimum of two sensors per type, per inlet.
 - .2 Individual flow sensors shall transmit digital flow/temperature information to a microprocessor based control panel which shall total/average signals and output flow signals (L/S or CFM) to the host DDC panel. The signals shall be linear 0 to 10 VDC or 4 to 20 mA.
 - .3 The velocity linearity shall be 2% of reading, with a repeatability of 3% scale, over a fan operating range of 6 to 1 capacity turndown. The station shall not induce a measurable pressure drop or increase the sound emitted by the system.
 - .4 A control panel shall be provided with an alpha numeric display of the air volumes and temperature of the points monitored. A keypad or PC link shall allow remote monitoring, trouble shooting or system reconfiguration.

BUILDING AUTOMATION SYSTEM (BAS)

.28 Air Flow Stations (Duct Mount):

- .1 Fan air volume measuring device shall be either rectangular or round as indicated. Unit shall have 14 gauge galvanized sheet steel casing, flanged for installation to duct or plenum as applicable, with aluminum honeycomb equalizer and air straightening grid with copper static pressure sensors and total pressure sensors, installed in a grid pattern to provide total coverage of the device. Unit shall be capable of reading volumes within 1% for a velocity range of 800 to 4000 feet per minute (4 to 20 m/s).
- .2 Velocity pressure transmitter shall be selected to suit the system working pressures and shall meet the following performance requirements:
 - .1 Calibrated Accuracy: +/- 0.25% of span.
 - .2 Repeatability: 0.05% of output.
 - .3 Dead band & hysteresis: Not detectable.
- .3 Square root extractor and multiplier shall meet the following performance requirements:
 - .1 Calibrated Accuracy: +/- 0.5% of flow.
 - .2 Hysteresis: Not detectable.
 - .3 Repeatability: 0.05% of output.
 - .4 Response: 0.5 seconds.
 - .5 Multiplier: Adjustable 0.3 to 2.8.
- .4 Control panel shall be industrial standard wall mounted and shall contain all control equipment. Each panel shall have a hinged door, latch and lock.
- .5 Flow measuring device and velocity pressure transmitter shall be Air Monitor Corporation Fan-Evaluator and Veltron II.
- .6 For LEED projects, where outdoor airflow rates are being measured, indirect measurements of airflow rates, such as temperature or current transducers are not acceptable. Provide air volume measuring devices capable of measuring the minimum outdoor air intake flow with an accuracy of +/- 10% of the design minimum outdoor airflow rate. Provide sensor with an alarm connection for monitoring of airflow setpoint.
- .7 Acceptable equal shall be Ebtron Gold Series:
 - .1 Each thermal flow sensor shall contain two individual sensing elements. One element shall determine velocity and the other shall provide a reference signal to the velocity sensor to compensate for temperature in the air flow. Each flow sensor shall operate independently and shall not affect any other flow sensors in the stations.
 - .2 Thermal flow sensor operation shall not be affected by dust particles in quantities typical to HVAC applications. The thermal flow sensors shall be mounted in aluminum probes for duct mounting and adjustable steel struts for fan inlet mounting. The number of sensors and probes shall be selected to provide maximum accuracy.

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- .3 Individual flow sensors shall transmit digital flow/temperature information to a microprocessor based control panel which shall total/average signals and output flow signals L/S (CFM) to the host DDC panel. The signals shall be linear 0 to 10 VDC or 4 to 20 mA. The velocity linearity shall be 2% of reading, with a repeatability of 3% of scale, over a fan operating range of 6 to 1 capacity turndown. The station shall not induce a measurable pressure drop or increase the sound emitted by the system.
- .4 A control panel shall be provided with an alphanumeric display of the air volumes and temperatures of the points monitored. A keypad or P.C. link shall allow remote monitoring, trouble shooting or system reconfiguration.

2.12 Wire And Conduit

- .1 Conduit: Electrical metallic tubing EMT with compression type fittings in dry locations; cold rolled steel zinc coated or zinc coated rigid steel with threaded fittings in wet locations or where exposed to weather.
- .2 Outlet boxes: Dry locations: sheradized or galvanized drawn steel 100 mm (4 in.) square or octagon with suitable raised cover; Exposed to Weather: threaded hub cast aluminum boxes with gasket plate.
- .3 Junction boxes: Sized according to number, size and position of entering raceway; type: suitable for the environment.
- .4 Wire:
 - .1 Network:
 - .2 Analog Input, Output: Stranded 18 gauge copper twisted shielded.
 - .3 Binary Input, Output: 18 gauge, minimum insulation rating of 600 volts.
 - .4 Class 2: FT-6 without conduit in ceiling plenums; FT-4 in conduit for all other cases.
 - .5 Plenum rated wiring to be used.

PART 3 - EXECUTION

3.1 General

- .1 Install all controllers, cabinets, control devices and power supplies in readily accessible locations providing adequate ambient conditions for its specified application and to the Canadian Electrical Code.
- .2 Install Products to manufacturer's installation instructions.
- .3 Install parallel to building walls and floors unless indicated or specified or required by manufacturer's installation instructions.
- .4 Mechanical Subcontractor shall install all in-line devices such as temperature wells, pressure taps, airflow stations, etc.

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3.2 Coordination

- .1 Submittals: To Part 1: General, Submittals.
- .2 Integrate and coordinate Work under this section to controls and control devices provided or installed by others.
- .3 Each Supplier of control Product to configure, program, start-up and commission that product to satisfy requirements of Sequence of Operation regardless of where within Contract Documents product is described or specified.
- .4 Resolve compatibility issues between control Product provided under this section and those provided under other sections or divisions of this Specification.

3.3 Wiring And Conduit

- .1 Wire shall be neatly tie wrapped to conduit mounted to the building structure but must be installed at right angles or parallel to the building. Loose wiring shall only be allowed over a distance of 1500 mm (5 ft.) but must not pass over lighting fixtures.
- .2 Wiring in Equipment Room, between floors, or between concrete walls shall be installed in conduit. Exposed wiring will not be accepted. Conduit shall be installed at right angles or parallel to the building walls.
- .3 Should it become necessary to splice field wiring it shall be soldered. If soldering is not possible, approved B type crimp connectors are an acceptable alternative. Wire nuts and Marr connections are not acceptable. Provide a 500 mm (20 in.) loop length at all splices.
- .4 Conceal conduit within finished shafts, ceilings, and walls as required. Install exposed conduit parallel with or at right angles to the building walls.
- .5 Plug or cap unused conduit openings and stubs with compatible fittings.
- .6 Route all conduit to clear beams, plates, footings and structural members except through column footings and grade beams.
- .7 Provide watertight seals at penetrations through outside foundation walls.
- .8 Support conduit 25 mm (1 in.) and smaller to the building with one-hole non-perforated malleable iron or steel pipe straps. Suspend conduits larger than 1 in. on pipe racks with split-ring hangers and rods.
- .9 Maintain caps on conduit openings throughout construction.
- .10 Where conduit is attached to vibrating or rotating equipment, install and anchor flexible metal conduit with a minimum length of 450 mm (18 in.) and a maximum length of 900 mm (36 in.) in such a manner that vibration and equipment noise will not be transmitted to the rigid conduit.
- .11 Where exposed to weather or in damp or wet locations, provide waterproof flexible conduit.
- .12 Fill conduit to maximum of 60 % of its capacity. Provide a pull rope within the conduit when the installation is complete. Bend conduit to a radius of greater than 3 times the conduit diameter to a maximum of three 1/4 bends permitted between pull boxes.
- .13 Wire within cabinets shall be installed in a plastic tray with a cover. Terminate wires to field-removable, modular terminal strips.
- .14 All field sensors shall be provided with a flexible conduit connection minimum length of 450 mm (18 in.) and an enclosure for the electrical connections.

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3.4 Power Wiring

- .1 Power for Section 23 09 00 - BUILDING AUTOMATION SYSTEM (BAS) shall be provided under Electrical Division 26 at 120 VAC 60 Hz single phase and shall terminate in junction boxes installed where shown on electrical and/or Mechanical Drawings. Wiring and conduit from these boxes to control devices being electrically powered to be provided by Section 23 09 00 - BUILDING AUTOMATION SYSTEM (BAS).
- .2 Where power for equipment is fed from MCC, 120 VAC power for Section 23 09 00 - BUILDING AUTOMATION SYSTEM (BAS) shall also be fed from the MCC from the 120 VAC section. Wiring and conduit from the MCC to control devices being electrically powered to be provided by Section 23 09 00 - BUILDING AUTOMATION SYSTEM (BAS).

3.5 Communication Wiring

- .1 Install communication wiring per controls manufacturer recommendations as to type of wire used and segment lengths.
- .2 Install communication wiring in conduit and raceways separated from other wiring.
- .3 Verify entire network's integrity following cable installation using appropriate tests for each cable.
- .4 Each run of communication wiring to be continuous length without splices.
- .5 Provide data cables in conduit back to the closest data/telecom closet/room to allow all BAS head end equipment to connect to the network and all BAS controllers in the building as applicable to the project.
- .6 Ensure data cables are coordinated with requirements of BAS equipment based on submitted Shop Drawings.

3.6 Operator Interface

- .1 Operator Software:
 - .1 Security: Set up operators with independent user login name and password and assign access levels to The City's requirements.
 - .2 Reports: Configure the following reports:
 - .3 List of objects and point object data that are in alarm state sorted by priority in descending order then by point object name in ascending order.
 - .4 List of disabled point objects sorted by point object name in ascending order.
 - .5 List of TOD Schedules: Indicate: objects assigned to the TOD Schedule, Occupied Mode times.
- .2 Graphics: Generate graphic representations for systems under Section 23 09 23 - SEQUENCE OF OPERATION FOR BAS and as follows:
 - .1 Building elevation in three dimensions; indicate: floors and mechanical rooms.
 - .2 Floor plans: Indicate: Equipment rooms; point object data for temperature, humidity and pressure. Directly access graphic representation for terminal systems.
 - .3 Equipment Rooms: Indicate locations for systems.
 - .4 Systems: Indicate: Equipment, service connections, point object data, set points, reset schedules. Highlight point objects under operator command.

BUILDING AUTOMATION SYSTEM (BAS)

- .5 Graphic representations link to and display graphic representations for associated systems.

3.7 Cabinets

- .1 Install rigidly to wall or to an independent frame installed to the floor slab. Installation to duct, equipment and locations subject to vibration is not accepted.
- .2 Cabinets for ASC controllers: Install to terminal equipment. Installation to duct, equipment and locations subject to vibration that could affect controller operation or calibration of control device is not accepted.
- .3 Coordinate cabinet locations with other trades and Contractor. Location to be easily accessible. Installation requiring moving of furniture, ladders or other means is not acceptable.

3.8 Control Devices

- .1 Provide or furnish control devices as indicated on the Drawings and to the requirements of this Section and to execute sequence of operation under Section 23 09 23 - SEQUENCE OF OPERATION FOR BAS.
- .2 Provide or furnish control devices as indicated on the Drawings and to the requirements of this Section and to execute sequence of operations.
- .3 Motor Operated Dampers (Insulated and Uninsulated):
 - .1 Furnish motor operated dampers for installation under Section 23 31 13 - DUCTWORK AND SPECIALTIES. Provide supervision on site during installation.
 - .2 Install in areas maintained above freezing.
 - .3 Install insulated motor operated dampers on all systems that connect with (or transfer air to/from) the exterior ambient environment and operate intermittently (i.e. time of day schedule, temperature sensor controlled, etc.).
- .4 Actuators for Dampers, Electronic:
 - .1 Mounting: Direct coupled to drive shaft or jackshaft using a V bolt design.
- .5 Combination Smoke and Fire Damper and Smoke Damper Positions:
 - .1 Monitor the positions of combination smoke and fire dampers and smoke dampers (e.g. open or closed) on the BAS based on damper end switches. Combination smoke and fire dampers, smoke dampers, and end switches are provided under Section 23 31 13 – DUCTWORK AND SPECIALTIES. Coordinate termination of wires with Fire Alarm Contractor, as the fire alarm system will also be monitoring the damper positions.
- .6 Control Valves:
 - .1 Furnish control valves for installation under Section 22 11 13 - PIPE, VALVES AND FITTINGS (EXCEPT PLUMBING). Provide supervision on site during installation.

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- .7 Actuators for Control Valves, Electronic:
 - .1 Factory install or field install actuator to valve body.
 - .2 Low Limit Electromechanical Thermostat.
 - .3 Install hardwire interlocked to supply fan starter for respective system.
 - .4 Provide according to Section 23 09 23 - SEQUENCE OF OPERATION FOR BAS.
 - .5 Shut down the fan when duct temperature is equal to or less than 1.67 deg. C (35 deg. F).
 - .6 Install to adequately cover potential areas of low level stratification. Provide one low-limit thermostat for each 2.8 sq. m. (25 sq. ft.) of duct cross section. Mount sensing element on plastic clips.
- .8 High Limit Electromechanical Thermostat:
 - .1 Install hardwire interlocked to fan starters for respective system.
 - .2 Shut down the fans when duct temperature is equal to or greater than 51.7 deg. C (125 deg. F).
 - .3 Provide one high-limit thermostat for each 3.7 sq. m (40 sq. ft.) of duct cross section.
- .9 Electromechanical Thermostats and Temperature Sensors:
 - .1 Furnish sensing wells for installation under Section 22 11 13 - PIPE, VALVES AND FITTINGS (EXCEPT PLUMBING). Provide supervision on site during installation.
 - .2 Samples: Provide for wall mount type to Part 1: Submittals, Samples.
 - .3 Wall Mount Type:
 - .1 Cover Colour: White.
 - .2 Install to furred-in columns and permanent walls on concealed junction boxes supported by wall framing or surface mount 1.2 m (4 ft) above finished floor. Installation to mobile and temporary partitions is not acceptable.
 - .3 Installation to exposed architectural concrete columns and walls is not acceptable, unless otherwise indicated or specified. For installation to concrete, set conduit in place before pouring of concrete.
 - .4 Single Point Type, Duct:
 - .1 Provide sufficient contact with process fluid to measure average conditions.
 - .2 Apply pipe sealing compound to plug thread.
 - .5 Single Point Type, Pipe:
 - .1 Provide sufficient contact with process fluid to measure average conditions.
 - .2 Install with heat conducting fluid in wells.

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- .6 Outdoor Type:
 - .1 Install to north side of building away from sources of heat such as lamps and exhaust vents; to greater than 1500 mm (5 ft) above horizontal surfaces.
 - .2 Where indicated or specified for installation in outside air intake, locate so as not to be affected by exhaust air flow or reverse flow.
 - .3 Provide solar shield. Install shield to open downward.
 - .4 Seal interior of conduit at penetration through exterior wall.
- .10 Guards for Thermostats and Temperature Sensors:
 - .1 Provide for wall mount sensors and thermostats where indicated on the Drawings.
 - .2 Samples: Provide to Part 1: Submittals, Samples.
- .11 Air Static Pressure Sensors:
 - .1 Duct Mount: Pipe the high-pressure tap to the duct using a pitot tube.
 - .2 Building Static: Pipe the low-pressure port of the pressure sensor to the static pressure port located on the outside of the building and install with a shielded static air probe to reduce pressure fluctuations caused by wind.
 - .3 The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.
- .12 Wet/Wet Differential Pressure Sensors:
 - .1 Differential pressure sensors shall be supplied with tee fittings and shut-off valves in the high and low sensing pick-up lines.
- .13 Relative Humidity Sensors:
 - .1 Install to requirements for Electric Thermostats and Temperature Sensors.
- .14 AC Current Sensors and Transducers:
 - .1 Install in motor starter cabinet.
- .15 CO Sensors:
 - .1 Mount the sensor between 900 mm (35.44 in.) and 1200 mm (47.24 in.) above finished floor.
 - .2 For parking garage applications, set low limit at 50 ppm and high limit at 100 ppm.
 - .3 Provide sufficient number of sensors for full coverage of the monitored area.
- .16 NO2 Sensors:
 - .1 Use two sensors per zone, mount one of the sensors 305 mm (1 ft.) from the floor and the other 305 mm (1 ft.) from the ceiling.
 - .2 For parking garage applications, set low limit at 1 ppm and high limit at 3 ppm.
 - .3 Provide sufficient number of sensors for full coverage of the monitored area.

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.17 Water Flow Meters:

- .1 The installing Contractor is responsible for providing suitable mating flanges and any required reducer/expander.

.18 Gas Meter Connection:

- .1 This Contractor shall provide connection from BAS to standard output of a gas meter transducer provided by local authorities.

.19 Air Flow Sensors, Fan Bell Mouth:

- .1 Coordinate installation of air flow sensors to inlet of fans with fan manufacturer.

.20 Refrigerant Gas Detection System:

- .1 Provide complete and operational system in accordance with CSA B52 "Mechanical Refrigeration Code."
- .2 Provide refrigerant vapour detector(s) in areas where refrigerant from a leak is most likely to concentrate and have detectors activate at a value no greater than the corresponding threshold limit value (TLV) / time-weighted average (TWA) limits or ammonia limits described in CSA B52.
- .3 Provide multiple detectors where leaks are likely to concentrate in multiple locations including but not limited to:
 - .1 High and Low elevations where multiple refrigerants may stratify to different heights.
 - .2 At each ventilation exhaust inlet where airflow patterns direct leaks to multiple locations.
- .4 Provide remote annunciator panels outside of each entrance to the Mechanical Room.

.21 Air Flow Sensors, Duct Mount:

- .1 Furnish duct mount air flow sensors for installation under Section 23 31 13 - DUCTWORK AND SPECIALTIES. Provide supervision on site during installation.

3.9 Identification

- .1 All wires shall be tagged at both ends. The tagging shall identify the device it is connected to. Use of the point object name is acceptable.
- .2 All wires passing through a junction box shall be tagged with the device identity or its termination point.
- .3 The junction boxes shall be tagged "BAS" with a sequential number suffix.
- .4 Label wires, control devices, controllers.

3.10 Testing And Commissioning

- .1 Test and commission the BAS prior to the Demonstration and Acceptance Test.
- .2 Test and commission the BAS prior to the Demonstration.
- .3 Prepare test forms which shall identify each test. The forms shall be sub-divided into:
 - .1 Points, controllers
 - .2 Programs, loops, networks and graphics.

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- .4 Upon completion of the installation, the Control System Contractor shall load all system software and start-up the system. The Control System Contractor shall perform all necessary calibration, testing and de-bugging and perform all required operational checks to insure that the system is functioning in full accordance with these Specifications.
- .5 Device tests shall identify and confirm successful completion of the following:
 - .1 Device installation.
 - .2 Device identification.
 - .3 Device calibration.
 - .4 Device operation.
 - .5 Wiring to device, connection details and wire type.
 - .6 Validation of the device signal at the controller.
- .6 Controller tests shall identify and confirm successful completion of the following:
 - .1 Controller installation.
 - .2 Power source and grounding.
 - .3 Make, model and serial number, software revisions.
- .7 Software tests shall identify and confirm successful completion of the following:
 - .1 Custom application programs.
 - .2 Alarm reporting.
 - .3 Trending and reports.
 - .4 Energy management programs.
- .8 Loop tuning tests shall identify and confirm successful completion of the following:
 - .1 Loop input signal.
 - .2 Loop output signal.
 - .3 Set point adjustment.
 - .4 Device response.
 - .5 Control response.
- .9 Network communication tests shall identify and confirm successful completion of the following:
 - .1 Primary network communication function.
 - .2 Secondary network communication function.
 - .3 Alarm reporting function.
 - .4 Operator communication.
- .10 Dynamic graphics tests shall identify and confirm successful completion of the following:
 - .1 All graphics.
 - .2 All point objects per graphic.

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- .3 All set-points per graphic.

3.11 Demonstration

- .1 When all tests have been completed and the documentation completed, request a meeting with the Contract Administrator and The City. Provide at this meeting a demonstration that all systems on the BAS are operating. At the successful conclusion of this demonstration the Contract Administrator will allow the Acceptance Test to begin.
- .2 When all tests have been completed and the documentation completed, request a meeting with the Contract Administrator and The City. Provide at this meeting a demonstration that all systems on the controls are operating.
- .3 At the discretion of the Contract Administrator and The City, demonstrate up to 10% of the tests described in Part 3: Execution, Testing and Commissioning and witnessed by the Contract Administrator and The City. Should any test fail then the BAS Contractor shall retest the failed components or functionality.

3.12 Acceptance Test

- .1 When Testing and Commissioning and the Demonstration have been completed satisfactorily the Contract Administrator will give approval for commencement of the Acceptance Test.
- .2 Notify The City in writing 2 weeks prior to the testing date.
- .3 Furnish a new operator's log book to building operators.
- .4 The Acceptance Test period shall be 21 days. Visit the site each morning, Monday to Friday, to review the BAS operation and the building operators log book which contains records of all problems experienced by the building operators, the point object name and value and time and date of failure, and time of return to service. During the first 14 days of the acceptance test, any operational failures due to malfunction of wiring, controllers or Operator Interfaces, shall designate a restart to testing for 21 days. Any failure of control devices shall be corrected and the acceptance test shall continue from the date the failure has been corrected. During the last 7 days of testing, no failures of any kind will be accepted, or the last 7 days shall be repeated.
- .5 The BAS shall not be accepted or considered Substantially Complete until the Acceptance Test is successfully completed.
- .6 At the successful completion of the Acceptance Test, provide a certificate of completion.

3.13 Instruction And Training

- .1 Provide three days of instruction during the BAS installation. This instruction shall include: identification of devices, power sources, conduit and wire installation, the operation of controlled devices and how they interface with the mechanical systems.
- .2 Provide one day of instruction that shall cover the operation and maintenance of the control systems.
- .3 Provide an additional five days of instruction that shall cover the operation and maintenance of the BAS systems. The instruction shall be conducted in the building and video taped by The City. Submit training course outline for review by the Contract Administrator before completion of the BAS and before instruction period commences. Instruction shall include:
 - .1 Operation and maintenance of Operator Interfaces.

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- .2 Operation and maintenance of controllers.
- .3 Custom Application Programming software.
- .4 Point objects addressing and commanding.
- .5 Custom reporting.
- .6 Creating and modifying graphics.
- .7 Data base modification, deletion and back-up and restore operations.
- .8 System malfunction diagnostics and maintenance.
- .9 Control devices, operation and maintenance.
- .4 Provide an additional three days of training that may be scheduled up to six months after BAS Acceptance. The City will advise the BAS Contractor of the training content required.
- .5 One day shall be 7.5 working hours excluding one hour lunch break.
- .6 Since The City may require to have more comprehensive understanding of the hardware and software, additional training must be available from the Contractor. If The City requires such training, it will be contracted at a later date. Provide description of available local and factory customer training. Provide costs associated with performing training at an off-site classroom facility and detail what is included in the manufacturer's standard pricing such as transportation, meals, etc.

3.14 BAS Maintenance And Service (Alternative Price).

- .1 Provide full BAS maintenance and service for one year after the warranty expires.
- .2 Assign a fully trained BAS service technician to perform all contract activities as described below with one backup person.
- .3 Service to include but not to be limited to: full day site visit once a week to perform system maintenance and service Work that is not urgent, including preparation of the visit report.
- .4 Scheduled preventive maintenance inspections will provide those services required to maintain the system at maximum performance and reliability levels and may include, but not be limited to the following: analyze, adjust, calibrate all sensors, diagnostic LEDs, printers, power supplies, work stations, controllers, input/output points, communication cabling, transmitters, transducers, damper and valve actuators, instrumentation and accessories directly pertaining to the Building Automation System.
- .5 Conduct inspections and thorough preventive maintenance routine on each piece of covered equipment. In addition, make tests and adjustments to ensure efficient and reliable operation of other major components.
- .6 Check and confirm control system sequence of operation to insure optimum system efficiency and economy. Monitor the operation of all systems connected to BAS and optimize the operation of those systems for better comfort and energy savings over the duration of operation and service contract.
- .7 Prepare a report on system operation once a month.
- .8 A log of each loop tested and each control sequence verified shall be reviewed with The City.
- .9 As part of the service, provide 24/7 contact number for service calls. Maximum response time to be 4 hours.

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- .10 Provide a price for a one-year service agreement based on the above requirements to come in to effect upon the completion of the warranty period. Show this price as separate line item: Service Agreement.
- .11 Not included in the contract is the following: any customer initiated changes and additions to the system

END OF SECTION

SEQUENCE OF OPERATION FOR BAS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS and SECTION 23 09 00 - BUILDING AUTOMATION SYSTEM (BAS).
- .2 The locations of all sensors shall be discussed with and approved by The City and/or Contract Administrator, before installation. Locations shown are approximate only, and are given to assist the Contractor in pricing only, and shall not be construed as being the final approved location.
- .3 The control sequence descriptions are complementary. Provide detailed sequences of operation and all points required to implement the sequences.
- .4 All settings and set points listed in this Section shall be variable and Operator adjustable without the need to create or modify Custom Application Programs.
- .5 All set points and reset schedules shall be visual on the associated dynamic graphic.
- .6 Where the project includes an existing BAS, ensure that any upgrades to the existing BAS for this project scope does not negatively impact existing BAS infrastructure. Maintain the functionality of existing controls not revised by this scope of work.

PART 2 - PRODUCTS

2.1 General Application Programs

- .1 Provide a specific set of programs to achieve automated, operator independent control of facility sub-systems.
- .2 All sequences reflect both Child Care and Rec Centre systems unless specifically identified otherwise.
- .3 Refer to Section 23 09 00 - BUILDING AUTOMATION SYSTEM (BAS) for software programs.

PART 3 - EXECUTION

3.1 Generic Thermal Zones

- .1 Applicable Systems:
 - .1 Single zone systems
 - .2 VAV boxes
- .2 Setpoints
 - .1 Provide zone temperature setpoints as follows:

Zone Type or Name	Occupied Heating	Occupied Cooling	Unoccupied Heating	Unoccupied Cooling
VAV	22 deg. C	24 deg. C	16 deg. C	32 deg. C
Gymnasium	20 deg. C	20 deg. C	18 deg. C	26 deg. C
Change Room	22 deg. C	22 deg. C	15 deg. C	22 deg. C
Mech/Elec Rooms	18 deg. C	30 deg. C	18 deg. C	30 deg. C
Networking/IT Rooms	18 deg. C	24 deg. C	18 deg. C	24 deg. C

- .2 Determine the active setpoint by the operating mode of the zone group.

SEQUENCE OF OPERATION FOR BAS

- .1 Provide the occupied set points during occupied mode, warm-up mode, and cooldown mode.
- .2 Provide the unoccupied set points during unoccupied mode, setback mode, and setup mode.
- .3 Provide zone relative humidity setpoints as follows:

Zone Type or Name	Occupied Heating	Occupied Cooling	Unoccupied Heating	Unoccupied Cooling
Gymnasium & Fitness Spaces	30% RH	45% RH	30% RH	50% RH

- .4 Provide zone CO2 concentration setpoints as follows:

OCCUPANCY CATEGORY	CO2 Setpoint (ppm)	Occupancy Category	CO2 Setpoint (ppm)
Daycare	1,000	Office Space	900
Classroom (age 5-8)	850	Reception	1,650
Lecture Classroom	1,305	Conference/Meeting	1,600
Restaurant/Dining	1,400	Lobby/Prefunction	1,500
Breakrooms	1,200	Library	800
Retail	1,050	Health Club (Aerobics)	1,700
		Health Club (Weights)	1,200

3.2 Air Handling Unit Constant Volume 100% Outside Air with Heat RECOVERY

- .1 Applicable Systems: R-AHU-04
- .2 System Start:
 - .1 System start is initiated by operator command at the BAS or through time schedule. Upon signal to start the system Exhaust Air Damper opens (EAD). Open position end switch (EADES) enables exhaust fan to start when exhaust air damper is fully opened. Exhaust Fan starts (EFSS) and a time delay of 30 seconds is initiated before the supply fan start signal is initiated. Upon the signal to start the supply fan Outdoor Air Damper opens (OAD). Open position end switch (OADES) enables the supply fan to start when outdoor air damper is fully opened. Supply fan is started (SFSS).
 - .2 Cooling Coil Valve (CCV) and Heating Coil Valve (HCV) are enabled when system fans are running.
 - .3 When outdoor air temperature is below 0 deg. C (32 deg. F), heating coil shall be enabled to hold a minimum valve position (adjustable) for a set period of time (adjustable) before supply and exhaust fans start.
- .3 Normal Operation:
 - .1 Cooling Coil Valve (CCV) and Heating Coil Valve (HCV) shall modulate in sequence to maintain Supply Air Temperature (SAT) at 12.7°C (55 deg F) (adjustable).
 - .2 Continually reset supply air temperature set-point higher until the first occurrence of a reheat coil hot water valve position of 10% open while all other valves are more than 10% open. Continually reset supply air temperature set-point lower until all reheat coil hot water valves are open at least 20%. Maximum rate of

SEQUENCE OF OPERATION FOR BAS

- supply air temperature set-point change shall be 0.5 deg. C (1 deg. F) every 15 minutes. If a reheat coil is found to be excessively driving the reset logic, generate an alarm and allow the operator to remove that reheat coil from reset logic.
- .3 Reversing Core heat recovery section to modulate based on manufacturer default sequence.
 - .4 Monitor amount of outdoor air entering the AHU within +/- 10% accuracy of the scheduled flow rate condition.
 - .4 System Stop:
 - .1 System stop is initiated by operator command at the BAS or through time schedule. Upon signal to stop the system the supply and exhaust fans (SFSS, EFSS) shall stop. Outdoor and Exhaust Air Dampers (OAD, EAD) shall close. Cooling Coil Valve (CCV) shall close, Heating Coil Valve (HCV) shall open.
 - .5 Schedule:
 - .1 Occupied Mode: 8am – 8pm (adjustable)
 - .1 System operates continuously.
 - .2 Unoccupied Mode: 9pm – 7am (adjustable)
 - .1 System shall maintain space temperature only. If space temperature is satisfied, unit shall be disabled.
 - .3 Building Open and Close Modes: 7am – 8am (adjustable) and 8pm – 9pm (adjustable)
 - .1 The unit shall run continuously for 1 hour before building opening
 - .2 The unit shall run continuously for 1 hour after building close.
 - .6 Alarms:
 - .1 Supply Fan Status (SFST) from current sensor.
 - .2 Exhaust Fan Status (EFST) from current sensor.
 - .3 Supply Air Temperature (SAT) out of range.
 - .4 Supply Air Humidity (SAH) high (over 80%).
 - .5 Safety alarms: low plenum air temperature (FZ), high plenum supply and exhaust air temperatures (F).
 - .6 Supply and Exhaust Pre Filters (PFPD) dirty at 250 Pa (0.036 psi) pressure drop.
 - .7 Final Filters (FFPD) dirty at 375 Pa (0.05 psi) pressure drop.
 - .8 General unit alarm (enabled/disabled)
 - .9 Supply air low-limit (Freeze-stat) disable.
 - .10 Heat recovery damper failure
 - .11 Air flow station alarm if outdoor air is greater than +/- 15% out of range.

3.3 Air Handling Unit: Constant Volume Makeup Air and Exhaust Fan

- .1 Applicable Systems: C-MUA-01 and C-EF-01
- .2 System Start:

SEQUENCE OF OPERATION FOR BAS

- .1 System start shall be initiated by BAS or time schedule. Upon signal to start the system, the exhaust damper shall open, when the damper end switch makes, C-EF-01 shall start.
- .2 Once C-EF-01 starts, the intake damper shall open, when the damper end switch makes, C-MUA-01 internal controls shall be enabled and the an shall start.
- .3 Normal Operation:
 - .1 C-MUA-01 Supply Fan (SFSS) shall run continuously when C-EF-01 is operating.
 - .2 C-EF-01 shall operate to maintain humidity in crawlspace based on differential dewpoint monitoring setpoint (adjustable)
 - .3 Electric heating element shall be controlled by unit's internal controls to maintain the supply air temperature at pre-set set-point 10°C (50 deg F) when the outdoor air temperature is -35 deg. C (-31 deg. F).
 - .4 When the outdoor air temperature reaches 18 deg. C (64.4 deg. F) the heating coil shall be disabled.
 - .5 Supply air set point shall reset to maintain 10 deg. C (50 deg. F) supply air.
 - .6 C-MUA-01 shall be interlocked with C-EF-01.
 - .7 The system shall operate to maintain a differential dewpoint between the crawlspace air and outdoor air. The system shall operate when outdoor air dewpoint is below the dewpoint target and the crawlspace is above the dewpoint target. The crawlspace shall maintain :
 - .1 Summer: 15 deg. C db, 6 deg. C wb (adjustable)
 - .2 Winter: 15 deg. C db, 6 deg. C wb (adjustable)
 - .8 Monitor supply air temperature and system status.
 - .9 Monitor fan status enabled/disabled.
- .4 System Stop:
 - .1 System stop is initiated by operator command at the BAS or through time schedule. Upon signal to stop the system, the supply and exhaust fans shall stop and the intake and exhaust dampers shall close. C-MUA-01 internal controls shall be disabled.
- .5 Schedule:
 - .1 To be determined by The City.
- .6 Alarms:
 - .1 Supply Fan Status (SFST) from current sensor.
 - .2 Filter (FDP) dirty at 250 Pa (0.036 psi) pressure drop.
 - .3 Exhaust Fan Status (EFST) from current sensor.
 - .4 Crawlspace humidity out of range.
 - .5 Final Filters (FFPD) dirty at 375 Pa (0.05 psi) pressure drop.
 - .6 General unit alarm (enabled/disabled)
 - .7 Supply air low-limit (Freeze-stat) disable.

SEQUENCE OF OPERATION FOR BAS

- .8 Air flow station alarm if outdoor air is greater than +/- 15% out of range.

3.4 Air Handling Unit: Variable Volume with heat recovery

- .1 Applicable Systems: R-AHU-02, R-AHU-03, and C-AHU-01
- .2 System Start:
 - .1 System start shall be initiated by operator command at the BAS or through time schedule. Upon signal to start the system, return fans shall start with the VSDs at minimum position. The supply fans shall be started 10 seconds later with the VSDs at minimum position.
 - .2 When system fans are running the heat recovery exhaust fan shall be started and shall be running continuously while AHU is on.
 - .3 Cooling Coil Valve (CCV), Heating Coil Valve (HCV) shall be enabled when system fans are running.
 - .4 Humidifier (HUME) in R-AHU-03 shall be enabled when system fans are running.
- .3 Normal Operation:
 - .1 The supply air static pressure control loop shall maintain the supply air static set-point of 0.3125 kPa (1.26 in. w.g.) by modulating the supply fan variable speed drive. The static sensor shall be located 2/3 down the supply ductwork.
 - .2 The fan tracking control loop shall maintain the set-point air volume between the supply air and return air by modulating the return fan variable speed drive.
 - .3 Cooling Coil Valve (CCV) and Heating Coil Valve (HCV) shall modulate in sequence with the mixing dampers to maintain Supply Air Temperature (SAT) at 12.8 deg. C (55 deg. F) (adjustable) in cooling and 18.3 deg. C (65 deg. F) (adjustable) in heating.
 - .1 R-AHU-03: Heating valve shall modulate to maintain humidifier cabinet and supply grid above 5 deg. C (41 deg. F).
 - .2 C-AHU-01: DX cooling coil shall modulate by staging compressors on and off to maintain set-point in cooling. Electric heating coil shall modulate to maintain set-point in heating.
 - .4 Reversing Core heat recovery section to modulate based on manufacturer default sequence.
 - .5 Supply Air Humidity (SAH) and Return Air Humidity (RAH) shall be monitored by BAS.
 - .1 Humidifier control (enable/disable) shall be hardwired complete with airflow proving switch and high humidity limit.
 - .6 Should the low temperature thermostat detect 1.67 deg. C. (35 deg. F.) then the system shall be shut down.
 - .7 Should any high temperature thermostat detect 57 deg. C. (135 deg. F.) then the system shall be shut down.
 - .8 Should high static pressure switch located after the supply fan detect supply pressure higher than set-point, the system shall be shut down.

SEQUENCE OF OPERATION FOR BAS

- .9 Monitor amount of outdoor air entering the AHU within +/- 10% accuracy of the scheduled flow rate condition.
- .4 System Stop:
 - .1 System stop is initiated by operator command at the BAS or through time schedule. Upon signal to stop the system the supply and return fans shall stop. ERV supply and exhaust fans shall stop and heat wheel shall be disabled. Mixed Air Dampers (MAD) shall close to outside air. Cooling Coil Valve (CCV) shall close, Heating Coil Valve (HCV) shall open. Humidifier shall be disabled.
- .5 Schedule:
 - .1 To be determined by The City.
- .6 Alarms:
 - .1 Supply Fan Feedback (SFFB) from variable speed drive.
 - .2 Return Fan Feedback (RFFB) from variable speed drive.
 - .3 Supply Fan VSD in manual override.
 - .4 Return Fan VSD in manual override.
 - .5 Supply Air Temperature (SAT) out of range.
 - .6 Supply Air Humidity (SAH) high (over 80%).
 - .7 Safety alarms: low plenum air temperature (FZ), high plenum supply and return air temperatures (F).
 - .8 Supply and Return Filters (FDP) dirty at 250 Pa (0.036 psi) pressure drop.
 - .9 Final Filters (FFPD) dirty at 375 Pa (0.05 psi) pressure drop.
 - .10 General unit alarm (enabled/disabled)
 - .11 Supply air low-limit (Freeze-stat) disable.
 - .12 Heat recovery damper failure
 - .13 Humidifier cabinet temperature low limit (5 deg. C / 41 deg. F)
 - .14 Air flow station alarm if outdoor air is greater than +/- 15% out of range.
- 3.5 Chilled/Heating Water Plant with Simultaneous Heating/Cooling Air Source Heat Pump (ASHP)**
 - .1 System Start:
 - .1 Air source heat pump system shall be enabled continuously above -13 deg. C (8.6 deg. F) (adjustable).
 - .2 Boilers shall be enabled continuously below -13 deg. C (8.6 deg. F) (adjustable).
 - .3 Boilers shall be enabled above -13 deg. C (8.6 deg. F) on air source heat pump failure to maintain heating water supply temperature.
 - .4 When the AHU unit cooling coil is open more than 10%, start lead glycol primary cooling pump.
 - .5 When the AHU unit heating coil is open more than 10%, start lead glycol primary heating pump.

SEQUENCE OF OPERATION FOR BAS

- .6 Air source heat pump shall start when the water flow is proven.
- .7 Boilers shall start when the water flow is proven.
- .2 Normal Operation:
 - .1 Air source heat pump shall be controlled internally through manufacturer supplied control panel to maintain glycol supply temperature at set point. In cooling mode, the setpoint will reset from 10 deg. C (50 deg F) when the OAT = 15 deg. C (59 deg F) to 7 deg. C (45 deg F) when the OAT = 30 deg. C (86 deg F). In the heating mode, the setpoint will reset from 25 deg. C (77 deg F) when the OAT = 10 deg. C (50 deg F) to 35 deg. C (95 deg F) when the OAT = -13 deg. C (8.6 deg F) (adjustable).
 - .2 The air source heat pumps shall be arranged in a lead/lag arrangement. The lead ASHP shall change on a weekly basis
 - .3 In heating mode, below OAT = -13 deg. C (8.6 deg F) (adjustable) the boilers shall be enabled to maintain the glycol setpoint.
 - .4 ASHP Heating Glycol Primary Pumps shall be arranged in a lead/lag/lag arrangement. The lead pump shall change on a weekly basis.
 - .5 ASHP Cooling Glycol Primary Pumps shall be arranged in a lead/lag arrangement. The lead pump shall change on a weekly basis.
 - .6 Heating Glycol Secondary Pumps shall be arranged in a lead/lag/lag arrangement. Pump speed shall be modulated in response to Glycol Differential Pressure (GLDP) set-point. Lead pump shall change on a weekly basis.
 - .7 Cooling Glycol Secondary Pumps shall be arranged in lead/lag arrangement. Pump speed shall be modulated in response to Glycol Differential Pressure (GLDP) set-point. Lead pump shall change on a weekly basis.
 - .8 The BAS will automatically schedule the ASHP will control to cooling or heating mode. The cooling mode is set when the OAT rises above 15 deg. C (59 deg F). The heating mode is set when the OAT drops below 10 deg. C (50 deg F) (unless a call for heat from one of the AHUs due to heat recovery failure and the OAT is below 15 deg. C (59 deg F)).
 - .9 Bypass Valve: The bypass valve is controlled to maintain the minimum ASHP flow at all times.
- .3 System Stop:
 - .1 Air source heat pump and heating and cooling primary pumps system shall be disabled below OAT = -13 deg. C (8.6 deg F) (adjustable).
 - .2 Boilers shall be disabled above OAT = -13 deg. C (8.6 deg F) (adjustable).
 - .1 BAS system to ensure that boilers and air source heat pump systems shall not both be engaged at the same time.
 - .2 A 30 second delay shall be required from air source heat pump shut down to boiler start up.
 - .3 A 30 delay shall be required from boiler shut down to air source heat pump start up. Monitor heating loop return temperature to ensure it is within heat pump operation limits before heat pumps are re-engaged.
 - .1 Temperature to be confirmed with heat pump shop drawings.
- .4 Schedule:

SEQUENCE OF OPERATION FOR BAS

- .1 To be determined by The City.
- .5 Alarms:
 - .1 System Pumps (PST) from Variable Speed Drives.
 - .2 Cooling Glycol Supply Temperature (CHWST) out of range.
 - .3 Cooling Glycol Return Temperature (CHWRT) out of range.
 - .4 Heating Glycol Supply Temperature (HWST) out of range.
 - .5 Heating Glycol Return Temperature (HWRT) out of range.
 - .6 Cooling Water Flow below minimum.
 - .7 Heating Water Flow below minimum.

3.6 Domestic Hot Water Tanks and Recirculation Pump

- .1 Normal Operation:
 - .1 The BAS shall monitor each domestic hot water tank temperature.
 - .2 The controls provided with each domestic hot water tank shall maintain tank temperature set-point.
 - .3 The BAS shall modulate the domestic water mixing valve to maintain the domestic hot water supply temperature.
 - .4 During occupied hours, domestic hot water recirculation pump shall run continuously.
 - .5 The BAS shall monitor the DHW supply temperature at the outlet of the tank and at a remote location downstream in the domestic water system as indicated on site by the Contract Administrator.
 - .6 During unoccupied hours, the BAS shall start the domestic hot water recirculation pump when the remote supply temperature falls below the minimum supply water set-point (initially set at 37.8 deg. C. (100 deg. F.)).
 - .7 The BAS shall stop the domestic hot water circulator when the remote temperature is maintained at a minimum of 51.7 deg. C. (125 deg. F.) for 10 minutes.

SEQUENCE OF OPERATION FOR BAS

.2 Alarms:

- .1 Domestic Water Recirculation Pump (DWRPST) from current sensor.
- .2 Domestic Hot Water Tank Temperature (DHWTT) out of range.
- .3 Domestic Hot Water Supply Temperature (DHWST) out of range.

3.7 Exhaust Fan

.1 Applicable Systems: Mechanical room exhaust fans and garbage room exhaust fans

.2 System Start:

- .1 System start shall be initiated by space temperature demand or through time schedule. Upon signal to start the system, the exhaust damper shall open, when the damper end switch makes, the fan shall start.

.3 Normal Operation:

- .1 Exhaust fan shall cycle to maintain Space Temperature (SPCT) at set-point (adjustable), shall run continuously during occupied hours, or on a time of day schedule.

.4 System Stop:

- .1 System stop is initiated when space temperature is satisfied or through time schedule. Upon signal to stop the system, the exhaust fan shall stop and the exhaust damper shall close.

.5 Schedule:

- .1 To be determined by The City.

.6 Alarms:

- .1 Exhaust Fan Status (EFST) from current sensor.
- .2 Space Temperature (SPCT) out of range.

.7 Applicable Systems: Smudging Exhaust R-EF-01 & R-EF-02

.8 System Start:

- .1 System start shall be initiated by BAS or wall timer. Upon signal to start the system, the exhaust damper shall open, when the damper end switch makes, the fan shall start and VAV boxes shall open to provide make-up air to the space.

.9 Normal Operation:

- .1 R-EF-01 shall be controlled by room R135.
- .2 R-EF-02 shall be controlled by room R137.
- .3 If the partial wall between R135 and R137 is open, both fans shall run in parallel.

.10 System Stop:

- .1 System stop is initiated after 20 minute run time (adjustable).
- .2 VAV boxes shall reset to maintain space control.

.11 Schedule:

- .1 To be determined by The City.

SEQUENCE OF OPERATION FOR BAS

.12 Alarms:

- .1 Exhaust Fan Status (EFST) from current sensor.

3.8 Force Flow Heater

- .1 Applicable Systems: Electric and Hydronic Force Flow Heaters in Child Care and Rec Centre

.2 System Start:

- .1 System shall be enabled only in winter mode.
- .2 System start shall be initiated by space temperature demand. Upon signal to start the system, supply fan shall start. Heating coil valve shall be enabled.

.3 Normal Operation Winter Mode:

- .1 Supply Fan (SFSS) shall cycle and Heating Coil Valve (HCV) shall modulate to maintain Space Temperature (SPCT) at set-point.

.4 System Stop:

- .1 System stop is initiated when space temperature is satisfied. Upon signal to stop the system, the supply fan shall stop. Heating coil valve shall be closed.
- .2 System shall be disabled in summer mode.

.5 Alarms:

- .1 Supply Fan Status (SFST) from current sensor.
- .2 Space Temperature (SPCT) out of range.

3.9 Fan Coil

- .1 Applicable Systems: Fan Coils in Rec Centre

.2 System Start:

- .1 System shall be enabled year round.
- .2 Upon signal to start the system, supply fan shall start. Heating coil valve shall be enabled.

.3 Normal Operation Winter Mode:

- .1 Supply Fan (SFSS) shall cycle and Heating Coil Valve (HCV) shall modulate to maintain Duct Supply Air Temperature at set-point 30 deg. C (85 deg F), adjustable.

.4 Normal Operation Summer Mode:

- .1 Supply Fan (SFSS) shall run continuously.

.5 System Stop:

- .1 Upon signal to stop the system, the supply fan shall stop. Heating coil valve shall be closed.
- .2 Heating coil valve shall be disabled in summer mode.

SEQUENCE OF OPERATION FOR BAS

.6 Alarms:

- .1 Supply Fan Status (SFST) from current sensor.
- .2 Heating coil valve (HCV) position.
- .3 Duct temperature out of range.

3.10 Heating Water Plant with Three Boilers

.1 System Start:

- .1 Lead boiler shall be enabled and circulator pump shall start when Outside Air Temperature (OAT) is less than -13 deg. C (8.6 deg F) for more than 30 minutes or when air source heat pumps have failed to maintain the heating water loop temperature set-point.
- .2 The secondary glycol heating water pumps shall maintain operation per the ASHP sequence.

.2 Normal Operation:

- .1 The lead boiler primary pump shall start and when the flow is proven, the lead boiler shall modulate to maintain Hot Water Supply Temperature (HWST) at set-point based on Outside Air Temperature (OAT) as per following:

Outdoor Air Temperature (OAT)	-13°C (8.6 Deg F)	-35°C (-31 deg. F)
Hot Water Supply Temperature (HWST) Set-Point	35°C (95 Deg F)	43.3°C (110 deg. F)

- .2 The lag boilers and their pumps shall be enabled if system load requires the second and third boiler.
- .3 Lead and lag boilers shall change on a weekly basis.

.3 System Stop:

- .1 The system shall be disabled when Outside Air Temperature (OAT) rises above -13 deg. C (8.6 deg F)

.4 Alarms:

- .1 Boiler General Alarms (BGAL) from boiler panels.
- .2 System pumps (PST) from current sensors.
- .3 Glycol Supply Temperature (GLYST) out of range.
- .4 Glycol Return Temperature (GLYRT) out of range.

3.11 Lighting Control

.1 Applicable Systems: Lighting System

.2 System Start:

- .1 Lighting zones shall be activated through time schedule.

.3 Normal Operation:

- .1 Lighting zones shall be on during occupied hours.

.4 System Stop:

SEQUENCE OF OPERATION FOR BAS

- .1 Lighting zones shall be deactivated through time schedule.
- .2 Lighting zones can be overridden on by a local override switch for an adjustable time period.
- .5 Schedule:
 - .1 To be determined by The City.
- .6 Alarms:
 - .1 Lighting Zone Status.

3.12 Miscellaneous Monitoring Points

- .1 Miscellaneous Points:
 - .1 Outdoor Air Temperature.
 - .2 Outdoor Air Enthalpy.
 - .3 Fire Alarm.
 - .4 Compressor Status.
 - .5 Domestic Water Pressure.
 - .6 OEM Control Panel General Alarm.
 - .7 Gas Meter.
 - .8 Water Meter.
 - .9 Energy Meters.
 - .1 Rec Centre Domestic Hot Water Heaters
 - .2 Rec Centre Boilers
 - .3 Rec Centre AHU and Smudging Fans
 - .4 Child Care Electric Heating
 - .10 Electrical Meter.
 - .11 Sump Water Level.
 - .12 Sump Pump.
 - .13 Heating Buffer Tank Temperature
 - .14 Cooling Buffer Tank Temperature
 - .15 Heat Trace Controllers – See Section 20 05 33

3.13 Roller Blinds

- .1 Applicable Systems: RWS3 Roller Blinds
- .2 System Start:
 - .1 Roller Blinds shall be activated through time schedule or manual override.
 - .1 Refer to Section 12 24 13 Roller Window Shades.
- .3 Normal Operation:

SEQUENCE OF OPERATION FOR BAS

- .1 Package system controls.
 - .1 Refer to Section 12 24 13 Roller Window Shades.
- .4 System Stop:
 - .1 Roller Blinds shall be deactivated through time schedule or manual override.
 - .1 Refer to Section 12 24 13 Roller Window Shades.
- .5 Schedule:
 - .1 To be determined by The City.
- .6 Alarms:
 - .1 Blind position status
 - .2 Motor status
 - .3 Light sensor status
 - .4 Refer to Section 12 24 13 Roller Window Shades for additional alarm points.

3.14 Variable Volume (Single Zone) with Humidifier and CO2 Control

- .1 Applicable Systems: R-AHU-01
- .2 System Start:
 - .1 System start shall be initiated by operator command at the BAS or through time schedule. Upon signal to start the system, return fan shall start with the VSD at minimum position. The supply fan shall be started 10 seconds later with the VSD at minimum position.
 - .2 Cooling Coil Valve (CCV), Heating Coil Valve (HCV) and Humidifier (HUME) shall be enabled when system fans are running.
- .3 Normal Operation:
 - .1 The space temperature control loop shall maintain the space temperature by adjusting the fan variable speed drives, Cooling Coil Valve (CCV) and Heating Coil Valve (HCV) in sequence. The cooling and heating coils shall be used as first stage of cooling or heating. The variable speed drives shall run at 50% when space temperature is satisfied and when cooling and heating space requirements are fully achieved by modulating the cooling and heating coil valves. If any of the coil valves are at 100% open for more than 2 minutes (adjustable) the variable speed drives shall be used as second stage of cooling or heating and shall modulate from 50% to 100% to achieve space temperature requirements.
 - .1 Space temperature and humidity shall be read by averaging return duct mounted temperature and humidity sensors from the high and low level return ducts.
 - .1 If the upper return air duct temperature is >1.5°C warmer than the lower return air duct, increase supply fans to 80% fan speed (adjustable) for 20 minutes (adjustable) to de-stratify and mix the air.
 - .2 Heating valve shall modulate to maintain humidifier cabinet and supply grid above 5 deg. C (41 deg F).

SEQUENCE OF OPERATION FOR BAS

- .2 The fan tracking control loop shall maintain the set-point air volume between the supply air and return air by modulating the return fan variable speed drive.
- .3 Supply and install a CO₂ monitor in the return air and identified area zones served by this unit. Refer to Mechanical HVAC Drawings for CO₂ sensors locations. If any of the monitored zone carbon dioxide concentration rises above set-point, initially set at 1000 ppm (adjustable) then the BAS shall modulate the mixing dampers until set-point is achieved. This control sequence shall not allow the minimum outdoor air position to be reduced from the baseline set-point or space temperature to fall below the set-point.

- .4 Humidifier Valve (HUMV) shall modulate to maintain Return Air Humidity (RAH) set-point. Return air humidity set-point to be scheduled in accordance with Outdoor Air Temperature (OAT) as follows:

Outdoor Air Temperature (OAT)	-5°C (23 deg. F)	1.7°C (35 deg. F)
Return Air Humidity (RAH) Set-Point	25	30

- .5 Supply Air Humidity (SAH) sensor shall override Return Air Humidity (RAH) signal to maintain Supply Air Humidity (SAH) below 80% (adjustable). When outdoor air temperature dew point is above 1.7°C (35 deg. F) (adjustable) humidifier shall be disabled.

- .1 Humidifier control (enable/disable) shall be hardwired complete with airflow proving switch and high humidity limit.

- .6 Should the low temperature thermostat detect 1.67 deg. C. (35 deg. F.) then the system shall be shut down.
- .7 Should any high temperature thermostat detect 57 deg. C. (135 deg. F.) then the system shall be shut down.
- .8 Should high static pressure switch located after the supply fan detect supply pressure higher than set-point, then the system shall be shut down.

.4 System Stop:

- .1 System stop is initiated by operator command at the BAS or through time schedule. Upon signal to stop the system, the supply and return fans shall stop. Mixed Air Dampers (MAD) shall close to outside air. Cooling Coil Valve (CCV) shall close, Heating Coil Valve (HCV) shall open. Humidifier shall be disabled.

.5 Schedule:

- .1 To be determined by The City.

.6 Alarms:

- .1 Supply Fan Feedback (SFFB) from variable speed drive.
 - .2 Return Fan Feedback (RFFB) from variable speed drive.
 - .3 Supply Fan VSD in manual override.
 - .4 Return Fan VSD in manual override.
 - .5 Supply Air Temperature (SAT) out of range.
 - .6 Return Air Humidity (RAH) out of range.

SEQUENCE OF OPERATION FOR BAS

- .7 Return CO2 levels 10% above space CO2 set point .
- .8 Return CO2 level high.
- .9 Supply Air Humidity (SAH) high (over 80%).
- .10 Safety alarms: low plenum air temperature (FZ), high plenum supply and return air temperatures (F), supply air high static pressure (SAHP).
- .11 Supply Filters (FDP) dirty at 250 Pa (0.036 psi) pressure drop.
- .12 General unit alarm (enabled/disabled)
- .13 Supply air low-limit (Freeze-stat) disable.
- .14 Heat recovery damper failure
- .15 Humidifier cabinet temperature low limit (5 deg. C / 41 deg F)
- .16 Air flow station alarm if outdoor air is greater than +/- 15% out of range.

3.15 Unit Heater

- .1 System Start:
 - .1 System start shall be initiated by operator command at the BAS or through time schedule. Upon signal to start the system, supply fan and heating coil valve shall be enabled.
- .2 Normal Operation:
 - .1 Supply Fan (SFSS) and Heating coil Valve (HCV) shall cycle in sequence to maintain Space Temperature (SPCT) at set-point (adjustable).
- .3 System Stop:
 - .1 System stop is initiated by operator command at the BAS or through time schedule. Upon signal to stop the system, the supply fan shall stop. Heating coil valve shall be closed.
- .4 Schedule:
 - .1 To be determined by The City.
- .5 Alarms:
 - .1 Supply Fan Status (SFST) from current sensor.
 - .2 Space Temperature (SPCT) out of range.

3.16 VAV with Reheat Coil and Radiant Heat (electric or hydronic)

- .1 System Start:
 - .1 The VAV box shall be enabled when the associated VAV air handling unit is started. Heating coil valve and radiant heat valve shall be enabled.

SEQUENCE OF OPERATION FOR BAS

- .2 Normal Operation:
 - .1 Provide static independent control. Provide set-points for minimum and maximum air flows.
 - .2 In occupied mode VAV box Damper (VAVD) and the Reheat and Radiation Valves (RHV, RADV) shall modulate in sequence to maintain Space Temperature (SPCT) at set-point (adjustable). The damper shall be modulated between its minimum and maximum air flow settings and shall be at minimum setting before the reheat and radiation valve open.
 - .1 Reheat shall be stage 1 heat
 - .2 Radiation (electric or hydronic) shall be stage 2 heat.
 - .3 In unoccupied mode, heating coil valve and radiant heat valve shall modulate to maintain the night set-back space temperature set-point.
 - .4 Where multiple thermostats are shown connecting to a single VAV box, temperature shall be averaged among the thermostats in a master – slave configuration.
- .3 System Stop:
 - .1 The VAV box shall be disabled when the associated VAV air handling unit is stopped. VAV reheat coil valve and radiant heat valve shall remain enabled.
- .4 Schedule:
 - .1 To be determined by The City.
- .5 Alarms:
 - .1 Space Temperature (SPCT) out of range.

END OF SECTION

NATURAL GAS PIPING SYSTEMS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 Conform to Section 23 35 16 - ELECTRIC POWER GENERATOR.

1.2 Reference

- .1 CSA B149.1 - Natural gas and propane installation code, latest edition.

PART 2 - PRODUCTS

2.1 Materials

- .1 Pipe and fittings for 860 kPa (125 psi) and lower, fully welded as accepted by Authority Having Jurisdiction:
 - .1 Schedule 40 steel, ASTM A106 or ASTM A53 up to 250 mm (NPS 10)
 - .2 Standard weight steel, ASTM A106 or ASTM A53 larger than 250 mm (NPS 10)
 - .3 Steel fittings, ANSI/ASME B16.3, Welded
 - .4 Malleable Iron fittings, threaded, up to 50 mm (2 in.) diameter for connections close to equipment and dirt pockets
 - .5 Viega MegapressG press fittings
 - .1 For use in accordance with manufacturer's: written application and installation instructions.
 - .2 Provide proof of Viega training for proposed installation tradespeople.
 - .6 Factory-applied, three-layer coating of epoxy, adhesive, and PE protective coating for underground steel pipe.
 - .1 Epoxy paint, adhesive, and heat-shrink PE sleeves joint cover kits.
- .2 Manual valves for 860 kPa (125 psi) and lower, as accepted by the Authority Having Jurisdiction:
 - .1 Ball or plug type
 - .2 CSA/CGA B3.16
 - .3 Supervisory switch (where specified or shown)
- .3 Electrically operated solenoid valves, normally closed, 2-position type in accordance with CSA C22.2 suitable for 120 Volt operation with electronic actuator and general purpose enclosure. Valves with pneumatically actuated components are not permitted.
- .4 Manual isolation valve supervisory switch:
 - .1 Potter PTS-C Plug type
 - .2 NEMA 6P enclosure for outdoor installation
 - .3 Hex key and tamper resistant screws

NATURAL GAS PIPING SYSTEMS

- .5 Roof penetrations:
 - .1 Thaler MEF-9-18 gas pipe flashing with perforated neck, removable cap, EPDM grommet seal.

PART 3 - EXECUTION

3.1 Installation

- .1 Connect to the metering station and provide all downstream pipe and appurtenances.
- .2 All piping up to and including the meter and incoming service pressure reducing station is by the natural gas service provider or their agent.
- .3 Provide pressure reducing valves and overprotection devices where shown or as required for conformance with CSA B149.1 for equipment supplied under this Contract.
- .4 Pipe relief from pressure reducing valves to outdoors. Vent-less pressure reducing valves may be used where permitted by the Authority Having Jurisdiction.
- .5 Weld all distribution piping within the building, and utilize screwed and/or flanged fittings at equipment only.
- .6 Paint natural gas piping in its entirety an approved colour in accordance with CSA B149.1. Banding is not permitted.
- .7 Provide thermal expansion control for gas piping on the roof as required by CSA B149.1.
- .8 Provide manually operated remote shutdown for the boiler room:
 - .1 Provide push/pull emergency stop switch with red mushroom operator (EPO) with normally closed contact wired in series with each control panel for all gas-fired equipment in the boiler room:
 - .1 Depression of the EPO interrupts power to all equipment control panels until manually reset.
 - .2 Locate an EPO outside the boiler room at each entrance. Where entrances are not enclosed to the elements, locate the EPO in a clear weather tight enclosure.
 - .3 Provide all interconnected wiring as required for a complete and operational system.
 - .2 Provide normally closed, electronically operated solenoid valve(s) or valve assembly that includes one or more valves, as required, to suit natural gas service size with no appreciable pressure drop.
 - .3 Provide isolation and lockable bypass valve for emergency operation.
 - .4 Power solenoid valves with emergency power where available. Coordinate with Electrical Division.
 - .5 Provide push/pull emergency stop switch with red mushroom operator (EPO) with normally closed contact wired in series with solenoid valve(s).
 - .1 Depression of the EPO interrupts power to all solenoid valves until manually reset.

NATURAL GAS PIPING SYSTEMS

- .2 Locate an EPO outside the boiler room at each entrance. Where entrances are not enclosed to the elements, locate the EPO in a clear weather tight enclosure away from public access.
- .3 Provide all interconnected wiring as required for a complete and operational system.
- .4 Power solenoid valves with emergency power where available. Provide UPS power to maintain valve in open position during short power outages or while transitioning to emergency power. Coordinate with Electrical Division.

END OF SECTION

PIPING, VALVES & FITTINGS (EXCEPT PLUMBING)

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 All gate, globe and check valve shall be approved under Canadian Interprovincial Regulations for the Construction and Inspection of Boilers, Tanks, and Appurtenances.
- .3 Provide Shop Drawings in accordance with Section 20 05 03 - SHOP DRAWINGS for all valves, appurtenances, and grooved components.
- .4 All steel pipe and fittings shall be manufactured in North America. Off-shore pipe shall not be accepted on site. Pipe shall be clearly marked as being manufactured in North America or it shall be removed from site.

PART 2 - PRODUCTS

2.1 Materials

- .1 Use pipes, fittings and valves as shown below unless specifically shown or specified otherwise.

2.2 Low Temperature and/Or Pressure Water

- .1 Heating water less than 121 deg. C. (250 deg. F.) at 1035 kPa (150 psi), or heating water less than 93.2 deg. C. (200 deg. F.) at 1139 kPa (165 psi), and chilled and condenser water less than 65.6 deg. C. (150 deg. F.) at 1380 kPa (200 psi).
- .2 Pipes 300 mm (12 in.) and larger, black steel ASTM A53, 9.5 mm (0.375 in.) wall, plain ends, ANSI B36.10.
- .3 Pipes 65 mm (2-1/2 in.) to 250 mm (10 in.) ASTM A53, Schedule 40, plain ends, ANSI B36.10.
- .4 Pipes 50 mm (2 in.) and smaller, black steel ASTM A53, Schedule 40, threaded, ANSI B36.10.
- .5 Pipe runouts to all induction and fan coil units and similar equipment soft temper copper ASTM B88, Type L, plain ends, size as shown, but minimum size of runouts 19 mm (3/4 in.). All joints made with 95-5 tin-antimony or tin-silver solder.
- .6 Fittings 300 mm (12 in.) and larger, black steel ASTM A234, 9.5 mm (0.375 in.) wall, butt-welding ends, ANSI B16.9.
- .7 Fittings 65 mm (2-1/2 in.) to 250 mm (10 in.) black steel ASTM A234, Schedule 40, butt-welding ends, ANSI B16.9.
- .8 Fittings 50 mm (2 in.) and smaller, malleable iron ASTM A197, 860 kPa (125 psi) WSP threaded, ANSI B16.3.
- .9 Flanges 65 mm (2-1/2 in.) and larger, forged steel ASTM A181, 1035 kPa (150 psi) WSP, ANSI B16.1. Use only weld neck flanges with butterfly valves.
- .10 Unions 50 mm (2 in.) and smaller malleable iron ASTM A197, 1035 kPa (150 psi) WSP, with bronze to iron ground joint, ANSI B16.3.
- .11 Flange accessories for heating water and condenser water:

PIPING, VALVES & FITTINGS (EXCEPT PLUMBING)

- .1 Gasket, 1.5 mm (1/16 in.) Synthetic fibres with rubber binder suitable for 205 deg. C. (400 deg. F.) continuous maximum temperature at 3440 kPa (500 psi), equal to Garlock Multi-Swell 3760.
- .2 Bolts, hexagonal head machine with hexagonal nut, steel ASTM A307, ANSI B18.2.
- .12 Flange accessories for chilled water, gasket, cloth inserted rubber ring, bolts, hexagonal head machine with hexagonal nut, steel ASTM A307, ANSI B18.2.
- .13 Strainers 65 mm (2-1/2 in.) and larger, cast iron 860 kPa (125 psi) WSP, flanged.
- .14 Strainers 50 mm (2 in.) and smaller, cast iron 1720 kPa (250 psi) WSP, threaded.
- .15 Strainers 50 mm (2 in.) and smaller, for copper pipes bronze 860 kPa (125 psi) WSP, threaded. Mueller #351M.
- .16 Gate valves 65 mm (2-1/2 in.) and larger, cast iron 860 kPa (125 psi) WSP, bronze mounted, O.S. and Y ANSI B16.1 Flanges, shall be Crane #465 1/2, Jenkins #454J, Toyo 421, NCI #GTVA-FCI-1333HW or Kitz 72.
- .17 Gate valves 50 mm (2 in.) and smaller, bronze 1035 kPa (150 psi) WSP rising stem, threaded shall be Crane #431, Jenkins #2810J, Toyo 298, NCI #GTVA-TBZ2333 or Kitz 42.
- .18 Globe valves 65 mm (2-1/2 in.) and larger, cast iron 860 kPa (125 psi) WSP, bronze mounted, renewable composition disc, ANSI B16.1 Flanges shall be Crane #351, Jenkins #2342, Toyo 400A, NCI #GLBA-FCI-1333HW or Kitz 76.
- .19 Globe valves 50 mm (2 in.) and smaller, bronze 1035 kPa (150 psi) WSP, renewable composition disc, threaded shall be Crane #7TF, Jenkins #106-B, Toyo 221, NCI #GLBA-TBZ2360 or Kitz 9.
- .20 Butterfly valves maybe used as an alternative to gate valves only and shall be iron body, one-piece alloy steel shaft, top and bottom bearings, bronze disc or iron disc with stainless steel trim, resilient elastomer replaceable seat with integral reinforcing ring or keyed to body. Body with threaded lugs. Bubble-tight shut-off to 1035 kPa (150 psi) pressure in either direction when the piping and connecting flange is removed from one side of the valve.
 - .1 Valves 100 mm (4 in.) and smaller with lever operator with lock.
 - .2 Valves 150 mm (6 in.) and larger with worm gear manual operator with indication of valve opening.
 - .3 Butterfly valves shall be shall be DeZurik Model BGS, Keystone Model 222-784, Bray Series 31, Challenger Model 20-CN4E, Apollo 143, Kitz 6122EL/G, Centerline 200, or Crane 44.
- .21 Check valves 50 mm (2 in.) and smaller bronze 860 kPa (125 psi) WSP, swing check, screwed cover, screwed shall be Crane #37, Jenkins #4092, Toyo 236, NCI CKVA-TBZ2331 or Kitz 22.
- .22 Check valves 65 mm (2-1/2 in.) and larger ANSI Class 150, 1030 kPa (150 psi) WSP, dual flapper retainerless design with carbon steel body and stainless steel check, renewable disc and seat for flanged installation, shall be Velan-Proquip model BDD10-1B or DUO CHEK II H15SMF-201, NCI/SSI #150WTCT, or Mueller 72-DHH-3-H.

PIPING, VALVES & FITTINGS (EXCEPT PLUMBING)

- .23 Drain valves for blow-off of sediment from strainers and tank drainage shall be 19 mm (3/4 in.) size 4140 kPa (600 psi) WOG ball valve with bronze or forged brass body, solid ball, virgin Teflon seat and packing, male threaded garden hose end, brass cap and chain shall be Watts B6000, Toyo 5046, Kitz 58CC or Apollo 78-100.
- .24 Float type eliminators, designed for a minimum of 1035 kPa (150 psi) water pressure with steel or cast iron body having removable flanged top, stainless steel or copper float and stainless steel valve and level mechanism.
- .25 Ball valves for heating water and chilled water 50 mm (2 in.) and smaller shall be bronze body 4140 kPa (600 psi) WOG, virgin Teflon seat, solid ball, TFE stem packing and thrust washer, 1/4 turn open-closed operation. All components to be replaceable in-line. Solder end valves are not acceptable. All ball valves shall be complete with stem extensions. Ball valves shall be Watts No. B-6800, Toyo 5050, Kitz 62, or Apollo 82-100-04.
- .26 Ball valves for heating water and chilled water 50 mm (2 in.) and smaller shall be bronze or forged brass 4140 kPa (600 psi) WOG, virgin Teflon seat, solid ball, TFE system packing and thrust washer, 1/4 turn open-close operation. All ball valves shall be complete with stem extensions. Ball valves shall be Watts B6000, Toyo 5044A, Kitz 58/59, NCI 600FP-T/600FP-S or Apollo 70-100/200-04.
- .27 Flow balancing valves shall have meter connection for attaching to a portable meter. Each connection shall have positive shut-off valves. Each valve shall be capable of precise flow measurement, accurate flow balancing and positive shut-off. Adjustment shall be by multiple turns of the handle for Vernier type setting and shall have a hidden memory feature for tamper-proof setting.
 - .1 For all valves 65 mm (2-1/2 in.) and larger, provide flanged or grooved as follows: Flanged: Victaulic / TA Hydronics Series 788 flanged, Nexus UltraMB MBF, or IMI Hydronic Engineering STAF; Grooved: Victaulic / TA Hydronics Series 789 grooved, Nexus UltraMB MBG, or IMI Hydronic Engineering STAG.
 - .2 For valves 50 mm (2 in.) and smaller, provide screwed as follows: Victaulic / TA Hydronics Series 787, Nexus UltraMB, or IMI Hydronic Engineering STAD.
 - .3 Provide a portable flow measuring meter, complete with hoses and carrying case to suit each size of valve provided. Meter shall be computerized, differential pressure type for direct reading of flow rate in either GPM or L/s.
- .28 As an alternative to Standard Details (MSD-765.02) for reheat coil installation provide preassembled coil pipe and fitting assembly with flow balancing valve, unions, air vent, temperature and pressure port, and serviceable strainer with isolation valves. Victaulic Series 799 Koil-Kit complete with 78K-STADK flow balancing valve, 78-UP union plus air vent and PT port, and 78Y with 20 mesh Y-strainer/ball valve/drain & coil hoses or Red & White complete with 9517/9519 flow balancing valve, 92STC Combination ball valve, Y-strainer, drain & test port, 92UTFM brass union, air vent and PT port, SSB stainless steel flexible hoses. Automatic air vent piped to drain shall be used if branch take-off is above the main. Stainless steel hose sizes to be determined by Contractor. Coordinate control valve with Controls Subcontractor.

2.3 Grooved Pipe and Fittings

- .1 For systems less than 120 deg. C. (248 deg. F.) at 2068 kPa (300 psi) or as specified.

PIPING, VALVES & FITTINGS (EXCEPT PLUMBING)

- .2 Grooved pipe and fittings may be used for hot water, chilled water, hot or chilled glycol, and condenser water systems.
- .3 Pipes 50 mm (2 in.) to 250 mm (10 in.) black steel ASTM A53, Schedule 40 cut or roll grooved.
- .4 Pipes 300 mm (12 in.) and larger black steel ASTM A53, 9.5 mm (0.375 in.) wall, cut or grooved.
- .5 Couplings shall consist of two ASTM A536 grade 65-45-12 ductile iron housing segments, ASTM D2000 pressure responsive elastomer gasket, and ASTM A449 zinc-electroplated steel bolts and nuts.
 - .1 Sizes 300 mm (12 in.) and smaller:
 - .1 Rigid Type: Housings shall be cast with torque-absorber and shift-limiting slant bolt pads to provide rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9 and to prevent mis-assembly due to overshift.
 - .1 50 mm (2 in.) through 300 mm (12 in.): Installation-Ready, for direct stab installation without field disassembly, with grade EHP gasket rated to 121 deg C. (250 deg. F). Victaulic Style 107V.
 - .2 As an alternative provide Victaulic Zero-Flex Style 07.
 - .2 Flexible Type: For use in locations where vibration attenuation and stress relief are required or in a Victaulic riser design. Three flexible couplings may be used in lieu of a flexible connector. The couplings shall be placed in close proximity to the source of the vibration. Victaulic Style 177N or 77.
 - .2 Size 350 mm (14 in.) and larger: Victaulic AGS Series with lead-in chamfer on housing key and wide width flush seal gasket.
 - .1 Rigid Type: Housing key shall fill the wedged shape AGS groove and provide rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9. Victaulic Style W07.
 - .2 Flexible Type: Housing key shall fit into the wedge shaped AGS groove and allow for linear and angular deflection. Victaulic W77.
- .6 Fittings 50 mm (2 in.) to 250 mm (10 in.) cast ductile iron ASTM A536 grade 65-45-12.
- .7 Fittings 300 mm (12 in.) and larger full flow cast fitting. Factory fabricated steel fittings to ASTM Grade B may only be used with the approval of Contract Administrator.
 - .1 350 mm (14 in.) and larger shall be complete with Victaulic 'AGS' grooved ends.
- .8 Branch connections: ductile iron ASTM A535; Victaulic Style 920, 920N, or 72.
- .9 Flanges; ductile iron ASTM A536 for sizes 50 mm (2 in.) to 600 mm (24 in.); Victaulic Style 741/W741.
- .10 Gaskets: EPDM conforming to ASTM D-2000, temperature range -34 deg. C. to 110 deg. C. (-30 deg. F. to 230 deg. F.).
 - .1 EHP conforming to ASTM D-2000, temperature range -34 deg. C to 121 deg. C. (-30 deg. F. to 250 deg. F.).

PIPING, VALVES & FITTINGS (EXCEPT PLUMBING)

- .11 Valves 50 mm (2 in.) to 300 mm (12 in.): ductile iron Body to ASTM A536, EPDM pressure-responsive seat, electroless-nickel coated ductile iron disc, with stem offset from the disc centerline to provide complete 360-degree circumferential seating for temperatures up to +110 deg. C. (+230 deg. F.), for bubble-tight service to 2065 kPa (300 psi). Victaulic Vic-300 MasterSeal.
 - .1 Butterfly Valves 350 mm (14 in.) to 600 mm (24 in.): Ductile iron body to ASTM A536, EPDM disc mounted seal, PPS (polyphenylene sulphide) coated ductile iron disc, and stainless steel stem. (Stem shall be offset from the disc centerline to provide full 360- degree circumferential seating). Rated for temperatures up to + 110 deg. C. (+230 deg. F.), for bubbletight service to 2065 kPa (300 psi). Victaulic AGS Vic-300.
- .12 Check valves 65 mm (2-1/2 in.) to 300 mm (12 in.): ductile iron ASTM A536 EPDM coated disc spring loaded design for non-slam operation. Victaulic Series 716.
 - .1 Check valves 350 mm (14 in.) to 600 mm (24 in.): Ductile iron body to ASTM A395, dual stainless steel disc(s), with stainless steel spring and shaft, rated for temperatures up to +110 deg. C. (+230 deg. F.), for service to 1575 kPa (230 psi) Victaulic Series W715.
- .13 Strainers 50 mm (2 in.) to 600 mm (24 in.): ductile iron ASTM A536 with type 304 stainless steel screen. Victaulic Style 730/732 and W730/W732.
- .14 As an alternative to Standard Details for pumps, piping may be manufactured vibration isolation pump drop assemblies 50 mm (2 in.) to 300 mm (12 in.). Includes flow control, vibration-isolation flexible couplings, access ports for gauges and thermowells, isolation and check valves, strainer or suction guide and an integral flanged pump connection. Victaulic Series 380, 381, 382 or 383.
- .15 All grooved Products, including couplings, fittings, valves and specialty items shall be Victaulic.
- .16 For other system components refer to Low Temperature and/or Pressure Water Article.

2.4 PRESS FITTINGS

- .1 For use in accordance with manufacturer's: written application and installation instructions.
- .2 Provide proof of Viega training for proposed installation tradespeople.
- .3 For carbon steel piping: Viega MegaPress.
- .4 For copper piping: Viega ProPress.

2.5 PLAIN END PIPE COUPLINGS AND FITTINGS

- .1 For systems 120 deg. C. (248 deg. F.) at 2068 kPa (300 psi).
- .2 Plain end couplings fittings may be used for hot water, chilled water, hot or chilled glycol, and condenser water systems.
- .3 Pipes 12 mm (1/2 in.) to 50 mm (2 in.) black steel ASTM A53 "Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless," Schedule 40.

PIPING, VALVES & FITTINGS (EXCEPT PLUMBING)

- .4 Couplings and fittings shall be ASTM A536 "Standard Specification for Ductile Iron Castings" grade 65-45-12 ductile iron housing segments, ASTM D2000 "Standard Classification System for Rubber Products in Automotive Applications" pressure responsive elastomer gasket, and ASTM A449 "Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use" zinc-electroplated steel bolts and nuts.
- .5 Gaskets: EPDM conforming to ASTM D2000 "Standard Classification System for Rubber Products in Automotive Applications," temperature range -34 deg. C. to 120 deg. C. (-29 deg. F. to 248 deg. F.).

2.6 Welding

- .1 Pipe welding shall be in accordance with:
 - .1 ANSI/ASME B31.1
 - .2 ANSI/ASME Boiler and Pressure Vessel Code, Section IX.
 - .3 Authorities Having Jurisdiction
 - .4 CSA B51 - Boiler, Pressure Vessel and Pressure Piping Code
- .2 Ensure complete penetration of deposited metal with base metal. Manufacturer shall provide filler metal suitable for use with base metal. Keep inside of fittings free from globules of weld metal. All welded pipe joints shall be made by the fusion welding process employing a shielded metallic arc process (SMAW). The use of a gas metal arc welding process (GMAW/ MIG) for pipe welding is not permitted. Inside of pipe shall be free of excessive reinforcement. The use of backing plates is not acceptable. Tack welds, if used, must be of the same material and made by the same procedure as the completed weld. Otherwise, remove tack welds during the welding operation.
- .3 In no cases shall Schedule 40 or standard weight pipe be welded with less than three passes including one stringer/ root, one filler and one lacer. Schedule 80 pipe shall be welded with not less than four passes including one stringer/ root, two filler and one lacer/ cap.
- .4 Each weld shall be uniform in width and size throughout its full length. In addition, the cover pass (final weld layer) shall be free of coarse ripples, grooves, overlaps, abrupt ridges and valleys/ under cut. The surface smoothness of the finished weld shall be suitable for the proper interpretation of non-destructive examination of the weld.
- .5 Each weld layer or pass shall be visually free of slag, inclusions, cracks, porosity and lack of fusion. Grinding to meet this criteria and elimination of defects and surface preparation of welds shall be done in a manner as not to gouge, groove or reduce the adjacent base material thickness below the minimum required.
- .6 All butt welds shall be full penetration with uniform crown, with reinforcement blending smoothly into the base material. Concavity on the root side of a single welded circumferential butt weld is permitted with the resulting thickness of the weld at least equal to the thickness of the thinner member of the sections being joined.
- .7 Socket welds shall have a gap of approximately 1.5 mm (1/16 in.) minimum to 3 mm (1/8 in.) maximum between the bottom of the socket and the end of the pipe prior to welding.

PIPING, VALVES & FITTINGS (EXCEPT PLUMBING)

- .8 Visually inspect all welds for compliance with this section. Welds found to be lacking penetration, or containing excessive porosity or cracks must be removed and replaced with an original quality weld as specified herein.

2.7 Pipe Coatings

- .1 For carbon steel piping: primer coated with an epoxy coating, 5 mil thickness or manufacturer's recommended thickness, whichever is more stringent.
- .2 For stainless steel piping: coated with an epoxy primer, 5 mil thickness or manufacturer's recommended thickness, whichever is more stringent, and an epoxy finish coat, 5 mil thickness or manufacturer's recommended thickness, whichever is more stringent.

2.8 General Requirements For Pipe Systems

- .1 Where a branch at least two pipe sizes smaller connects into a main, welding fittings of Bonney Forge, full flow fittings or other approved manufacturer may be used.
- .2 For chilled, condenser and low temperature heating water, where a branch at least two pipe sizes smaller connects into a main, branch may be mitred and welded to main.
- .3 Use Y pattern strainers with screens of type 304 stainless steel or Monel with approximately 1 mm (1/32 in.) perforations for sizes 100 mm (4 in.) and smaller, and approximately 3 mm (1/8 in.) perforations for larger sizes. Provide a valved blow-off connection in all caps 65 mm (2-1/2 in.) and larger. Maximum pressure drop with clean screen shall not exceed 7 kPa (1 psi) with water velocity through inlet pipe of 1.5 m/s (5 ft./s). For 50 mm (2 in.) and larger pipe size all heads retaining the basket shall be bolted. For 38 mm (1-1/2 in.) and smaller pipe heads shall be gasketted with straight threads.
- .4 Solder end globe, angle and gate valves, sizes 50 mm (2 in.) and smaller, are acceptable if it can be shown that they are similar in design and construction to the valves specified.
- .5 Except where special features are required or unless otherwise approved, all globe, gate and check valves shall be of one manufacturer, with the manufacturer's name and the pressure rating clearly marked on the outside of the valve body.
- .6 Strainers shall be Colton Industries or Mueller.
- .7 Air vents shall be Bell and Gosset, Taco, Sarco, Watts, Zurn, or Maid-O-Mist.
- .8 Manufacture air and dirt separators in an ISO recognized facility. Factory test each unit per Hydraulic Institute standards at the factory of origin. Provide air and dirt separator with flanged or grooved inlet and outlet connections. Provide the vessel shell diameter as three times the nominal inlet/outlet pipe diameter and provide the separator complete with coalescing media. Provide air and dirt separator that allows access for removal and cleaning of coalescing media. Provide bottom of air and dirt separator with dirt chamber and ball valve for dirt purge. Provide separator with inlet and outlet connections of the same size. Design, construct and stamp the separator for the system design pressure class in accordance with ASME Boiler and Pressure Vessel Code. Supply the separator with automatic air vent and connect the vent connection into the bottom of the compression tank for air control systems. Provide air and dirt separator from one of the following manufacturers: Spirotherm Spirovent, Xylem Bell & Gossett, Taco, or Armstrong.

PIPING, VALVES & FITTINGS (EXCEPT PLUMBING)

2.9 Buffer Tanks

- .1 Acceptable manufacturers for buffer tanks for hydronic heating and cooling systems: Niles Steel, Lochinvar, Amtrol, A.O. Smith, Wessels, or Taco.
- .2 Construct tanks in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code, and design and stamp tanks for 860 kPa (125 psi) operating pressure.
- .3 Construct tanks of carbon steel with internal baffle. Prime exterior surfaces and paint with red oxide paint.
- .4 Include with tank: screwed, flanged, or grooved system connections at the same elevation; temperature gauge port; pressure relief valve; drain valve connection; and air vent connection.
- .5 Provide tanks complete with ring base and lifting rings. Provide tanks that are self supporting.
- .6 Provide tank with capacity and dimensions as follows:
 - .1 Chilled Water System R-BT-01: 2271 L (600 US gal) volume, 2235 mm (88 in.) tall, 1220 mm (48 in.) diameter.
 - .2 Heating Water System R-BT-02: 3217 L (850 US gal) volume, 2490 mm (98 in.) tall, 1375 mm (54 in.) diameter.

PART 3 - EXECUTION

3.1 Installation

- .1 For pipe 65 mm (2-1/2 in.) and larger, use flanges, and for smaller pipe, use unions at all valves and equipment.
- .2 Flare connections may be used on soft copper tubing where one end of the flare connection is an integral part of the equipment or valve.
- .3 Provide pipe coatings in accordance with the requirements of this section, where carbon steel piping or stainless steel piping is installed exterior to the building.
- .4 Provide automatic air vents at all high points on piping mains for hot and chilled water systems. Where venting a horizontal pipe, grade pipe up in direction of flow with vent at high point. Provide gate valve at the float inlet. Pipe outlets to drain using copper pipe. Drain pipe shall be run such that its route is visible.
- .5 Provide manual air vents on all hot water heating units where air may be trapped. Use screw-driver operated vents of chrome plated brass. Vents shall be accessible without removing cover of heating unit.
- .6 Provide air separators and air and dirt separators where shown on the Drawings.
- .7 Arrange all runs of piping to prevent interference and to achieve a satisfactory and professional installation of neat appearance. Run all piping parallel to walls. All valves, controls, equipment, expansion compensators, flexible connections and, as far as possible, all piping shall be easily accessible for inspection, maintenance and operation.
- .8 Pitch all lines 25 mm in 12 m (1 in. in 40 ft.-0 in.) unless shown otherwise.

PIPING, VALVES & FITTINGS (EXCEPT PLUMBING)

- .9 Install drain valves at all low points for draining and locate where easily accessible. In order to achieve this, install remote from system where necessary, clearly marked. Typical marking similar to the following:
 - .1 Heating system
 - .2 Danger, authorized personnel only
- .10 Carefully ream threaded joints and join with compound on the male thread only. Re-tighten flanged connections after the installation has been brought up to its service. Following testing, apply insulation. Take care not to overstress the material during construction.
- .11 Pipe welding operations shall be performed by welders Provincial Certification for the class of piping to be welded. Ensure the internal opening of pipes and fittings are not restricted by superfluous material.
- .12 When welding or cutting with a torch, take precautions to prevent fire by maintaining fully charged 4.5 kg (10 lbs.) carbon dioxide extinguisher immediately adjacent to the operation. Protect wooden structure with fire retardant blankets.
- .13 Arrange piping to permit ease of equipment removal. Provide flanges or unions on all pipe connections to each piece of equipment.
- .14 Connect all multi-row water coils in counter flow.
- .15 Drains from packaged air handling unit drain pans shall be of same size as connection on unit. Provide traps on all drains and deep seal traps on both sides of the fan and coil sections.
- .16 Connect bases of all pumps with packed glands to drain with 12 mm (1/2 in.) OD copper tubing.
- .17 Provide on the discharge line of each spray pump, a 12 mm (1/2 in.) valved bleed-off. Connect to discharge line above sump water level and run to drain.
- .18 Provide strainers upstream of each pump suction, steam control valve and steam trap not preceded by a control valve, and where shown.
- .19 Provide butterfly valves where shown; these are permitted in lieu of gate valves in sizes 65 mm (2-1/2 in.) and larger.
- .20 Install all valves in Equipment Rooms in accessible locations from the floor. Where valves are not accessible from the floor, equip with chain operators at the discretion of the Contract Administrator.
- .21 Provide gate, globe and check valves in all piping systems as shown and as required for satisfactory operation and control of equipment. Provide shut-off valves wherever piping is connected to all equipment. Provide one flow balancing valve and one shut-off valve on water coils.
- .22 Install all control devices, valves and any other appurtenances as directed by the controls and/or BAS trades.
- .23 Make connections between copper and steel with brass or bronze fittings.
- .24 Ball valves may be used in low temperature and/or pressure systems only in lieu of gate valves in 50 mm (2 in.) and smaller. Provide union downstream of ball valves for servicing if ball valve is not a three piece design.

PIPING, VALVES & FITTINGS (EXCEPT PLUMBING)

- .25 For grooved piping ensure ends are clean and free from indentations, projections, and roll marks in the area from the pipe end to the groove for proper gasket sealing.
- .26 Grooved pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing. All couplings shall meet the manufacturer's standards for visual inspection. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Install in accordance with manufacturer's latest recommendations. A manufacturer's factory trained representative shall periodically visit the site and review the installation for best practices. The Contractor shall correct any identified deficiencies. Grooved Product that has been examined and has not met the visual inspection criteria for proper installation must be corrected and re-examined by the manufacturer prior to the completion of the Work. Install flow balancing valves in sections of straight pipe as recommended by the manufacturer, but in no case with less than 10 pipe diameters upstream of the valve.
- .27 Install flow balancing valves in the following locations:
 - .1 At each heating, chilled or condenser water riser, or main floor branch
 - .2 Each heating water and cooling water coils including unit heaters, fan coils and force flow heaters
 - .3 Each heat exchanger
 - .4 Each wall fin, radiant ceiling or similar heating device
 - .5 Each heat pump
 - .6 Each pump pressure differential line
 - .7 Each main building or secondary heating or cooling circuit
 - .8 And where shown
- .28 Provide bird screen on all vents terminating horizontally, with a gooseneck or other configurations where a vent stack cover is not provided.
- .29 Buffer tanks:
 - .1 Place tanks on 100 mm high housekeeping pads.
 - .2 Provide drain valve, automatic air eliminator, and pressure relief valve for buffer tanks and pipe to nearest floor drain.
 - .3 Provide a manual isolation valve on each buffer tank system connection.

END OF SECTION

CENTRIFUGAL PUMPS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Materials

2.2 General

- .1 Single or double suction pumps, as shown, from:
 - .1 Armstrong
 - .2 Xylem Bell & Gossett
 - .3 Taco
 - .4 Grundfos-Paco
 - .5 Patterson Pump Company
- .2 Pumps shown as operating in parallel must be selected for stable performance under single pump operation. Submit Shop Drawings showing both single and parallel pump operation.
- .3 Pump volute shall be sized for a maximum of 17 fps velocity. When a pump cannot meet this requirement the manufacturer shall clearly indicate this on the Shop Drawing and include a written explanation as to why the particular pump has been selected.
- .4 Impeller shall be enclosed type. Complete impeller and shaft assembly shall be statically and dynamically balanced.
- .5 For fixed speed pumps impeller shall not exceed 85 percent of casing cut water point. For variable speed pumps the duty point shall be selected similar to a fixed speed pump and the impeller shall be maximized to operate 5% greater than the rated motor horsepower at pump run out.
- .6 Pump inlet and outlet shall be flanged for 860 kPa (125 psi) ANSI flanges or for 1720 kPa (250 psi) ANSI flanges to meet the system requirements. Inlet and outlet flanges shall be equal in size.
- .7 Motor shall be in conformance with Section 20 05 13 - ELECTRIC MOTORS.
- .8 Select motors to be non-overloading over the entire pump curve.
- .9 Provide pumps in accordance with the Pump Schedule.
- .10 Where Vertical In-Line pumps are scheduled or specified as the basis of design, base mounted pumps shall not be permitted as a substitute.

CENTRIFUGAL PUMPS

2.3 Vertical In-Line Pumps

- .1 Pumps shall be vertical P base motor driven units with split type rigid spacer coupling for pumps 7.5 kW (10 hp) and over to be easily removed on site to reveal a space between the pump and motor sufficient to allow servicing of seal without disturbing pump or motor.
 - .1 Casing shall be cast iron, impeller shall be bronze and shaft shall be stainless steel.
 - .2 Mechanical seal shall be outside balanced.
 - .3 For double volute pumps less than 345 kPa (50 psi) operating pressure, inside unbalanced mechanical seals are acceptable. For operating pressures 345 kPa (50 psi) and higher, a balanced mechanical seal shall be provided.
- .2 Seal flushing connection complete with filter and sight flow indicator to suit system working conditions shall be provided on all pumps 7.5 kW (10 hp) and over. Filter shall be sized to suit the flow rate required for the seal and shall be oversized by three times for glycol systems.
 - .1 As an alternative to the above provide a cyclone sediment separator and sight flow indicator where differential pressures exceed 207 kPa (30 psi).
- .3 Internal mechanical seal shall be John Crane Silicon Carbide or equal.
- .4 External mechanical seal shall be stainless steel multi-spring outside balanced type with Viton secondary seal, carbon rotating face and silicon carbide stationary seat.
 - .1 Provide a 316 stainless steel gland plate.
 - .2 Provide a factory installed flushline with manual vent.
- .5 For heating systems with operating temperatures greater than 82.2 deg. C. (180 deg. F.) and for condenser water systems use Silicon Carbide seals.
- .6 Provide strainer guide vanes on vertical suction piping section of all vertical in-line pumps, where specifically shown. Refer to Section 23 21 13.23 - PIPES, VALVES AND FITTINGS for detailed Specification.

PART 3 - EXECUTION

3.1 Installation

- .1 Grout base-mounted pumps to vibration isolation base after shimming and aligning in accordance with manufacturer's written instructions. Alignment shall be provided by a certified millwright once at start-up and once at operating temperature. Grout void under steel or cast iron base full of concrete. Base shall be large enough to support base elbow at pump suction for single suction pumps and both suction and discharge elbow on double suction pumps.
- .2 Increases and reducers on pump suction and discharge shall be eccentric fittings and shall be of a gradual increase or reduction to prevent unnecessary turbulence or noise.
- .3 Provide vibration isolation and flexible connections for all pumps in accordance with Section 20 05 48 - VIBRATION AND NOISE CONTROL.
- .4 Filters shall be changed by this Division after the system is flushed and on a regular basis until handed over to The City or their representatives.

END OF SECTION

PRESSURE RELIEF VALVES

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Materials

- .1 All pressure relief valves shall be code rated for the service and shall be approved under Canadian Interprovincial Boiler Inspection Regulations.
- .2 Pressure relief valves shall be Spirax Sarco or approved equal.

PART 3 - EXECUTION

3.1 Installation

- .1 Hot water pressure relief valves shall operate at 207 kPa (30 psi) unless shown otherwise. Where higher pressure relief settings are required, relief valve shall operate at 70 kPa (10 psi) less than the maximum rated pressure of the lowest rated system component (tank, boiler, heat exchanger, etc.) or 1034 kPa (150 psi) whichever is less.

END OF SECTION

REFRIGERANT PIPING

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 Provide low Global Warming Potential (GWP) refrigerant complying with the performance requirements stated within Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Submittals

- .1 Submit Product data sheets for all Products required, except for pipe and fittings.
- .2 Submit a schematic piping diagram for each refrigerant piping system indicating pipe sizes, slopes, valves, traps, and piping specialties sealed by a Professional Engineer in the Province of the installation.
- .3 Submit confirmation of registration of the Project with the Authority Having Jurisdiction.

1.3 Regulatory Compliance and Quality Assurance

- .1 The installing Contractor shall be certified and shall register all Projects in accordance with the requirements of the Authority Having Jurisdiction.
- .2 All components of a refrigeration piping system shall have a Canadian Registration Number or CSA certification acceptable to Authority Having Jurisdiction.
- .3 All systems shall display appropriate Ozone Depletion Prevention (ODP) tags prior to commissioning. Manufacturer shall not commission any system not displaying proper ODP tags.

1.4 Special Considerations For Variable Refrigerant Flow (VRF) Piping Systems

- .1 VRF refrigeration piping systems shall be installed as per the balance of this Specification with the following considerations and/or exceptions:
- .2 Refrigerant Contractors shall be certified by the VRF Equipment Supplier. Proof of training certification shall be made available upon request.
- .3 There shall be minimal use of refrigeration specialties (filter driers, accumulators, receivers, check valves, etc.) in the VRF pipe system. Install in accordance with VRF manufacturer's recommendations.
- .4 Pressure relief valves shall be 4482 kPa (650 PSI) rated and installed in pairs (two valves per circuit).
- .5 Y style piping joints and headers shall be provided by the manufacturer to ensure proper refrigerant balance and flow for optimum system capacity and performance.
- .6 T style joints, field fabricated joints, or Y joints that are not provided by the manufacturer shall not be permitted.
- .7 Approved flaring block, and approved torque wrenches, both available from VRF manufacturer, shall be used for all flare connections.

REFRIGERANT PIPING

- .8 Pipe clamps shall fasten around the piping insulation. Pipe clamps that compress the copper directly shall be installed a minimum of 900 mm (36 in) away from joints, and shall be loosely tightened to allow for copper expansion.
- .9 Provide VRF manufacturer with actual pipe lengths installed for calculation of refrigerant charge. Supply and charge VRF system with required quantity of refrigerant prior to VRF manufacturer commissioning. Refrigerant charging shall be done in the liquid state.

PART 2 - PRODUCTS

2.1 Pipe, Fittings and Joints

- .1 Provide hard drawn, air conditioning / refrigerant grade ASTM B280 "Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service" copper piping for runs longer than 3 m (10 ft.); for shorter runs air conditioning / refrigerant grade ASTM B280 soft annealed copper piping is permissible provided the requirements of Part 3 are met..
 - .1 Braze all joints except as noted.
 - .2 Joints 22 mm (7/8 in) and smaller may be flared.
 - .3 Fittings shall be cast copper alloy for flared copper tube, or wrought copper and bronze solder-joint pressure fittings.
 - .4 Joints and fittings for brazed joint shall be wrought-copper or forged-brass sweat fittings.
 - .5 Cast sweat-type joints and fittings shall not be permitted for brazed joints.
 - .6 Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of equipment.

2.2 Brazing Filler Metal

- .1 Filler metal shall be type BAg-5 with AWS Type 3 flux except as noted.
- .2 Copper to copper joint filler metal shall be BCuP-5 or BCuP-6.
- .3 Brazing rods for all joints shall be 15% Lucas Milhaupt "sil-Fos".

2.3 Valves

- .1 Valves shall be designed, manufactured, and tested specifically for refrigerant service. Valve bodies shall be of brass, bronze, steel, or ductile iron construction. Valves 25 mm (1 in) and smaller shall have brazed or socket welded connections. Valves larger than 25 mm (1 in) shall have butt welded end connections. Threaded end connections shall not be used, except in pilot pressure or gauge lines where maintenance disassembly is required and welded flanges cannot be used. Internal parts shall be removable for inspection or replacement without applying heat or breaking pipe connections. Valve stems exposed to the atmosphere shall be stainless steel or corrosion resistant metal plated carbon steel. Direction of flow shall be legibly and permanently indicated on the valve body. Purge, charge and receiver valves shall be of manufacturer's standard configuration.
- .2 Refrigerant access valves and hose connections shall be in accordance with AHRI 720.

REFRIGERANT PIPING

- .3 Isolation valves shall be installed where shown on the schematics. Isolation valves shall be bi-flow self-seating with operating pressures up to 4482 kPa (650 PSI). Valves shall be complete with brass Schrader connections located on the valve body only.
- .4 Check Valves shall be Mueller Industries Inc. "Checkmaster" straight through type for valves 6.4 mm to 16 mm (1/4 in to 5/8 in) diameter, globe type for valves 22 mm (7/8 in) diameter and larger, each complete with extended tubing for brazing connections, and as follows:
 - .1 Straight through type check valves are to be complete with a machined brass gasketed body, phosphor bronze spring, and neoprene seat.
 - .2 Globe type check valves are to be complete with a cast bronze body, forged brass cap, phosphor bronze spring, PTFE seat disc, and neoprene O-ring seal.
- .5 Liquid Solenoid Valves
 - .1 Ball type valves as specified above, each in accordance with AHRI 760 and be suitable for continuous duty with applied voltages 15 % under and 5 % over nominal rated voltage at maximum and minimum encountered pressure and temperature service conditions, direct-acting or pilot-operating type, moisture-proof, ULC approved, totally encapsulated or encapsulated and metal jacketed as required. Valves shall have an operating pressure differential suitable for the refrigerant used.
- .6 Expansion Valves
 - .1 Valve shall be the diaphragm and spring-loaded type with external equalizers, and bulb and capillary tubing. Valve shall be equipped with an external superheat adjustment along with a seal cap. Internal equalizers may be utilized where flowing refrigerant pressure drop between outlet of the valve and inlet to the evaporator coil is negligible and pressure drop across the evaporator is less than the pressure difference corresponding to 1 Deg. C. (2 Deg. F.) of saturated suction temperature at evaporator conditions. Pilot-operated valves shall have a characterized plug to provide required modulating control.
 - .2 Electronic expansion valves shall be brass body, needle valve with floating needle and machined seat, stepper motor drive.
- .7 Safety Relief Valves
 - .1 Suction lines shall be rated at 2413 kPa (350 PSI) and liquid at 4482 kPa (650 PSI) or liquid and discharge lines at 4482 kPa (650 PSI) respectively.
 - .2 Purpose built Y-fitting shall be Superior Products model 3155W.
- .8 Evaporator Pressure Regulators, Direct-Acting
 - .1 Valve shall include a diaphragm/spring assembly, external pressure adjustment with seal cap, and pressure gauge port. Valve shall maintain a constant inlet pressure by balancing inlet pressure on diaphragm against an adjustable spring load. Pressure drop at system design load shall not exceed the pressure difference corresponding to a 1 Deg. C. (2 Deg. F.) change in saturated refrigerant temperature at evaporator operating suction temperature. Spring shall be selected for indicated maximum allowable suction pressure range.

REFRIGERANT PIPING

2.4 Piping Accessories

.1 Filter Driers

- .1 Sizes 15 mm (5/8 in) and larger shall be the full flow, replaceable core type. Sizes 15 mm (1/2 in) and smaller shall be the sealed type. Cores shall be of suitable desiccant that will not plug, cake, dust, channel, or break down, and shall remove water, acid, and foreign material from the refrigerant. Filter driers shall be constructed so that none of the desiccant will pass into the refrigerant lines. Minimum bursting pressure shall be 10.3 MPa (1500 PSI).

.2 Discharge Line Oil Separator

- .1 Discharge line oil separator shall be provided in the discharge line from each compressor. Oil return line shall be connected to the compressor as recommended by the compressor manufacturer.

.3 Accumulator

- .1 Accumulators shall be provided in the suction line to protect the compressor from liquid refrigerant damage. Accumulator shall be cUL listed under the required operating pressures and must be installed as close to the compressor as possible.

.4 Refrigerant Moisture and Liquid Indicators

- .1 Indicators shall be single or double port, ULC listed. Body shall be copper or brass with flared or soldered ends. Sight glass shall have color coded paper moisture indicator with removable element cartridge and plastic cap. Maximum working pressure shall be 3447 kPa (500 PSIG). Maximum working temperature shall be 93.3 Deg. C. (200 Deg. F.).

.5 Pressure and Vacuum Gauges

- .1 Gauges shall conform to ASME B40.100 and shall be provided with throttling type needle valve or a pulsation dampener and shut-off valve. Gauge shall be a minimum of 85 mm (3-1/2 in) in diameter with a range from 0 kPa (0 PSIG) to approximately 1.5 times the maximum system working pressure. Each gauge range shall be selected so that at normal operating pressure, the needle is within the middle-third of the range.

.6 Insulation

- .1 Liquid, suction and hot gas lines shall be individually insulated in accordance with Section 20 07 00 – INSULATION.

PART 3 - EXECUTION

3.1 General

- .1 Consider the piping shown on the Drawings as diagrammatic, indicating the general runs and connections only, and parts may not be shown in the true position. Be responsible for the proper erection of the systems of piping in every respect suitable for the work intended.

REFRIGERANT PIPING

- .2 Install all piping in a professional manner and in accordance with the best practices of the trade. Piping shall be pitched 13 mm (1/2 in) for every 3000 mm (10 ft) of length in the direction of flow to ensure adequate oil drainage. Open ends of refrigerant lines or equipment shall be properly capped or plugged during installation to keep moisture, dirt, or other foreign material out of the system. Piping shall remain capped until installation. Equipment piping shall be in accordance with the equipment manufacturer's recommendations and as shown.
- .3 Pipe supports shall be a maximum of 1800 mm (6 ft.) apart. Pipe clamps shall fasten around the piping.
- .4 Piping supports and guides using steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.
- .5 Anchors shall be provided wherever necessary or indicated to localize expansion or to prevent undue strain on piping. Anchors shall consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces shall be installed in the most effective manner to secure the desired results using turnbuckles where required. Supports, anchors, or stays shall not be attached where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline. Where pipe and conduit penetrations of vapor barrier sealed surfaces occur, these items shall be anchored immediately adjacent to each penetrated surface, to provide essentially zero movement within penetration seal.
- .6 Install in accordance with CSA B52 and ASME B31.5 Mechanical Refrigeration Code.
- .7 Safety pressure relief valves shall be installed in the piping as per CSA B52. All pressure relief valves and brazed joints shall be suitably sized.
- .8 Install two pressure relief valves per refrigeration circuit using a purpose built "Y" fitting complete with integral ball valves.
- .9 Install on the liquid and suction line or liquid and discharge line as per Drawing details. Pressure relief valves shall be individually isolated to allow for maintenance and replacement.
- .10 Nitrogen purging / sweeping shall be used when brazing and welding to minimize oxidation.
- .11 Isolation valves shall be installed where shown on the schematics or as required.
- .12 Prevent the release of refrigerants into the atmosphere during installation and testing.
- .13 Pipe shall be cut accurately to measurements established at the jobsite, and worked into place without springing or forcing, completely clearing all windows, doors, and other openings. Pipe or tubing shall be cut square reamed to remove burrs, and shall permit free expansion and contraction without causing damage to the building structure, pipe, joints, or hangers.
- .14 Install pipe, valves, and fittings to facilitate easy maintenance. Do not locate valves, couplings, or flanged/union connections directly above electrical panels, motor starters or MCC's.
- .15 Where soft annealed copper piping is permissible above, install it straight and free of dips that may trap refrigerant.

REFRIGERANT PIPING

- .16 A liquid line filter dryer shall be installed in each refrigerant circuit located such that all liquid refrigerant passes through a filter dryer. Dryers shall be sized in accordance with the manufacturer's recommendations for the system in which it is installed.
- .17 A moisture indicating sight glass shall be installed in all refrigerant circuits down stream of all filter dryers and where indicated. Site glasses shall be full line size.

END OF SECTION

HEATING SYSTEM CHEMICAL TREATMENT

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Submittals

- .1 Shop Drawings: Submit Shop Drawings of all components of the system in accordance with Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS. Include all wiring diagrams.
- .2 Manufacturer's Data: Submit details of all testing equipment to be provided.

1.3 Quality Assurance

- .1 Qualifications of Manufacturers: Work under this section shall be limited to the following companies:

PART 2 - PRODUCTS

2.1 Materials

2.2 Closed Recirculating Loop For Heating System

- .1 For each heating system provide an adequately sized pot feeder for the entire system but not less than a 7.6 L (2 gallon) pot feeder. Pot feeder shall have a maximum working pressure of 300 psi at 200 deg F. Tank shell shall be 10 gauge steel, tank heads shall be 9 gauge steel, and cap shall be cast iron with Buna N seal ring, equal to Solenis PN 9233-03-2 or Neptune DBF-2HP. Pot feeder assembly shall be complete with valved inlet and outlet, screen, drain and pot feeder.
- .2 For each heating system provide an adequately sized pot feeder for the entire system but not less than a 19 L (5 gallon) pot feeder. Pot feeder shall have a maximum working pressure of 300 psi at 200 deg F. Tank shell and heads shall be 11 gauge steel, and cap shall be cast iron with Buna N seal ring, equal to Solenis PN 9233-04-0, or Neptune DBF-5HP. Pot feeder assembly shall be complete with valved inlet and outlet, screen, drain and pot feeder.
- .3 Provide two (2) corrosion test coupons, one copper equal to Drew PN 7721-01-3 and one steel equal to Solenis PN-7722-01-1. Corrosion coupons to be installed in 19 mm (3/4 in.) tee fittings on the upstream side of the pot feeder.
- .4 Corrosion and scale inhibitor for closed loop heating systems shall be equal to GE W&P Technologies CORRSIELD MD4102 or Solenis CSW 311.
- .5 Provide an adequate quantity of chemical treatment for 6 months of operation after Substantial Completion of the Contract.
- .6 Provide bypass filter as specified in Section 23 25 14 - PIPE SYSTEM FILTERS.

HEATING SYSTEM CHEMICAL TREATMENT

PART 3 - EXECUTION

3.1 Installation

- .1 Pot feeder is to be installed in parallel with filter on supply and return line headers. Headers shall be in an accessible location, less than 1.5 m (5 ft.) above the floor.
- .2 The Water Treatment Supplier shall provide a service program for a period of 1 year from Substantial Completion of the Contract. Service visits shall be conducted on regular frequency suitable to meet system stability requirements. A report containing findings and recommendations shall be submitted to The City following each visit.
- .3 Provide two days service (7-1/2 hours per day) of manufacturer's representative to add chemicals to the systems until properly protected, adjust the equipment and the blow down rates. Representative shall also, during this time, instruct The City's representative in the correct use of the treatment, show The City the test results for the systems, how to test the systems, and how often.

END OF SECTION

PIPE SYSTEM FILTERS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Materials

- .1 For systems under 600 GPM, provide pipe system filter housings capable of receiving a single double open end (DOE) filter cartridge. Construct head of cast iron; construct shell of Type 304 or Type 316L stainless steel.
- .2 For systems over 600 GPM, provide pipe system filter housings capable of receiving multiple double open end (DOE) filter cartridges. Construct shell and heads of Type 316L stainless steel.
- .3 Provide shell and heads suitable for 1035 kPa (150 psi) working pressure and provide filter media suitable for 149 deg. C. (300 deg. F.) service temperature.
- .4 Provide bleached cotton filter media for selective removal of particles from 1 to 100 microns. Provide non-rupturing media and mount so that no by-pass of media can occur.
- .5 Size filters for 3% of total system flow and apply within the mid-capacity of the filter operating flow rate.

PART 3 - EXECUTION

3.1 Installation

- .1 Install pipe system filters in the following systems:
 - .1 Perimeter heating systems
 - .2 Constant temperature heating system
 - .3 Chilled water system
- .2 Install pipe system filters across the pumps with valved inlet and outlet. Provide flow balancing outlet valve. Refer to Section 23 21 13.23 - PIPES, VALVES AND FITTINGS (EXCEPT PLUMBING). Provide flanges or unions for servicing. Provide valved drain on unit casing.

END OF SECTION

CHILLED WATER TREATMENTS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Submittals

- .1 Shop Drawings: Submit Shop Drawings of all components of the system in accordance with SECTION 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS. Include all wiring diagrams.
- .2 Manufacturer's Data: Submit details of all testing equipment to be provided.

1.3 Quality Assurance

- .1 Qualifications of Manufacturers: Work under this section shall be limited to the following companies:

PART 2 - PRODUCTS

2.1 Materials

2.2 Closed Recirculating System (Chilled Water)

- .1 For each chilled water system provide an adequately sized pot feeder to inject nitrate borate solutions into the entire system but not less than a 7.6 L (2 gallon) pot feeder. Pot feeder shall have a maximum working pressure of 300 psi at 200 deg F. Tank shell shall be 10 gauge steel, tank heads shall be 9 gauge steel, and cap shall be cast iron with Buna N seal ring, equal to Solenis PN 9233-03-2 or GE W&P Technologies DBF-2. Pot feeder assembly shall be complete with valved inlet and outlet, screen, drain and pot feeder.
- .2 For each chilled water system provide an adequately sized pot feeder for the entire system but not less than a 19 L (5 gallon) pot feeder. Pot feeder shall have a maximum working pressure of 300 psi at 200 deg F. Tank shell and heads shall be 11 gauge steel, and cap shall be cast iron with Buna N seal ring, equal to Solenis PN 9233-04-0, or GE W&P Technologies DBF-5. Pot feeder assembly shall be complete with valved inlet and outlet, screen, drain and pot feeder.
- .3 Provide two (2) corrosion test coupons, one copper equal to Solenis PN 7721-01-3 and one steel equal to Solenis PN-7722-01-1. Corrosion coupons to be installed in 19 mm (3/4 in.) tee fittings on the upstream side of the pot feeder.
- .4 Spray coils on each system shall be provided with a chemical treatment system controlled from a make-up water meter to supply a sequestering agent to the spray water. Bleed-off shall be controlled from a conductivity controller. Provide a biocide/algaecide for control of slime in the tank.
- .5 Corrosion and scale inhibitor for closed loop heating systems shall be equal to GE W&P Technologies CORRSIELD MD4102 or Solenis CSW 311.

CHILLED WATER TREATMENTS

- .6 Provide an adequate quantity of each type of chemical for complete oxygen removal, scale protection or other type of protection sufficient to treat the entire system or systems for six (6) months after Substantial Completion of the Contract.
- .7 Provide testing equipment as per Section 23 25 26 - CLEANING AND FILLING for all types of chemicals used in the systems. Equipment shall be mounted in a baked enamel steel storage cabinet with hinged door. Colour of cabinet shall be to the Contract Administrator's requirements.
- .8 Provide bypass filter as specified in Section 23 25 14 - PIPE SYSTEM FILTERS.

PART 3 - EXECUTION

3.1 Installation

- .1 Pot feeder is to be installed in parallel with filter on supply and return line headers. Headers shall be in an accessible location, less than 1.5m (5 ft) above the floor.
- .2 The Water Treatment Supplier shall provide a service program for a period of 1 year from Substantial Completion of the Contract. Service visits shall be conducted on regular frequency suitable to meet system stability requirements. A report containing findings and recommendations shall be submitted to The City following each visit.
- .3 Install system in accordance with reviewed Shop Drawings and manufacturer's installation instructions.
- .4 Wall mount control panel, starters, and similar components where shown, unless otherwise directed. Controls shall be flush mounted. Provide manual-off-automatic switches for chemical feed pumps together with running and trip lights. Provide interlock with condenser water pumps to prevent chemical injection when condenser water pumps are off.
- .5 Furnish isolating gate valve upstream of the bleed off valve.
- .6 Furnish isolating gate valve upstream of the control valve.
- .7 Furnish control valve, size of which shall be equal to the blow-down pipe size.
- .8 Install isolating valves and valved by-pass around water meter. Provide interconnecting wiring between meter and chemical feed control system.
- .9 Provide manufacturer's representative to add chemicals to the systems until properly protected, adjust the equipment and the cooling tower bleed-off. Representative shall also instruct The City's representative in the correct use of the treatment. Upon completion submit a letter stating that all systems have been correctly set-up, are operating as required for adequate protection, and The City has received adequate instruction for the ongoing maintenance of the systems.
- .10 Provide all interconnecting wiring and piping to complete the system. All electrical connections as required are the responsibility of the Mechanical Subcontractor.

END OF SECTION

CLEANING AND FILLING

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Submittals

- .1 Shop Drawings: Submit Shop Drawings of all chemicals used in the system in accordance with SECTION 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Materials

- .1 Water piping cleaning solution for closed loop systems shall be equal to GE W&P Technologies FERROQUEST FQ7103 or Solenis CSW 600. Refer to manufacturer's written instructions for chemical concentrations.
- .2 Provide inhibited ethylene glycol system solution that is 50% by volume of factory, pre-mixed solution. Acceptable Products: Dow Chemical Co. "Dowtherm SR-1", Interstate Chemical Co. "Intercool NFE", Chemfax Chem-Cool, or Recochem Inc. "Recotherm IG".
- .3 Provide inhibited propylene glycol system solution that is 50% by volume of factory, pre-mixed solution. Acceptable Products: Chemfax Chem-Frost propylene glycol.
- .4 Provide alcohol Anti-freeze solution that is 40% by volume of Anchem Sales "Ancool-100."
- .5 Glycol make-up packages shall be provided for glycol water make-up. Each glycol make up package shall be equal to Solenis Chemical E5800; PN 9243-01-5, Expanflex model GMP-2-50, GE W&P Technologies AGS-2045, or Armstrong GLA-STD-LP-1 for 1.8 gpm make-up at 50 psig with a 120 V (1/3 hp) motor and 50 gallon polyethylene storage tank complete with hinged cover. Unit shall be complete with cut-off and (audible and visual) alarm in case of high pressure or low solution level. The pumping assembly shall be mounted in a sturdy steel frame, complete with legs to keep it off the floor. The package shall include a motor, a pump, a magnetic starter, a pressure tank, a priming valve, a PRV, a shut-off valve and a pressure gauge

PART 3 - EXECUTION

3.1 Installation

- .1 All systems shall have been hydrostatically tested prior to cleaning.
- .2 Thoroughly flush all systems with raw water to remove loose mill scale and debris. Remove and clean all strainers and flush low points before chemical cleaner is added.
- .3 Disconnect all coils and by-pass flow.
- .4 A temporary pump shall be installed in the system and shall be capable of pumping adequate discharge at adequate head.

CLEANING AND FILLING

- .5 A temporary heater shall be installed in the system and shall be capable of maintaining the circulating water temperature as required for chemical treatment.
- .6 Systems shall be filled with city water and approved chemical cleaner introduced by a small temporary chemical injector pump at the temporary circulating pump section. Cleaner shall be introduced to maintain concentrations as per the manufacturer's recommendations.
- .7 All systems shall be cleaned in accordance with manufacturer's written instructions and under the supervision of the Chemical Supplier's representative. Minimum cleaning procedures shall be to fill all water piping cleaning solution, circulate at 1.5 times specified system flow rate and maintain at highest possible temperature for 72 hours. During this period heavy blowdown of all low points shall be carried out every 6 hours. Strainers shall be cleaned as necessary to permit maximum flow possible and, in any event, at least every 6 hours. Drain the solution, all strainers, and flush entire system with clean water for a minimum of 24 hours. Repeat fill and flush procedure as often as required, adding inhibitor with each fill, to achieve acceptable contaminant levels. Systems shall then be refilled, ready for use. Temperature of system for cleaning shall be to suit Chemical Supplier's requirements.
- .8 Take samples of system from a series of representative drains as directed by the Contract Administrator. If system is still dirty, repeat cleaning procedure specified above until acceptable. Acceptable samples shall indicate that alkalinity and pH have returned to potable water levels. Copies of all test reports shall be submitted by the Water Treatment Supplier to the Contract Administrator for verification prior to final filling.
- .9 Add fluid and chemical treatment immediately after cleaning has been completed and accepted. Acceptable control parameters shall be as follows:
 - .1 Nitrite: 1000 - 1500 ppm
 - .2 pH: 8.5 – 10 or as required by equipment manufacturer
 - .3 Iron: Less than 2.0 ppm
 - .4 Copper: Less than 0.3 ppm
 - .5 Molybdate: 100 - 150 ppm
 - .6 Hardness (CaCO₃): Less than 50 ppm or as required by equipment manufacturer (soften water as required)
- .10 For glycol systems install glycol make-up system as per manufacturer's written instructions and in accordance with Section 23 77 13 - EXPANSION TANKS. Fill system with specified glycol product to achieve the required glycol concentration. Glycol systems shall be provided with a Freezing Point Glycol Test Kit equal to Solenis PN 7729-01-7.
- .11 For ground source closed loop heat pump systems after cleaning and draining, fill the system with alcohol or propylene glycol anti-freeze solution as specified or shown in equipment schedules.
- .12 For tenant Work the Base Building Contractor shall drain and fill the base building system. Arrange and pay for this Work.

CLEANING AND FILLING

- .13 The Mechanical Subcontractor shall supply the Contract Administrator with certified documentation from the Water Treatment Supplier that the systems have been properly equipped, chemically cleaned and that they are maintaining sufficient levels of scale/corrosion inhibitor. The Contractor shall request such documentation from the Water Treatment Supplier within one week of presentation to the Contract Administrator.
- .14 A label or tag identifying any chemical additives, their concentration, and their maintenance requirements shall be permanently and prominently displayed on the heat source.

END OF SECTION

PIPE EXPANSION JOINTS, GUIDES AND ANCHORS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 Select hangers, supports, anchors, guides and restraints to withstand all static and dynamic loading conditions which act upon the piping system and associated equipment. Design expansion and contraction solution to suit the temperature and spatial restraints of the location where the pipes are installed. Prepare detailed Shop Drawings showing all anchors, guides, and expansion compensation for all systems with the potential for thermal expansion/contraction and/or loads due to weight or thrust. Provide Shop Drawings bearing the signed seal of a Professional Engineer licensed to practice in the appropriate discipline and Place of the Work. Include in the Shop Drawings all details of construction, static and dynamic forces at points of attachment, etc. necessary for review and acceptance by the Project Structural Engineer's Representative. Make adjustments as necessary to satisfy the requirements of the Structural Division. Do not install any anchor points without reviewed Shop Drawings and, where installed prior to review, remove and replace to the satisfaction of the Engineer's Representative.

1.2 System Temperatures

- .1 Refer to schematics on Drawings for required operating pressures.
- .2 Base Shop Drawings required above on the following minimum and maximum temperatures.

System Type	Minimum Temperature	Maximum Temperature	Notes
Heating Water	4 C	115 C	Max temperature includes safety factor
Chilled Water	4 C	45 C	
Domestic Cold Water	4 C	45 C	
Domestic Hot Water / Recirculation	4 C	70 C	

1.3 Warranty

- .1 Provide a warranty in accordance with the requirements of Section 20 05 00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Materials

- .1 Expansion joints, guides and anchors: United Flexible, Flexonics, Hydroflex, or Victaulic, specifically designed for the system in which they are installed.

PIPE EXPANSION JOINTS, GUIDES AND ANCHORS

- .2 Victaulic Floor-Mounted Riser Anchor for Grooved Steel Piping: Engineered pipe anchor, sizes 50 mm (2 in.) through 300 mm (12 in.), standard weight carbon steel to ASTM A53 "Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless" with orange enamel coating with carbon steel brackets. Victaulic Original-Groove System grooved ends. Anchors suitable for system operating pressure to 3447 kPa (500 psi). Victaulic No. A10. SPEC SHEET LINK: MODEL A10
- .3 Victaulic AGS Heavy Riser Anchor: Engineered pipe anchor, sizes 350 mm (14 in.) through 600 mm (24 in.), standard weight carbon steel to ASTM A53 "Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless" with orange enamel coating with carbon steel brackets. Victaulic Advanced-Groove System (AGS) grooved ends. Anchors suitable for system operating pressure to 3447 kPa (500 psi). Victaulic No. WA20. SPEC SHEET LINK: MODEL WA20
- .4 Victaulic Floor-Mounted Riser Anchor for Grooved Stainless Steel Piping: Engineered pipe anchor, sizes 50 mm (2 in.) through 300 mm (12 in.), schedule 40 stainless steel to ASTM A312 "Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes," type 304 with carbon steel brackets. Victaulic Original-Groove System grooved ends. Anchors suitable for system operating pressure to 3447 kPa (500 psi). Victaulic No. A10S. SPEC SHEET LINK: MODEL A10S
- .5 Expansion compensation:
 - .1 Expansion compensation solution as presented per Part 1 requirements.
 - .2 Expansion joints for 75 mm (3 in.) diameter pipe and larger: packless bellows type with equalizing rings, stainless steel bellows, limit stops, internal telescoping sleeves and carbon steel schedule with bevelled welding ends, or flanged to suit installation.
 - .3 Expansion joints for 65 mm (2-1/2 in.) diameter pipe and smaller: packless bellows type with stainless steel bellows, anti-torque device, limit stops, guides and threaded pipe ends.
 - .4 Grooved expansion joints for 20 mm (3/4 in.) and larger sizes: expansion joint consisting of a series of grooved end nipples joined with flexible-type couplings. Joint movement and expansion capabilities determined by number of couplings / nipples used in the joint. Victaulic Style 155, 155P and W155 AGS.
 - .5 Furnish an inspection and data report, furnish with expansion compensation system.

PART 3 - EXECUTION

3.1 Installation

- .1 Provide for the expansion and contraction of all pipes, and install with sufficient flexibility to prevent end thrust and movements caused by thermal expansion or contraction causing detrimental distortion or damage of connected equipment. Provide offsets between mains and equipment of sufficient length to safely absorb the expansion of the main.
- .2 During operation, the chilled water supply temperature will be 4 deg. C. (39 deg. F.). Pre-compress expansion joints in accordance with manufacturer's installation instructions based on the ambient installation temperature.
- .3 Guides shall be as shown and shall be located as follows:

PIPE EXPANSION JOINTS, GUIDES AND ANCHORS

- .1 Distance from expansion joint to first guide shall be maximum 4 pipe diameters
- .2 Distance from first to second guide shall be maximum 14 pipe diameters
- .3 Maximum spacing between additional guides:
 - .1 3.7 m for 65 mm (12 ft. for 2-1/2 in.) pipe
 - .2 7.3 m for 75 mm and 100 mm (24 ft. for 3 in. and 4 in.) pipe
 - .3 11 m for 125 mm and 150 mm (36 ft. for 5 in. and 6 in.) pipe
 - .4 14.6 m for 200 mm (48 ft. for 8 in.) pipe
 - .5 18.3 m for 250 mm (60 ft. for 10 in.) pipe
- .4 Anchors shall be as shown.
- .5 Ensure anchors, expansion compensation, and guides are located and installed in accordance with the Engineered Shop Drawings required by this specification section.
- .6 Expansion joint and anchor manufacturer to provide on-site inspection to ensure proper installation per design requirements and manufacturer's installation instructions.

END OF SECTION

FLEXIBLE PIPE CONNECTORS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Materials

- .1 Pipe connectors, where shown, for water, shall be Hydroflex Hose, Flexonics or Vibro-Flo or corrugated metal with braided sheath.
- .2 Corrugated metal and sheath shall be of bronze or stainless steel with threaded ends for 50 mm (2 in.) pipe size and smaller and flanged ends for larger sizes.
- .3 Total length of connector shall vary from a minimum of 300 mm (12 in.) for 25 mm (1 in.) deflection, and up to 450 mm (18 in.) for 50 mm (2 in.) or greater deflection.
- .4 Minimum working pressure at 21.1 deg. C. (70 deg. F.) shall be 1200 kPa (175 psi) based on maximum working pressure not exceeding burst pressure.

PART 3 - EXECUTION

3.1 Not Used

END OF SECTION

DUCTWORK AND SPECIALTIES

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Submittals

- .1 Shop Drawings
 - .1 Submit Shop Drawings of all catalogued components to be supplied. Include manufacturer's data sheets for certification, performance criteria, ratings, and physical dimensions and finishes.
 - .2 Submit Shop Drawings of each supporting structural assembly required in the ductwork systems, designed by an engineer licensed to practice in the Place of the Work in the appropriate discipline. Same design engineer stamps each and every Shop Drawing.
- .2 Samples: Submit samples as required.
- .3 Submit marked up prints showing detailed locations of all devices mounted in or on ductwork, dimensioning their locations including, but not limited to; balancing dampers, back draft dampers, and splitter dampers.

PART 2 - PRODUCTS

2.1 Materials

- .1 Fabricate all ductwork unless specifically noted otherwise, of galvanized sheet steel with Z180 coating to A653/A653M.
- .2 Sealing compound: Minnesota Mining and Manufacturing or other approved manufacturer. Duct tape shall be Duro-Dyne or other approved manufacturer.
- .3 Flexible ducting:
 - .1 Flexible metal ducting shall be Flexmaster Triple-Lock Aluminum Flexible ducting T/L. ULC listing S110.
- .4 Access Ports shall be Lawson-Taylor or other approved manufacture of 32 mm (1-1/4 in.) dia. ports.
- .5 Flexible Connections:
 - .1 Ventfabrics, Duro Dyne, or Dyne-Air.
 - .2 For fans less than 0.5 kPa (2 in. wg.) connections shall be minimum 680 gm/sq.m. (20 oz./sq.yd.) fire retardant polyvinyl-chloride polyester fabric equal to Vinyl-Flex.
 - .3 For fans in excess of 0.5 kPa (2 in. wg.) connections shall be minimum 1,080 gm/sq.m. (32 oz./sq.yd.) non-toxic neoprene coated fibreglass fabric equal to Neoprene N.T.
 - .4 For all flexible connections located outside the building (e.g. roof top units) flexible connections shall be fire retardant Hypalon coated fibreglass fabric and shall be a minimum 9915 gm/sq.m. (27 oz./sq.yd.) equal to Hypalon.

DUCTWORK AND SPECIALTIES

- .5 For all systems where the temperature may exceed 112 deg. C. (235 deg. F.) silicone rubber coated fibreglass shall be used, and shall be equal to Silicone H1-T. Submit flexible connections for review before installation.
- .6 Dampers:
 - .1 Dampers: For right angle branch duct take-off from vertical riser; Air vector Vectrol or other approved manufacturer.
 - .2 Construct fire dampers, smoke dampers and combination smoke and fire dampers of stainless steel where dampers are installed in aluminum or stainless steel ductwork.
 - .3 Fire Dampers: Underwriters' Laboratories Classified to ANSI/UL 555 Standard for Fire Dampers and CAN/ULC S112 Standard Method of Fire Test of Fire Damper Assemblies or ANSI/UL 555C Standard for Ceiling Dampers as applicable.
 - .1 Fire dampers shall be curtain type, rated as "Dynamic," and shall have the blades clear of the air stream. Fire dampers shall be Type B or Type C as required to suit system air velocity and pressure. Fire dampers in return and exhaust systems may be Type A with the blades in the air stream where permitted by the Contract Administrator. Dampers shall be multi-sectional as required to suit size and UL/ULC Listing requirements. Where the specified curtain fire dampers are limited by the UL/ULC Listing for maximum size, they shall be substituted with multi-blade type complete with power actuation and/or fusible link as required to satisfy the fire rating of the partition. Where a fire damper is required to be installed behind a wall grille, Slimline type dampers may be used to provide a flush to wall grille installation.
 - .2 Fire-stop flaps or ceiling mounted fire dampers shall be as shown in the Underwriters' Laboratories Listing for the specific ceiling assembly used.
 - .3 Thermally insulated motorized control dampers: in accordance with the requirements contained within Section 23 09 00 – BUILDING AUTOMATION SYSTEM (BAS).
 - .4 Combination Smoke and Fire Dampers: Multi-blade type complete with operating shaft, stainless steel side seals and fire resistant insulating blade seals. Dampers shall bear label corresponding to fire rating shown on the Architectural Drawings and shall be of the same manufacturer as noted for fire dampers. Damper shall be opened/closed by electric damper actuator and fully closed on activation of electric temperature sensing device. Limit switches shall be provided to show position of damper blades. Leakage through dampers shall not exceed 40.6 L/s/sq.m. (8 cfm/sq.ft.) of damper area at 1.0 kPa (4.0 in. wg.) of differential pressure when determined in accordance with CAN/ULC S112.1 "Leakage Rated Dampers for Use in Smoke Control Systems." Submit test data with Shop Drawings.
 - .5 Smoke Dampers: Similar to dampers described above but without electric temperature sensing device.
 - .6 Provide integral smoke detector as part of combination smoke and fire dampers, and smoke dampers required above. Provide integral smoke detector that is rated for zero flow.
 - .7 Actuators For Combination Smoke and Fire Dampers and Smoke Dampers, Electronic:

DUCTWORK AND SPECIALTIES

- .1 Actuator Type: Modulating.
 - .2 Control Signal: Compatible with fire alarm system and BAS.
 - .3 Power: Where a 120 V circuit is provided by the Electrical Subcontractor, provide a 120:24 V transformer, where required based on the actuator in question.
 - .4 Operating Time: Maximum 75 seconds throughout the full rotation.
 - .5 Angle of Rotation: Adjustable between 0 to 90 degrees.
 - .6 Stall protection: Mechanical or electronic.
 - .7 Provide actuators with electronic overload protection or digital rotation sensing circuitry to prevent actuator damage throughout the entire rotation.
 - .8 Failsafe: Spring return. Spring return to normal position within 10 seconds.
 - .9 Manual Override: Crank type.
 - .10 Position Indicator: Reversible for clockwise or counter-clockwise rotation; set the 0 degrees mark to the failsafe position.
 - .11 Torque: To damper manufacturer's requirements to provide complete compression of seals between frame and blades and for smooth control.
 - .12 Provide 2 SPDT auxiliary switches to prove open-closed.
 - .13 Provide electric temperature sensing device with damper actuators for all combination smoke and fire dampers. Temperature sensing device shall be ULC listed and suitable for UL 555S "Smoke Dampers" smoke and fire damper application.
 - .14 Provide UL 555S "Smoke Dampers" listed damper actuators for all dampers used in smoke control. All actuators shall be factory installed on dampers.
 - .15 Listed to UL 2043 "Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces."
- .8 Positive Seal Shut-off Dampers:
- .1 Isolation type, positive seal, bubble tight damper at a differential pressure of 2.5 kPa (10 in. wg.). Damper shall be constructed with 1.9837 mm (0.0781 in - 14 USS gauge) thick, Type 304 stainless steel dish shaped disc with a knife-edge that seals against a T-304 stainless steel frame. The frame shall have a closed-cell neoprene rubber gasket that creates a gasket-to-knife edge seal. The damper shall have a ¼ turn worm-gear actuator with handwheel. The actuator shall have an aluminum base and cover. The rated torque shall be 225 Joules (2,000 in. lbs.) with a gear ratio of 30:1. The actuator shall be fully lubricated and self-locking.
 - .2 The damper shall be all weld design, all pressure retaining weld joints and seams shall be continuously welded. Weld joints and seams requiring only intermittent welds by design shall not be continuously welded interior weld joints, where possible, shall be continuously welded to provide a smooth interior design, as a minimum, all welds shall be wire brushed and/or buffed to remove heat discolouration, burrs and sharp edges. All welding procedures, welders, and welder operators shall be qualified in accordance

DUCTWORK AND SPECIALTIES

with ASME Boiler and Pressure Vessel Code, Section IX. All production welds shall be visually inspected in accordance with standard procedure incorporating the work acceptance criteria in Section 5 and 6 of ANSI/ANWS D9.1-1990 Specification of Welding of Sheet Metal.

- .9 Fabricate manual duct dampers as shown on Standard Details from galvanized steel 1.26 mm thick (0.048 in - 18 GSG gauge) or heavier. Dampers for ducts up to 300 mm (12 in.) deep shall be one blade carried on a 9 mm (3/8 in.) square steel rod mounted inside the duct. Dampers for ducts of greater depth than 300 mm (12 in.) shall be multi-blade, opposed-acting type, and shall have blades mounted in 38 mm (1-1/2 in.) steel channel frame, and interconnected for operation from one locking type hand quadrant. Dampers for right angle take-off of branch from vertical riser shall have operator extended to an accessible location. For externally insulated ducts, mount quadrant on a bracket, designed to clear the insulation. All dampers shall have indicator to show position of damper blade.
- .10 Fabricate splitter dampers as shown on Standard Details from at least the same thickness of galvanized steel as the duct in which it is installed, down to a minimum of 0.95 mm thick (0.0374 in - 20 GSG gauge). Fabricate of double thickness so that the entering edge presents a round nose to the air flow, and mount securely on hinges at the air leaving edge. Length of splitter shall be at least 1-1/2 times the width of the smaller branch duct, but in no case less than 300 mm (12 in.) long. Attach splitter hinge near the air entering edge with support passing through a clamp on the side of the duct, located where it is most accessible for external adjustment and locking of the damper.
- .11 Motorized dampers for Control Operation: In accordance with applicable requirements control systems (pneumatic) or central energy management systems section.
- .7 Interior Duct Protective Coating: Chlorinated rubber base paint or Eisenheiss Black.
- .8 Hardware and Accessories:
 - .1 Spin-in connections shall be specifically built for that purpose. Dampers shall be a minimum 1 gauge heavier than the ductwork in which it is installed and shall have a full length shaft pivoted at two diametrically opposed points. An indicator shall be attached to the shaft to indicate the damper position.
 - .2 Hardware for balancing or splitter dampers shall be rattle-free and leak resistant. Bearing rods shall be sized to suit the damper size. Neoprene seals shall be used to minimize leaks. Hardware shall be Dyn-Air or equal.
 - .3 Provide single thickness turning vanes built to and supported at intervals dictated by SMACNA HVAC Duct Construction Standards Metal and Flexible. Provide rails securely set in the elbow so that they cannot loosen.

2.2 Fabrication

- .1 Fabricate ductwork in accordance with applicable duct construction requirements of SMACNA.

DUCTWORK AND SPECIALTIES

PART 3 - EXECUTION

3.1 Installation

- .1 Make all laps in the direction of air flow. Use no sheet metal screws in the duct where it is possible to use rivets and bolts. Hammer down all edges and slips so as to leave smooth finished surface inside the ducts.
- .2 Brace and stiffen all ducts, and make tight so that they will not breathe, rattle, vibrate or sag. Cross-break all rectangular ducts with heights or widths of 300 mm (12 in.) or larger.
- .3 Where rectangular ducts are shown, round ducts may be substituted at the Contractor's option, provided there is sufficient room. Conversion from rectangular to round duct, sizing shall be as shown on charts in ASHRAE.
- .4 Hang all ductwork securely and in a rigid manner. Provide hangers in accordance with SMACNA Standard "HVAC Duct Construction Standards Metal and Flexible."
- .5 Where pre-engineered support systems are provided, provide systems that have been evaluated and certified by SMACNA as well as a 3rd party evaluation service. Ensure application of pre-engineered support systems comply with the limitations noted in the SMACNA and 3rd party certification documents for the specific product in question (e.g. maximum duct width, single tier trapeze only, etc.). Install pre-engineered support systems in strict conformance to the manufacturer's written installation instructions and the conditions of the SMACNA and 3rd party evaluation documents.
- .6 Support all vertical ducts at each floor, on all sides, with angle riveted to the ducts.
- .7 The following low pressure, medium pressure and high pressure duct construction is based on an ASHRAE method of construction, and gives a minimum standard of construction. Alternative ASHRAE or SMACNA duct construction is acceptable, provided it meets the minimum standards as outlined by these Specifications. Submit proposed alternatives for review prior to fabrication.
- .8 Low pressure ductwork 0.5 kPa (2 in. wg) static pressure and less as follows:
 - .1 Rectangular/round duct location:
 - .1 Ductwork serving fans with an external static pressure of 0.5 kPa (2 in. wg) or less.
 - .2 Downstream of terminal heating and cooling devices.
 - .2 Seal ducts to Seal Class C in accordance with SMACNA "HVAC Duct Construction Standards Metal and Flexible" and "HVAC Air Duct Leakage Test Manual."
 - .3 SMACNA leakage class:
 - .1 Rectangular ductwork: 16
 - .2 Round ductwork: 8
 - .4 Refer to tables for low pressure rectangular duct construction and round duct construction below for further duct construction requirements.
- .9 Medium pressure ductwork greater than 0.5 kPa (2 in. wg) and less than 1.5 kPa (6 in. wg) static pressure as follows:
 - .1 Rectangular/round duct location:

DUCTWORK AND SPECIALTIES

- .1 Ductwork serving fans with an external static pressure greater than 0.5 kPa (2 in. wg) and less than 1.5 kPa (6 in. wg).
- .2 Smoke exhaust systems.
- .3 Life safety pressurization systems.
- .4 Ductwork downstream of Ecology unit.
- .5 Refer to Section 23 31 16.29 – SPECIAL DUCTWORK for additional requirements.
- .2 Seal ducts 1 kPa (4 in. wg) and greater static pressure to Seal Class A and 0.75 kPa (3 in. wg) static pressure to Seal Class B in accordance with SMACNA “HVAC Duct Construction Standards Metal and Flexible” and “HVAC Air Duct Leakage Test Manual.”
- .3 SMACNA leakage class:
 - .1 Rectangular ductwork:
 - .1 1 kPa (4 in. wg) and greater static pressure: 4
 - .2 0.75 kPa (3 in. wg) static pressure: 8
 - .2 Round ductwork:
 - .1 1 kPa (4 in. wg) and greater static pressure: 2
 - .2 0.75 kPa (3 in. wg) static pressure: 4
- .4 Refer to tables for medium pressure rectangular duct construction and round duct construction below for further duct construction requirements.
- .10 High pressure ductwork 1.5 kPa (6 in. wg) static pressure and greater as follows:
 - .1 Rectangular/round duct location:
 - .1 Ductwork serving fans with an external static pressure of 1.5 kPa (6 in. wg) and greater.
 - .2 Laboratory exhaust systems.
 - .3 Dust collector systems.
 - .4 Welding exhaust systems.
 - .5 Refer to Section 23 31 16.29 – SPECIAL DUCTWORK for additional requirements.
 - .2 Seal ducts to Seal Class A in accordance with SMACNA “HVAC Duct Construction Standards Metal and Flexible” and “HVAC Air Duct Leakage Test Manual.”
 - .3 SMACNA leakage class:
 - .1 Rectangular ductwork: 4
 - .2 Round ductwork: 2
 - .4 Refer to tables for high pressure rectangular duct construction and round duct construction below for further duct construction requirements.
- .11 Comply with the tables below in conjunction with the clauses above.

TABLE 1: LOW PRESSURE RECTANGULAR DUCT CONSTRUCTION

MAX. DUCT DIMENSION	SHEET METAL	TRANSVERSE JOINT CONNECTION AND BRACING

DUCTWORK AND SPECIALTIES

	US GAUGE	
Up to 300 mm (12 in.)	26	Flat drive or flat 'S' no bracing
325 mm to 425 mm (13 in. to 18 in.)	24	Flat drive or flat 'S' no bracing
475 mm to 750 mm (19 in. to 30 in.)	24	25 mm (1 in.) standing 'T' bracing 25 mm x 25 mm x 3 mm (1 in. x 1 in. x 1/8 in.) at maximum 1500 mm (60 in.) centres.
775 mm to 1050 mm (31 in. to 42 in.)	22	25 mm (1 in.) standing 'T' bracing 25 mm x 25 mm x 3 mm (1 in. x 1 in. x 1/8 in.) at maximum 1500 mm (60 in.) centres.
1075 mm to 1200 mm (43 in. to 48 in.)	22	38 mm (1-1/2 in.) standing 'T'; bracing 38 mm x 38 mm x 3 mm (1-1/2 in. x 1-1/2 in. x 1/8 in.) at maximum 1500 mm (60 in.) centres.
1225 mm to 1350 mm (49 in. to 54 in.)	22	38 mm (1-1/2 in.) standing 'T'; bracing 38 mm x 38 mm x 3 mm (1-1/2 in. x 1-1/2 in. x 1/8 in.) at maximum 1200 mm (48 in.) centres.
1375 mm to 1500 mm (55 in. to 60 in.)	20	38 mm (1-1/2 in.) standing 'T'; bracing 38 mm x 38 mm x 3 mm (1-1/2 in. x 1-1/2 in. x 1/8 in.) at maximum 1200 mm (48 in.) centres.
1525 mm to 2100 mm (61 in. to 84 in.)	20	38 mm (1-1/2 in.) standing 'T'; bracing 38 mm x 38 mm x 3 mm (1-1/2 in. x 1-1/2 in. x 1/8 in.) at maximum 1200 mm (48 in.) centres.
2125 mm to 2400 mm (85 in. to 96 in.)	18	50 mm (2 in.) standing 'T' bracing 38 mm x 38 mm x 5 mm (1-1/2 in. x 1-1/2 in. x 3/16 in.) at maximum 600 mm (24 in.) centres.
2425 mm to 3000 mm (97 in. to 120 in.)	18	50 mm (2 in.) standing 'T' bracing 50 mm x 50 mm x 6 mm (2 in. x 2 in. x 1/4 in.) at maximum 600 mm (24 in.) centres.
3025 mm and over (121 in. and over)	18	As above with addition of tie rods at 300 mm (120 in.) centres for joint bracing.
1	Bracing spacing shown is maximum spacing between two bracings or between bracing and joint.	
2	Locate bracings mid-way between joints.	
3	Make longitudinal joints Pittsburgh lock seam at edge of duct, and grooved seam on face of duct.	

DUCTWORK AND SPECIALTIES

TABLE 2: MEDIUM PRESSURE RECTANGULAR DUCT CONSTRUCTION

MAX. DUCT DIMENSION	SHEET METAL US GAUGE	TRANSVERSE JOINT CONNECTION & BRACING
Up to 300 mm (12 in.)	24	25 mm (1 in.) standing seam, 16 mm (5/8 in.) welded flange 25 mm (1 in.) pocket lock, no bracing.
325 mm to 425 mm (13 in. to 18 in.)	24	25 mm (1 in.) standing seam, 22 mm (7/8 in.) welded flange, 25 mm (1 in.) pocket lock, bracing 25 mm x 25 mm x 16 gauge (1 in. x 1 in. x 16 UG gauge) at 1200 mm (48 in.) centres.
475 mm to 600 mm (19 in. to 24 in.)	22	32 mm (1-1/4 in.) standing seam, 35 mm (1-3/8 in.) welded flange, 30 mm (1-1/8 in.) pocket lock, bracing 25 mm x 25 mm x 3 mm (1 in. x 1 in. x 1/8 in.) at maximum 120 mm (48 in.) centres.
625 mm to 900 mm (25 in. to 36 in.)	22	38 mm (1-1/2 in.) standing seam, 38 mm (1/2 in.) pocket lock, bracing 25 mm x 25 mm x 3 mm (1 in. x 1 in. x 1/8 in.) at maximum 120 mm (48 in.) centres.
925 mm to 1200 mm (37 in. to 48 in.)	22	50 mm (2 in.) standing seam or 50 mm (2 in.) flanged joint, bracing 38 mm x 38 mm x 3 mm (1-1/2 in. x 1-1/2 in. x 1/8 in.) at maximum 750 mm (30 in.) centres.
1125 mm to 1500 mm (49 in. to 60 in.)	20	38 mm (1-1/2 in.) standing seam or 38 mm (1-1/2 in.) flanged joint with tie rod in centre, bracing 50 mm x 50 mm x 3 mm (2 in. x 2 in. x 1/8 in.) at maximum 600 mm (24 in.) centres.
1525 mm to 1800 mm (61 in. to 72 in.)	20	38 mm (1-1/2 in.) standing seam or 38 mm (1-1/2 in.) flanged joint with tie rod in centre, bracing 50 mm x 50 mm x 3 mm (2 in. x 2 in. x 1/8 in.) at maximum 600 mm (24 in.) centres.
1825 mm to 2100 mm (73 in. to 84 in.)	18	50 mm (2 in.) standing seam or 38 mm (1-1/2 in.) flanged joint with tie rod in centre, bracing 65 mm x 65 mm x 5 mm (2-1/2 in. x 2-1/2 in. x 3/16 in.) at maximum 600 mm (24 in.) centres.
2425 mm and over (96 in. and over)	18	50 mm (2 in.) standing seam or 38 mm (1-1/2 in.) flanged joint with tie rod in centre, bracing 65 mm x 65 mm x 5 mm (2-1/2 in. x 2-1/2 in. x 3/16 in.) at maximum 600 mm (24 in.) centres.
1	Bracing spacing shown above is maximum spacing between two bracings or between bracing and joint. Locate bracing mid-way between joints.	
2	Make longitudinal joints Pittsburgh lock seam at edge of duct, and grooved seam on face of duct.	

DUCTWORK AND SPECIALTIES

TABLE 3: HIGH PRESSURE RECTANGULAR DUCT CONSTRUCTION

MAX. DUCT DIMENSION	SHEET METAL US GAUGE	CONSTRUCTION
Up to 300 mm (12 in.)	22	Flanged angle gasketed joint or butt welded joint with 32 mm x 32 mm x 3 mm (1-1/4 in. x 1-1/4 in. x 1/8 in.) angle.
325 mm to 450 mm (13 in. to 18 in.)	22	Flanged angle gasketed joint or butt welded joint with flanged angle 32 mm x 32 mm x 3 mm (1-1/4 in. x 1-1/4 in. x 1/8 in.) and reinforcing angle 25 mm x 25 mm x 16 US gauge (1 in. x 1 in. x 16 US gauge) at maximum 1200 mm (48 in.) centres.
475 mm to 600 mm	22	Flanged angle gasketed joint or butt welded joint with flanged angle 32 mm x 32 mm x 3 mm (1-1/4 in. x 1-1/4 in. x 1/8 in.) and reinforcing angle 25 mm x 25 mm x 3 mm (1 in. x 1 in. x 1/8 in.) at maximum 1200 mm (48 in.) centres.
625 mm to 900 mm (25 in. to 36 in.)	22	Flanged angle gasketed joint or butt welded joint with flanged angle 32 mm x 32 mm x 3 mm (1-1/4 in. x 1-1/4 in. x 1/8 in.) and reinforcing angle 32 mm x 32 mm x 3 mm (1-1/4 in. x 1-1/4 in. x 1/8 in.) at maximum 800 mm (32 in.) centres.
925 mm to 1200 mm (37 in. to 48 in.)	22	Flanged angle gasketed joint or butt welded joint with flanged angle 38 mm x 38 mm x 3 mm (1-1/2 in. x 1-1/2 in. x 1/8 in.) and reinforcing angle 65 mm x 65 mm x 3 mm (2 in. x 2 in. x 1/8 in.) at maximum 750 mm (30 in.) centres.
1225 mm to 1500 mm (49 in. to 60 in.)	20	Flanged angle gasketed joint or butt welded joint with flanged angle 50 mm x 50 mm x 5 mm (2 in. x 2 in. x 3/16 in.) and reinforcing angle 50 mm x 50 mm x 3 mm (2 in. x 2 in. x 3/16 in.) at maximum 600 mm (24 in.) centres.
Over 1500 mm (60 in.) and all sizes between fan and round duct	20	Flanged angle gasketed joint or butt welded joint with flanged angle 50 mm x 50 mm x 5 mm (2 in. x 2 in. x 3/16 in.) and reinforcing angle 50 mm x 50 mm x 3 mm (2 in. x 2 in. x 3/16 in.) at maximum 600 mm (24 in.) centres.

DUCTWORK AND SPECIALTIES

TABLE 4: ROUND DUCT CONSTRUCTION

1. Round ducts up to 750 mm (30 in.) diameter factory fabricated, helically wound galvanized iron strips with spiral lock seam.			
DIAMETER	STRIP METAL US GAUGE	STRIP JOINT	GIRTH JOINT
Up to 200 mm (8 in.)	26	100 mm (4 in.)	50 mm (2 in.) long slip
225 mm to 550 mm (9 in. to 22 in.)	24	100 mm (4 in.)	50 mm (2 in.) long slip
575 mm to 750 mm (23 in. to 30 in.)	22	150 mm (6 in.)	100 mm (4 in.) long slip

Join with galvanized iron coupling sleeves or conduit fittings of welded construction.

Construct larger ductwork as follows with longitudinal lock or butt welded seams:

DIAMETER	SHEET METAL US GAUGE	REINFORCING	GIRTH JOINT
775 mm to 900 mm (31 in. to 36 in.)	20	None	100 mm (4 in.) long slip
925 mm to 1500 mm (37 in. to 60 in.)	18	32 mm x 32 mm x 3 mm (1-1/4 in. x 1-1/4 in. x 1/8 in.) angle on max 1800 mm (72 in.) centres	32 mm x 32 mm x 3 mm (1-1/4 in. x 1-1/4 in. x 1/8 in.) angle flanged.

- .12 Seal all joints of all ducts. Brush joints with the compound before and again after assembly. Seal any leaks causing noise.
- .13 Seal the bottom and side joints of outside air ducts or plenums water-tight.
- .14 Flexible duct shall be connected to sheet metal duct and diffusers using duct sealer, minimum of two screws separated by 180 degrees and metal draw bands. Duct tape is not acceptable.
- .15 Flexible ductwork may be used under the following conditions:
 - .1 Where shown on Drawings to allow easy location of diffusers.
 - .2 Except where indicated otherwise in clauses below, minimum length of flexible duct used to connect diffusers and interior troffers: 2,400 mm (84 in.).
 - .3 Except where indicated otherwise in clauses below, maximum length of flexible duct: 3,000 mm (120 in.).
 - .4 Do not pass flexible ductwork through floors or fire walls.

DUCTWORK AND SPECIALTIES

- .5 Install flexible ductwork as a single section of duct (no joints). In the event that building construction requires connection between lengths of flexible duct, use a rigid section of duct as the joint. Secure flexible duct to the rigid section using ties and sealant.
- .6 Support flexible duct lengths greater than 2,400 mm (84 in.) at the midpoint with strap hangers.
- .16 Where ductwork passes through a wall or floor, other than when a fire damper is required, pack around the duct using a fire resistant material to ensure a sound and airtight joint.
- .17 If changes of size of ducts are necessary because of building construction, maintain the same circular equivalent for the new size. Ratio of the longest side of the duct to the least shall not exceed 4 to 1 unless specifically authorized by the Contract Administrator.
- .18 Select the gauge of metal and method of construction for the new size. Notify the Contract Administrator of any change before such changes are incorporated into the Work.
- .19 If changes of location of duct are required because of building construction, review with the Contract Administrator before the locations indicated are changed in any way.
- .20 Make changes of direction of horizontal ducts with elbows having an inside radius not less than 3/4 the width of the duct. Make change of direction from horizontal to vertical duct with elbows having an inside radius equal to the depth of the duct. Where this is not possible due to the building construction, use turning vanes.
- .21 Provide access ports at convenient locations in all main ducts and main branch take-offs with airtight covers and extension sleeves through insulation to allow air meter readings. Access ports shall be approved by the Contract Administrator and the testing company before installation.
- .22 Provide flexible connections at each air handling unit (where not provided internally) and fan duct connections before and after any required transitions on the fan inlet and outlet respectively (i.e. on the largest duct perimeter and not directly installed on the fan inlet and outlet to reduce noise and air turbulence).
- .23 Install manual duct dampers as shown on Standard Details. Ensure dampers for right angle take-off of branch from vertical riser have operator extended to an accessible location. Adjust quadrants to clear duct insulation.
- .24 Provide splitter dampers as shown on Standard Details.
- .25 Install motorized dampers where directed.
- .26 Install fire dampers where shown and at all penetrations through all fire rated assemblies. Provide firestop flap type fire dampers where fire dampers are shown in grilles or diffusers at ceiling level. Provide the appropriate fire damper model to suit the installation condition and provide all necessary flanges, frames, fittings, and accessories to ensure a flush installation. Obtain local authorities' approvals for all damper locations and keep one set of marked-up prints on site. Approvals shall be obtained before installation of fire dampers.
- .27 Where a fire damper is required to be installed behind a wall mounted grille, provide damper, angles, and retaining devices as required to provide a smooth, flat to wall installation.

DUCTWORK AND SPECIALTIES

- .28 Where fire dampers for ducts shown on Drawings require a change of type and/or powered actuation due to dimension limitations to satisfy the cUL Classification requirements, provide transitions as required to adjust duct dimensions while maintaining the equivalent circular duct diameter to avoid exceeding any specific listed maximum dimension. Where transitions are not possible or dimensions cannot be adjusted to avoid powered actuation, provide power from the closest available emergency power source as required. Review all conditions with the Contract Administrator in advance of fabrication.
- .29 Install combination smoke and fire dampers and smoke dampers where shown. Ensure operators are accessible for maintenance. Coordinate installation of required fire alarm connections with Electrical Subcontractor and provide wiring connections to BAS where required by damper sequence of operations. Coordinate connections to damper actuators in accordance with sequence of operations and damper locations.
- .30 Receive automatic dampers from separate Section on site, and set in place under the supervision of the control manufacturer.
- .31 Provide access panels at all fire dampers, gravity dampers, motorized dampers, coils, heaters, humidifiers, fan bearings or similar equipment requiring occasional maintenance or inspection. Panels shall be 600 mm x 450 mm (24 in. x 18 in.) or full width of duct if less than 450 mm (18 in.) wide. Panels shall be of double wall construction and shall be internally insulated on insulated ducts. Frame shall be of structural angle with welded corners, gasketed to receive the panel. Panel shall be held in place with 4 window sash locks.
- .32 Paint visible internal surface behind each grille or register flat black.
- .33 Where duct is acoustically lined, duct dimensions shown are net, inside of lining, free area dimensions.
- .34 Provide internal acoustic duct lining in accordance with Section 20 05 48 – VIBRATION AND NOISE CONTROL.
- .35 Spin-in connections shall only be used downstream of variable volume boxes.
- .36 Ductwork shall be run parallel to the closest wall. Coordinate with piping and structural elements.
- .37 All exposed open ends of ductwork located less than 2000 mm (79 in) above the finished floor that do not have a diffuser, grille or register shall have a protective screen mounted in a suitable frame to connect the screen securely to the duct, wall and floor as applicable. The screen shall be installed and painted matte black and shall not be capable of passage of anything larger than a 15 mm (1/2 in.) sphere through the openings.
- .38 Supply air ductwork to variable volume boxes shall be rigid duct of size shown in schedules. If the length exceeds 3000 mm (10 ft.) or if there are 2-45 deg. elbows or 1-90 deg. elbow or more increase the supply air ductwork to the variable volume box one size. If the length exceeds 6000 mm (20 ft.) increase the duct by two sizes. Under no conditions shall the supply ductwork exceed 9000 mm (30 ft.) or have more than 3-90 deg. elbows or the equivalent. Transition to variable volume box inlet sizes a minimum of 4 duct diameters upstream of the terminal unit.
- .39 Where acceptable to Contract Administrator, and where fans shut down upon detection of fire, static fire dampers may be used in lieu of dynamic fire dampers.

END OF SECTION

INTAKE AND EXHAUST AIR PLENUMS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 This section is intended for all outside air intake and exhaust plenums. Refer to Section 20 05 48 - VIBRATION AND NOISE CONTROL for acoustic plenums.

1.2 Submittals

- .1 Shop Drawings - Submit Shop Drawings of the plenums for review. Shop Drawings shall include material type and construction details.

PART 2 - PRODUCTS

2.1 Materials - Field Built-Up Plenums

- .1 Field built-up panels shall be 1.56 mm thick (0.614 in - 16 GSG gauge) galvanized steel sheets with coating to A653/A653M-98, Designation Z275. Construction of plenums shall be as shown. Casings, plenums and connections between components of built-up apparatus shall be constructed from a completely self-supporting rigid structural steel frame bolted or welded. The entire casing shall be constructed to absolutely prevent deflection or drumming under vacuum or pressure conditions applicable to the particular system, with all joints caulked or gasketed to give an airtight applicable to the particular system, with all joint caulked or gasketed to give an airtight installation. Waterproof gaskets shall be provided at all wet sections. At the floor line and at other joints where casing joins masonry construction, panels shall be attached to a galvanized steel angle which has been secured to masonry with expansion shields and bolts on approximately 300 mm (12 in.) centres and caulked air and water tight to masonry. At floor, provide channel to which insulation can be finished off.
- .2 The inner wall of the floor shall be fabricated from minimum 0.9525 mm thick (0.0375 in - 20 USS gauge) or 1.27 mm thick (0.05 in -18 USG gauge) galvanized steel sheet and formed stainless steel angles, and shall extend full length of plenum, double sloped to prevent standing water. The inner skin shall be welded construction. Provide 3 in. (75mm) of insulation between the floor panels.
- .3 Provide insulation on field built-up plenums in conformance with Section 20 07 00 - INSULATION
- .4 Construction of plenums shall be as shown and shall be constructed from a completely self-supporting rigid structural steel frame bolted or welded. The entire plenum shall be constructed to absolutely prevent deflection or drumming under vacuum or pressure conditions applicable to the particular system, with all joints caulked or gasketed to give an airtight installation.
- .5 Waterproof gaskets shall be provided at all wet sections. At the floor line, and at other joints where casing joins masonry construction, panels shall be attached to a galvanized steel angle that has been secured to masonry with expansion shields and bolts on approximately 12 in. (300 mm) centres and caulked air and water tight to masonry. At floor, provide channel to which insulation can be finished off.

INTAKE AND EXHAUST AIR PLENUMS

- .6 Doors shall be flush mounted, minimum 1350 mm x 500 mm (54 in. x 20 in.) size and mounted 450 mm (18 in.) above the floor and shall be constructed of materials similar to the plenum panels. Doors shall have matching 2.7533 mm thick (12 G.S. gauge) frames, heavy duty hinges, pressure type latches operable from inside and outside and continuous rubber seal gaskets. Doors shall open against the plenum pressure.
- .7 LED marine lights with protective metal cage and glass seals shall be installed on the wall opposite the access doors or where shown. A switch with an indicator light shall be installed on the exterior of the unit. Factory wire from one switch to each light. Electrical power shall be 120 V/1/60 from a single source at the access side of the fan section.
- .8 Vapour proof LED strip light fixtures shall be installed on the ceiling, the wall opposite the access doors, or where shown. A switch with an indicator light shall be installed on the exterior of the unit. Factory wire from one switch to each light. Electrical power shall be 120 V/1/60 from a single source at the access side of the fan section.

PART 3 - EXECUTION

3.1 Installation

- .1 Make all connections in a way to ensure the integrity of the plenum. Provide flanged or collar openings for ducts constructed of 1.6129 mm (1/16 in.) thick (16 G.S. gauge) galvanized steel. Fit pipes penetrating plenum with a 0.1067" - 12 GSG gauge (2.71 mm thick) flange, welded to the pipe and bolted and caulked to the plenum. Caulk all other joints in plenums
- .2 Where panels are required inside plenums, they shall be similar to the wall panels to prevent air crossover. Internal panels are not required to be double wall.
- .3 Provide a 200 mm thick curb for all full height plenums. Install a plenum drain at the bottom of plenum where shown on the Drawings with a minimum of one drain per plenum. Provide a cast iron dome if there is a change of debris entering the plenum. Double slope the plenum floor to the drain.
- .4 Double slope all suspended plenums towards the exterior louvre. Provide a minimum 2% slope in one direction along the entire length of the plenum. Fit pipe penetrating plenum with a 2.71mm thick (0.1067 in - 12 GSG gauge) flange, welded to the pipe and bolted and caulked to the plenum.
- .5 Coat all plenum seams and welds with 2 coats of rust resistant finish.
- .6 Provide readily removable sections of plenums. These sections shall be flanged, gasketed and bolted such that the section may be removed after withdrawing the bolts.
- .7 Each plenum shall be flood tested to ensure no leaks are present. Plug the drain in the plenum and fill the plenum with 3 inches of water using a garden hose and wait for 5 minutes. Visually inspect for leaks and perform remedial Work as required. Notify Contract Administrator, Testing and Balancing trades, and/or The City to witness the flood test.

END OF SECTION

AXIAL FLOW FANS, MIXED FLOW FANS, AND CENTRIFUGAL FANS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Related Work Specified Elsewhere

- .1 Electrical hard wire supply and primary connections to electrical components - under Electrical Division.

1.3 Submittals

- .1 Shop Drawings:
 - .1 Submit Shop Drawings of all axial flow fans and mixed flow fans with catalogued components to be supplied. Include manufacturer's data sheets for discharge volume for all fans at specified primary exhaust, performance criteria, ratings, and physical dimensions and finishes. Provide fan curves for each fan at the specified operation point, with the flow, static pressure and horsepower clearly plotted. Provide outlet velocity and both inlet and outlet sound power readings for the eight octave bands.
 - .2 Submit Shop Drawings of all centrifugal fans with catalogued components to be supplied. Include manufacturer's data sheets for performance criteria, ratings, and physical dimensions and finishes. Provide fan curves for each fan at the specified operation point, with the flow, static pressure and horsepower clearly plotted. Provide outlet velocity and both inlet and outlet sound power readings for the eight octave bands.
- .2 Manufacturer's Data
 - .1 Conform to AMCA Standard 205 "Energy Efficiency Classification for Fans," 211 "Certified Ratings Program – Product Rating Manual for Fan Air Performance" and 311 "Certified Ratings Program – Product Rating Manual for Fan Sound Performance." Test fans in accordance with ANSI/AMCA Standard 210 "Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating" and AMCA Standard 300 "Reverberant Room Method for Sound Testing of Fans" in an AMCA accredited laboratory and provide fans bearing the AMCA seal for air and sound performance.
 - .2 Conform to AMCA Standard 99 "Standards Handbook" classifications for spark resistant construction.
 - .3 Give each fan an electronic vibration analysis in accordance with ANSI/AMCA Standard 204 "Balance Quality and Vibration Levels for Fans," while operating at the specified fan RPM. Take the vibration signatures on each bearing in the horizontal, vertical and axial direction. Limit the maximum allowable fan vibration to 3.81 mm/sec (0.15 in/sec) peak velocity, filter-in as measured at the fan RPM. Provide report summarizing test results for inclusion in operations and maintenance manuals.

AXIAL FLOW FANS, MIXED FLOW FANS, AND CENTRIFUGAL FANS

PART 2 - PRODUCTS

2.1 Materials

- .1 Provide fans that comply with UL/cUL 705 "Power Ventilators."
- .2 Comply UL/cUL 762 "Outline of Investigation for Power Roof Ventilators for Restaurant Exhaust Appliances" and NFPA 96 "Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations" for all fans used to convey grease laden air and provide fans with a grease collection device.
- .3 Provide all steel fan components with an electrostatically applied, baked polyester powder coating or other equivalent protective coating.
- .4 Provide vibration isolation as specified in Section 20 05 48 - VIBRATION AND NOISE CONTROL.
- .5 Provide all fans, without ducts or dampers on the inlet or outlet, including fans in plenums, with protective screens on the openings.
- .6 Provide fans that are suitable for operation with variable frequency drives where indicated in the Fan Schedule or as required to meet the requirements of Section 23 09 23 - SEQUENCE OF OPERATION FOR BAS.
- .7 Axial flow fans:
 - .1 Provide fans of bolted and welded construction utilizing corrosion resistant fasteners. Provide housing of heavy gauge steel with a continuously welded seam and integral inlet and outlet flanges pre-punched for mounting.
 - .2 Provide fan propeller that uses cast aluminum or steel airfoil blades. Provide propeller keyed and secured to the shaft with a split taper bushing, and retaining plate. Provide assembled wheel that is electronically balanced both statically and dynamically to balance grade G6.3 per ANSI S2.19 "Mechanical Vibration – Balance Quality Requirements of Rigid Rotors, Part 1: Determination of Possible Unbalance, Including Marine Applications."
 - .3 Provide blower shaft of accurately turned and polished steel. Provide shaft that is sized for a critical speed of at least 125% of the maximum RPM.
 - .4 Provide bearings that are heavy duty, grease lubricated, anti-friction ball or spherical roller, self-aligning, block type and selected for a minimum L50 life in excess of 200,000 hours at maximum load. For all inaccessible bearings, provide with prefilled factory extended lubrication lines fitted with grease fittings terminating at the case exterior. Permanently lubricated bearings are not acceptable.
 - .5 Provide direct drive or belt drive motor as shown in the Fan Schedule.
 - .1 Provide direct drive motor with external electrical terminal box.
 - .2 Provide belt drive motor with adjustable motor plate utilizing threaded studs for positive belt tensioning.
 - .3 Provide belts of oil and heat resistant, non-static type.
 - .4 Provide drives that are precision machined cast iron type, keyed and securely attached to the wheel and motor shafts.
 - .5 Size drives for 150% of the installed motor horsepower.

AXIAL FLOW FANS, MIXED FLOW FANS, AND CENTRIFUGAL FANS

- .6 Provide motors that comply with the requirements of Section 20 05 13 - ELECTRIC MOTORS. See Fan Schedule for hp (wattage) ratings.
- .6 Provide axial flow fans in accordance with the Fan Schedule.
- .7 Except as otherwise indicated, provide all axial flow fans of Cook, FlaktWoods, Greenheck, PennBarry, Soler & Palau or Twin City.
- .8 Mixed flow fans:
 - .1 Provide fans of welded and bolted construction utilizing corrosion resistant fasteners. Provide housing of steel with integral inlet and outlet collars for slip fit duct connections. Include straightening guide vanes to assure maximum efficiency and low noise levels. Provide lifting lugs for ease of installation. Provide adjustable mounting feet that allow field adjustment of motor position.
 - .2 Provide wheel that is steel, non-overloading, high efficiency mixed-flow type. Provide blades that are continuously welded to the backplate and inlet shroud. Provide hubs that are keyed and securely attached to the fan shaft. Provide assembled wheel that is electronically balanced both statically and dynamically to balance grade G6.3 per ANSI S2.19 "Mechanical Vibration – Balance Quality Requirements of Rigid Rotors, Part 1: Determination of Possible Unbalance, Including Marine Applications."
 - .3 Provide blower shaft of accurately turned and polished steel. Provide shaft sized for a critical speed of at least 125% of the maximum RPM.
 - .4 Provide direct drive or belt drive motor mounted on outside of casing as shown in the Fan Schedule.
 - .1 Provide direct drive motor with external electrical terminal box.
 - .2 Provide belt drive motor with adjustable motor plate utilizing threaded studs for positive belt tensioning.
 - .3 Provide belts of oil and heat resistant, non-static type.
 - .4 Provide drives of precision machined cast iron type, keyed and securely attached to the wheel and motor shafts.
 - .5 Size drives for 150% of the installed motor horsepower.
 - .6 Provide motors that comply with the requirements of Section 20 05 13 - ELECTRIC MOTORS. See Fan Schedule for hp (wattage) ratings.
 - .5 Provide bearings that are heavy duty, grease lubricated, anti-friction ball or spherical roller, self-aligning, block type and selected for a minimum L50 life in excess of 200,000 hours at maximum load. Provide all inaccessible bearings with prefilled factory extended lubrication lines fitted with grease fittings terminating at the case exterior. Permanently lubricated bearings are not acceptable.
 - .6 Provide mixed flow fans in accordance with the Fan Schedule.
 - .7 Except as otherwise indicated, provide all mixed flow fans of Cook, FlaktWoods, Greenheck, PennBarry, Soler & Palau or Twin City.

AXIAL FLOW FANS, MIXED FLOW FANS, AND CENTRIFUGAL FANS

.9 Centrifugal fans:

- .1 Provide fans of bolted and welded construction utilizing corrosion resistant fasteners. Provide scroll wrapper and side panels made of steel. Provide the entire fan housing with continuously welded seams for leak-proof operation. Provide bearing support constructed of welded steel members.
- .2 Unless shown otherwise, for fan wheels handling more than 472 L/s (1000 cfm) provide non-overloading backward inclined centrifugal type. Provide wheel hub keyed and securely attached to the fan shaft. Provide the wheel and fan inlet carefully matched and with precise running tolerances for maximum performance and operating efficiency. Provide assembled wheel that is electronically balanced both statically and dynamically to balance grade G6.3 per ANSI S2.19 "Mechanical Vibration – Balance Quality Requirements of Rigid Rotors, Part 1: Determination of Possible Unbalance, Including Marine Applications."
- .3 Provide blower shaft of accurately turned and polished steel. Size shaft for a critical speed of at least 125% of the maximum RPM. Provide ends of fan shafts that have centered depressions to allow for mechanical tachometer readings.
- .4 Provide each fan with fan sheave, motor sheave, matched V-belts and belt guard.
 - .1 Provide belt guard that is OSHA compliant and completely covers the motor pulley and belt(s).
 - .2 Where motor is 7.5 kW (10 hp) or less, provide variable pitch motor sheave.
 - .3 Where motor exceeds 7.5 kW (10 hp), provide variable pitch motor sheave, and replace with a correctly sized fixed pitch sheave after balancing.
 - .4 Provide motors that comply with the requirements of Section 20 05 13 - ELECTRIC MOTORS. See Schedule for hp (wattage) ratings.
 - .5 Provide belt drive motor with adjustable motor plate utilizing threaded studs for positive belt tensioning. Provide belts of oil and heat resistant, non-static type. Provide drives that are precision machined cast iron type, keyed and securely attached to the wheel and motor shafts. Size drives for 150% of the installed motor horsepower.
 - .6 For all fans, with the exception of utility fans, provide arrangement 3 drive or arrangement 2 drive for smaller fans.
- .5 Permanently lubricated bearings are not acceptable. For shafts 24 mm (15/16 in.) diameter and larger, provide pillow block self-aligning ball or roller bearings with seals and grease nipple. In addition, for bearings on shafts 36.5 mm (1-7/16 in.) diameter and larger provide grease nipple and grease relief valve. For bearings on shafts smaller than 24 mm (15/16 in.) diameter, provide pillow block, self-aligning ball bearings with seals and with grease nipple. Make all bearings accessible for lubrication and service, unless otherwise permitted by the Contract Administrator. Where it is difficult to provide such access, provide extended lubrication lines. When such lines extend to pillow block bearings, provide a grease relief valve. Select bearings for a minimum L50 life in excess of 200,000 hours at maximum load.

AXIAL FLOW FANS, MIXED FLOW FANS, AND CENTRIFUGAL FANS

- .6 Provide access doors on the fan scroll. Hinge doors, in reinforced angle frames and provide with clamping devices. Provide minimum size of 457 mm x 356 mm (18 in. x 14 in.) or full width of fan scroll, if scroll is less than 457 mm (18 in.) wide.
- .7 Provide drain connections as shown. Provide drains of minimum 25 mm (1 in.) pipe size, half coupling, welded into the bottom of the scroll with a square headed, threaded, brass plug. Extend drain clear of fan scroll.
- .8 Provide utility fans that conform to the Specification for centrifugal fans above with the exception of the drive arrangement and belt guard. Provide standard utility arrangement drive and belt guard may be omitted if a hood is provided over the drive.
- .9 Provide centrifugal and utility fans in accordance with the Fan Schedule.
- .10 Except as otherwise indicated, provide all centrifugal and utility fans of Cook, FlaktWoods, Greenheck, PennBarry, Soler & Palau or Twin City.

PART 3 - EXECUTION

3.1 Installation

- .1 Install fans in locations shown on plans.
- .2 Align shafts, belt drive and motor, adjust belt tension, ensure all set screws are tight and check motor rotation before start-up.
- .3 Protect motors and fans during construction.
- .4 Provide an access door in the adjacent ductwork 457 mm x 457 mm (18 in. x 18 in.) minimum size or larger if required to remove the motor.
- .5 Provide duct transitions that are rigidly connected directly to the fan inlet and outlet flanges or connections. Locate flexible connections required for isolation from the duct system on the inlet and outlet of the transition piece representing the greatest cross-sectional area and lowest velocity. Include for the weight of the transitions when selecting vibration isolation.
- .6 Install all fan components, including controllers, shipped loose to site. Mechanical Division to install wiring between components as required.
- .7 Provide drain connections as shown on the Drawings or where called for in Part 2 above.

END OF SECTION

ROOM VENTILATORS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Submittals

- .1 Shop Drawings:
 - .1 Submit Shop Drawings of all room ventilators with catalogued components to be supplied. Include manufacturer's data sheets for, performance criteria, ratings, and physical dimensions and finishes.

PART 2 - PRODUCTS

2.1 Materials

- .1 Room ventilators shall be Penn Zephyr, Greenheck, Loren Cook Gemini, Soler & Palau or Twin City.
- .2 Centrifugal fans shall be mounted in a galvanized steel, acoustically insulated housing and shall be internally isolated. Fans shall be AMCA certified for both air and sound, UL labelled and CSA approved.
- .3 Arrange casing for in-line installation with access to both fan and motor through the casing.
- .4 Inlet and discharge shall be flanged for duct connections.
- .5 Discharge shall be complete with spring loaded backdraft damper.
- .6 Motors shall be prewired to terminal box located on the unit housing.
- .7 Motors shall be 120 volts, 1 phase for all sizes.
- .8 Speed control shall be Lek-Trol variable speed/off, solid state controller.
- .9 All intake and discharge ductwork shall have 25 mm (1 in.) thick acoustic lining.
- .10 Room ventilators shall be in accordance with the Fan Schedule.

PART 3 - EXECUTION

3.1 Installation

- .1 Install room ventilators where shown.
- .2 All ventilators on vibration isolation hangers shall have flexible connections on both inlet and outlet.

END OF SECTION

ROOF MOUNTED FANS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Related Work Specified Elsewhere

- .1 Electrical hard wire supply and primary connections to electrical components - under Electrical Division.
- .2 Supply and installation of built-up wood curb and flashings - under Section 06100 and 07600.

1.3 Submittals

- .1 Shop Drawings:
 - .1 Submit Shop Drawings of all roof mounted fans with catalogued components to be supplied. Include manufacturer's data sheets for all fans at specified airflow, performance criteria, ratings, and physical dimensions and finishes. Provide fan curves for each fan at the specified operation point, with the flow, static pressure and horsepower clearly plotted. Provide outlet velocity and both inlet and outlet sound power readings for the eight octave bands.
- .2 Manufacturer's Data:
 - .1 Conform to AMCA Standards 205 "Energy Efficiency Classification for Fans," 211 "Certified Ratings Program - Product Rating Manual for Fan Air Performance," and 311 "Certified Ratings Program - Product Rating Manual for Fan Sound Performance". Test fans in accordance with ANSI/AMCA Standard 210 "Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating" and AMCA Standard 300 "Reverberant Room Method for Sound Testing of Fans" in an AMCA accredited laboratory and provide bearing the AMCA seal for air and sound performance.
 - .2 Conform to AMCA 99 "Standards Handbook" for Classification for Spark Resistant Construction.

PART 2 - PRODUCTS

2.1 Materials

- .1 Except as otherwise indicated, provide roof mounted fans by Cook, FlaktWoods, Greenheck, PennBarry or Twin City.
- .2 For all fans, comply with UL/cUL 705 "Power Ventilators."
- .3 Provide low silhouette fans of bolted and welded construction utilizing corrosion resistant fasteners. Enclose the fan with a galvanized steel hood with the entire assembly primed with a zinc rich primer or, an aluminum hood, treated to prevent corrosion. Bolt the hood to the fan housing and make removable to allow unobstructed access to the motor and power assembly. Provide aluminum base with continuously welded curb cap corners for maximum leak protection.

ROOF MOUNTED FANS

- .4 Provide dome type fans of bolted and welded construction utilizing corrosion resistant fasteners. Provide motor cover, shroud, curb cap, and lower wind band constructed of heavy gauge aluminum and treated to reduce corrosion. Provide aluminum base with continuously welded curb cap corners for maximum leak protection. Provide shroud with an integral rolled bead for added strength.
- .5 Provide wheel that is non-overloading centrifugal backward inclined, constructed of aluminum. Provide wheel inlet that overlaps an aerodynamic aluminum inlet cone or venturi to provide maximum performance and efficiency. Provide assembled wheel that is electronically balanced both statically and dynamically to balance grade G6.3 per ANSI S2.19 "Mechanical Vibration - Balance Quality Requirements Of Rigid Rotors - Part 1: Determination Of Possible Unbalance, Including Marine Applications."
- .6 Mount the motor, bearings and drives on a steel power assembly, isolated from the unit structure with rubber vibration isolators. Enclose these components in a weather-tight compartment, separated from the exhaust airstream.
- .7 Provide units complete with a galvanized bird screen treated to prevent corrosion.
- .8 Provide bearings that are heavy duty, grease lubricated, anti-friction ball or spherical roller, self-aligning, pillow block type and selected for a minimum L50 life in excess of 200,000 hours at maximum load.
- .9 Size blower shaft for a critical speed of at least 125 % of the maximum RPM.
- .10 Provide belts that are oil and heat resistant, non-static type. Provide drives that are precision machined cast iron type, keyed and securely attached to the wheel and motor shafts. Size drives for 150 % of the installed motor horsepower. Factory set the variable pitch motor drive to the specified fan RPM.
- .11 Coat all steel fan components with an electrostatically applied, baked polyester powder coating or other equivalent protective coating.
- .12 Provide motors in accordance with the requirements of Section 20 05 13 - ELECTRIC MOTORS. See Fan Schedule for hp (wattage) ratings.
- .13 Provide motor operated dampers under a separate Section as shown on Drawings and specified in Section 23 09 00 - BUILDING AUTOMATION SYSTEM (BAS). Where motor operated dampers are not shown, provide gravity dampers at the fan by this Section.
- .14 Mount unit on a prefabricated roof curb to match the fan size. Provide flat curb for flat roofs and pitched curb to suit slope of roof for pitched roofs. Acoustically line all exhaust curbs, except for kitchen and laboratories. Provide unit that is nominally 610 mm (24 in.) high.
- .15 Provide vibration isolation as specified in Section 20 05 48 - VIBRATION AND NOISE CONTROL.
- .16 Provide roof mounted fans in accordance with the Fan Schedule.

ROOF MOUNTED FANS

PART 3 - EXECUTION

3.1 Installation

- .1 Install fans in locations shown on Drawings.
- .2 Align shafts, belt drive and motor, adjust belt tension, ensure all set screws are tight and check motor rotation before start-up.
- .3 Protect motors and fans during construction.

END OF SECTION

VARIABLE VOLUME BOXES

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Related Work Specified Elsewhere

- .1 Actuator for damper and controller furnished under Section 23 09 00 - BUILDING AUTOMATION SYSTEM (BAS).

1.3 Submittals

- .1 Shop Drawings: Submit Shop Drawings of all components in accordance with Section 20 05 03 – SHOP DRAWINGS.
- .2 Manufacturer's Data: Submit manufacturer's certified sound power ratings with an octave band analysis when tested in accordance with ASHRAE Standard 36B-63. Where a second sound attenuator is required in the system or where attenuators with outlets are used in conjunction with rated outlets and not as straight attenuators without outlets, submit certified data for review.

PART 2 - PRODUCTS

2.1 Materials

- .1 The mechanical variable volume boxes shall be E.H. Price, Titus, Nailor, Krueger, or JCI Enviro-Tec as shown and specified below.
- .2 Boxes shall be low pressure terminal boxes having unit casings fabricated of galvanized steel of sufficient thickness to prevent drumming or rattling, and lined with 25 mm (1 in.) thick thermal and sound attenuating insulation. The units shall be end outlet and shall be complete with DDC actuator. Leakage through the unit casing shall be less than 0.3% of the design volume.
- .3 Provide VAV boxes and actuators selected to accommodate the airflow direction as shown on the Drawings and/or equipment schedules.
- .4 Provide all supply air VAV boxes and general exhaust air VAV boxes with silencers. Provide actuators oriented to align with airflow direction for supply and exhaust. Refer to VAV Schedule and corresponding Drawings.
- .5 Design volumes shall be factory pre-set and calibrated and both maximum and minimum volumes shall be independently adjustable in the field, by using a cfm scale and without changing components. The box volumes are shown on Drawings. For all boxes, the minimum volume shall be set at the minimum volume recommended by the manufacturer. Maximum volume control shall be maintained within plus 5% of volume shown for box, with inlet pressures of 0.05 to 1.5 kPa (0.2 in. to 6 in.) of water.

VARIABLE VOLUME BOXES

- .6 Acoustically line ductwork downstream from boxes as shown. Lengths of 25 mm (1 in.) thick acoustic lining, shall be as designed in following Schedules:

BOX VOLUME	LENGTH
755.5 to 1180 L/s (1601 to 2500 cfm)	6100 mm (20 ft.)
283.5 to 755 L/s (601 to 1600 cfm)	4600 mm (15 ft.)
95 to 283 L/s (201 to 600 cfm)	3000 mm (10 ft.)
Under 94.5 L/s (200 cfm)	1500 mm (5 ft.)

- .7 When the scheduled lengths of lined duct cannot be obtained and/or where specifically shown, utilize straight attenuators.
- .8 With these attenuators and a room attenuation of 8 dB, the sound power level with reference to 10 to the -12 power watts shall be such that the sound pressure level in the room receiving air and in room in which the box is located, shall not exceed noise criterion 32 at an inlet static pressure 0.37 kPa (1.5 in. wg.) with noise generated by diffusers excluded. Provide manufacturer's certified sound power ratings with an octave band analysis when tested in accordance with ASHRAE Standard 36B-63.
- .9 Where one attenuator fails to provide the sound attenuation required, utilize additional attenuators or lengths of duct lining. Where attenuators with outlets are used they shall be rated with the outlets and not as straight attenuators without outlets.
- .10 Where outlets are provided, they shall be complete with manual dampers in each outlet.
- .11 The box radiated noise level shall meet the criteria for specific room noise levels as specified under Section 20 05 48 - VIBRATION AND NOISE CONTROL.
- .12 Pressure drop for L/s (cfm) ranges shown for each box size shall be 0.07 kPa (0.3 in. wg.) maximum. Boxes shall be capable of modulating down to the minimum volume shown and shall shut-off tight where zero L/s (zero cfm) is shown.
- .13 Provide VAV boxes that fail open.

PART 3 - EXECUTION

3.1 Installation

- .1 Install VAV boxes in accordance with reviewed Shop Drawings and to manufacturer's written instructions.
- .2 Air velocity sensor, actuator for damper, controller and interconnecting tubing and cable are installed by terminal box manufacturer at its manufacturing facilities; the costs for installation labour are paid for by this Section. Make control devices readily accessible from the access panel in the suspended ceiling.
- .3 Where a VAV box does not meet specified sound ratings, field enclose with (0.80 mm thick (1 lb.) lead sheeting over a 25 mm thick (1 in.) glass fibre blanket wrap, as part of the Work.

END OF SECTION

DIFFUSERS, GRILLES AND REGISTERS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Related Work Specified Elsewhere

- .1 Continuous air slot in ceiling - under Division 9 - Finishes.
- .2 Door grilles - under Architectural Division - Grilles.

1.3 Submittals

- .1 Shop Drawings: Submit detailed Shop Drawings of all components furnished under this Section. Manufacturer to indicate ceiling installation type for each type of diffuser specified.
- .2 Manufacturer's Data: Submit test results of type " "diffuser models to be used on the Project, including air pattern and noise levels for air quantities from 10% to 110% of the required maximum air flow.
- .3 Sample of exposed duct detail. See mechanical standard details on the Drawings.

PART 2 - PRODUCTS

2.1 Materials

- .1 Diffusers, registers and grilles shall be Price, Nailor, Krueger, or Titus equal to the units specified.
- .2 Select all diffusers to provide uniform air coverage without overlap. Air velocity up to a height of 1800 mm (6 ft.) above the floor shall be 0.127 to 0.254 m/s (25 to 50 fpm).
- .3 Noise generated by diffusers shall be such that room sound pressure level does not exceed noise criteria 32 with an 8 dB room attenuation, the sound power level reference to 10 to -12 power watts.
- .4 All volume and air pattern devices shall be fully adjustable from the face of the diffuser, register or grille.
- .5 In gypsum board or plaster ceiling applications, provide matching mounting frame. Finish shall be prime painted, off-white in plaster and gypsum board ceilings.
- .6 In T-bar ceilings, manufacturer shall coordinate diffuser compatibility with T-bar ceiling specified by the architectural division. Colour shall match colour of ceiling tile in lay-in ceilings. Diffusers to suit ceiling grid as required imperial or metric.
- .7 Diffusers shall meet test requirements of ASHRAE Standard 36B-63, including air pattern and noise levels for air quantities from 10% to 110% of the required maximum air flow. Sound power tests shall be measured in accordance with ASHRAE Standards 36B-63 and NC ratings shall be determined using an 8 dB room attenuation factor.

DIFFUSERS, GRILLES AND REGISTERS

2.2 Square Supply Diffusers

- .1 All diffusers shown as type "P" shall be steel square plaque diffuser 600 mm x 600 mm (24 in. x 24 in.) face size and shall be square, coned metal. Diffusers shall consist of a precision formed back cone of one piece seamless construction which shall incorporate a round (or square) inlet collar of sufficient length for connecting rigid or flexible duct as shown. An inner plaque assembly shall be incorporated that drops no more than 1/4" below the ceiling plane to assure proper air distribution performance. The inner plaque assembly shall be completely removable from the diffuser face to allow full access to any dampers or other ductwork components located near the diffuser neck. E.H. Price SPD, Nailor UNI, Krueger PLQ.
- .1 All diffusers shown as type "P1" shall be as specified above but with 300 mm x 300 mm (12 in. x 12 in.) face size for installation in ceiling specified by the Contract Administrator.

2.3 Linear Supply and Return Diffusers

- .1 All diffusers shown as type "S1" shall linear supply diffusers of the sizes, configurations and mounting types required. Diffusers shall have (1) discharge slots - 25 mm (1 in.) wide with extruded aluminum aerodynamically curved pattern controller for 180 degree air pattern control and airflow dampering if required. The diffuser border shall be heavy extruded aluminum construction with extruded aluminum spacers and (mitered end flanges, open ends, flush end caps or angle end caps). Frame shall be recessed into plaster or gypsum board with no mounting flange visible. All diffusers shall have a removable concealed fixing device. Colour shall match architectural ceiling and diffuser face shall be pre-coated with a lacquer protective. Continuous length units shall be provided with factory assembled corner modules to suit Drawings and on site conditions. Joiner strips shall be provided to align continuous slot assemblies. E.H. Price SDS/SDA, Nailor Series 5000/5300, Krueger 1900.
- .2 All diffusers shown as type "S2" shall be linear supply diffusers of the sizes configurations and mounting types required. Diffusers shall have (2) discharge slots 25 mm (1 in.) wide with extruded aluminum aerodynamically curved pattern controller for 180 degree air pattern control and airflow dampering if required. The diffuser border shall be heavy extruded aluminum construction with extruded aluminum spacers and (mitered end flanges, open ends, flush end caps or angle end caps). Frame shall be recessed into plaster or gypsum board with no mounting flange visible. All diffusers shall have a removable concealed fixing device. Colour shall match architectural ceiling and diffuser face shall be pre-coated with a lacquer protective. Continuous length units shall be provided with factory assembled corner modules to suit Drawings and on site conditions. Joiner strips shall be provided to align continuous slot assemblies. E.H. Price SDS/SDA, Nailor Series 5000/5300, Krueger 1900
- .1 Return slots sections shall match supply and shall have return air sight baffles and mitred corners. Return linear grilles shall be specified as above and indicated as return on the Drawings. Slots shown as "R1" shall have (1), 1" return slot, "R2" shall have (2), 1" return slots, and "R3" shall have (3), 1" return slots.

DIFFUSERS, GRILLES AND REGISTERS

2.4 Sill, Sidewall And Floor Grilles

- .1 Sill and side wall registers as type "G" shall be pencil proof linear extruded aluminum blades mechanically locked into a heavy extruded aluminum border. Grilles shall have fixed 0 degree blades spaced 1/4" on center. The border shall be complete with precise factory mitered corners. Blades shall run parallel to the long dimension of the grille. E.H. Price LBPH, Nailor 4900 Series, Krueger 1850 Series, Carnes CT580.

2.5 Wall and Duct Grilles

- .1 All supply registers shown as type "B" shall be standard double deflection type with adjustable horizontal face bars and vertical rear bars. Frame shall be gasketed. Construction shall be aluminum with prime coat. Registers larger than listed sizes shall be shop fabricated in Sections such that the Sections will appear as one integral register when installed. The integral volume control damper shall be of the opposed blade type and shall be constructed of cold rolled steel. The damper shall be operable from the register face. The damper shall be coated or galvanized steel. E.H. Price 620D, Nailor 5100 Series, Krueger 5880 Series.
- .2 All supply registers shown as type "B1" shall be standard double deflection type with adjustable horizontal face bars and vertical rear bars. Frame shall be gasketed and the face frame shall be curved to match the radius of the duct. Construction shall be aluminum with prime coat. Registers larger than listed sizes shall be shop fabricated in Sections such that the Sections will appear as one integral register when installed. The integral volume control damper shall be of the opposed blade type and shall be constructed of cold rolled steel. The damper shall be operable from the register face. The damper shall be coated or galvanized steel. E.H. Price SDG

2.6 Return, Exhaust and Transfer Grilles

- .1 Return grilles shown as type "E" shall be size as shown and shall be egg crate type with aluminum construction. Egg crate shall be 12 mm (1/2 in.) deep, formed of 12 mm (1/2 in.) wide aluminum strips on 12 mm (1/2 in.) centres. Strips shall be approximately 0.64 mm (0.025 in.) thick. Grilles shall be enclosed in a channel frame for inverted T-bar mounting or with a flanged frame for plaster or gypsum ceiling mounting. Grilles shall lay on inverted T-bar ceiling suspension system. Colour shall match adjacent ceiling tiles. E.H. Price Series 80, Nailor 5100 Series, Krueger EGC5 Series.
- .2 Return registers shown as type "K" shall be standard return grilles with horizontal fixed bars set at approximately 45 deg. for wall returns and set straight for ceiling return. Key operated damper shall be mounted behind. General appearance, type of material and finish shall match the type "..." supply register. E.H. Price 530, Nailor 6100 Series, Krueger S80.
- .3 Return registers shown as type "D" shall be heavy duty gym return grilles with horizontal fixed bars set at approximately 0 deg. parallel to the long dimension. Key operated damper shall be mounted behind. General appearance, type of material and finish shall be aluminum. Registers larger than listed sizes shall be shop fabricated in sections such that the sections will appear as one integral register when installed. E.H. Price Series 90, Nailor 6145H-HD, Krueger S480.
- .4 Transfer Grilles shown as type "J" shall be standard single deflection fixed blade type. Finish shall match wall. E.H. Price model 535/F/L/0m, Nailor 6155H/V, Krueger S85.

DIFFUSERS, GRILLES AND REGISTERS

2.7 Laminar Flow Diffusers

- .1 Laminar flow diffusers shown as type "L" shall be 600mm X 600mm (24" X 24"). Air shall be admitted to the top plenum chamber through an inlet collar and butterfly style volume control damper. The diffuser plenum shall be continuously welded and feature four (4) integral hanger tabs for securing the unit to structural supports above the ceiling. Mounting frames shall utilize corner alignment brackets. The free-area perforated distribution plate shall be secured to the face using stainless steel quarter-turn fasteners with anti-slip, snap-in retainers and stainless steel retainer cables for ease of installation and removal. Colour shall match adjacent ceiling tiles. E.H. Price LFD.

PART 3 - EXECUTION

3.1 Installation

- .1 Refer to the Architectural Drawings for actual locations of diffusers, grilles and registers and install to suit these Drawings. The Mechanical Drawings show intent and number of diffusers, grilles and registers required.
- .2 Provide transfer grilles in all finished spaces where air is transferred through a ceiling or partition.
- .3 For exposed ductwork installations, all connections to grilles shall be oversized and shall have in-turned flanges to meet the flange of the grilles and the duct. Out-turned or exposed flanges with screw mounting shall not be accepted.
- .4 For special mounting of diffusers, grilles and registers refer to Architectural Drawings.
- .5 Where rigid duct is connected to the diffuser, grille or register all devices used for flow pattern adjustment, flow balancing and flow equalizing shall be accessible from the face of the diffuser.
- .6 Install mounting frame tied into plaster and gypsum board ceilings to allow lay-in type diffusers to rest on the frame.
- .7 Diffusers for installation in lay-in ceiling shall lay on inverted T-bars spaced on 635 mm (24 in.) centers.
- .8 Be responsible for mounting concealed flange linear diffusers in heated environment and following manufacturers' instructions.
- .9 Caulk around edges of linear diffusers in installations with imperfect walls.

END OF SECTION

DISPOSABLE FILTERS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Materials

- .1 Filters shall be American Air Filter, Camfil Farr, Cambridge, Purafil, or Airguard
- .2 Pre-filter shall be constructed of galvanized steel frame, 3.0607 mm thick (0.1205 in - 11 gauge) galvanized wire grid and 50 mm (2 in.) thick disposable media. Filter shall have an Underwriters' Class 2 rating. Static pressure drop for a clean filter shall not exceed 0.042 kPa (0.17 in. wg.) for 944 L/s (2000 cfm) passing through a 600 mm x 600 mm (24 in. x 24 in.) filter.
- .3 Final filters shall be supported pleated type constructed of water resistant, fireproof cell walls and spun glass media. Filters shall have an Underwriters' Class 2 rating. Filters shall be nominally 600 mm x 600 mm x 300 mm (24 in. x 24 in. x 12 in.) deep. Media shall have a Minimum Efficiency Reporting Value of MERV11, MERV 13, MERV14, or MERV15. Media efficiencies shall be as shown on Schedules. Static pressure drops for filter for a nominal 944 L/s (2000 cfm) passing through a 600 mm x 600 mm (24 in. x 24 in.) filter shall be as follows:

MEDIA	INITIAL	FINAL
MERV 11	0.10 kPa (0.39 in. wg.)	0.37 kPa (1.5 in. wg.)
MERV 13	0.14 kPa (0.56 in. wg.)	0.37 kPa (1.5 in. wg.)
MERV 14	0.14 kPa (0.58 in. wg.)	0.37 kPa (1.5 in. wg.)

- .4 All bag filters shall be complete with a supporting frame to prevent assembly bag collapse under low-air flow or no-air flow conditions.
- .5 Each filter bank shall be complete with retainer and frames for assembly into a panel and complete with all miscellaneous fittings and gaskets to ensure a complete assembly.
- .6 Operate units with pre-filters during finishing time. Provide one complete set of new prefilters and final filters on date of acceptance of the building. Ensure all filters are installed before testing and balancing.
- .7 Prefilters shall be in conformance with the Prefilter Schedule.
- .8 Final filters shall be in conformance with the Final Filter Schedule.

PART 3 - EXECUTION

3.1 Installation

- .1 Install blank-off panels between filter banks and plenums to ensure no air by-pass occurs.

END OF SECTION

POSITIVE PRESSURE VENT AND CHIMNEY SYSTEMS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Related Work Specified Elsewhere

- .1 Supply and installation of guy wire roof anchors - under Division 7.
- .2 Supply and installation of roof flashings only - under Division 7.

1.3 Submittals

- .1 Shop Drawings: Submit Shop Drawings of the entire system being supplied, including details and catalogue cuts of any standard components being incorporated into the system.
- .2 Design and install system layout in compliance with manufacturer's written installation instructions and all applicable local codes.
- .3 Provide details for chimney support system, including all guy wire locations, wind loads, etc. as required.

PART 2 - PRODUCTS

2.1 Materials

- .1 Provide vent and chimney system that is continuous from the appliance's flue outlet to the termination to atmosphere outside the building. Provide system components that are ULC Listed and supplied from the same manufacturer.
- .2 Provide stainless steel guy wires and accessories with all necessary components for proper support.
- .3 NFPA 37 "Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines" and NFPA 211 "Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances" Medium Heat Gas, Liquid, or Solid Fuels:
 - .1 Provide factory built modular exhaust system that is tested and listed by Underwriters Laboratories in the United States and Canada according to UL/ULC standard for use with medium heat equipment burning gas, liquid or solid fuels as described in NFPA 37 and NFPA 211, which produce exhaust flue gases at a maximum temperature of 740 deg. C. (1400 deg. F.) under continuous firing.
 - .2 Provide chimney that is listed for temperatures not exceeding 740 deg. C. (1400 deg. F.) under continuous firing and 980 deg. C. (1800 deg. F.) in brief forced firing according to UL 2561 "1400 Degree Fahrenheit Factory-Built Chimneys."
 - .3 Provide exhaust system that is listed by Underwriters Laboratories in accordance with UL 103 "Factory-Built Chimneys for Residential Type and Building Heating Appliances" to withstand up to 14.93 kPa (60 in. internal water column) pressure at 538 deg. C. (1000 deg. F.).

POSITIVE PRESSURE VENT AND CHIMNEY SYSTEMS

- .4 Provide UL Listed fiber insulated flue and air insulated flue system with surface temperatures published as per the UL 103 538 deg. C. (1000 deg. F.) chimney test.
- .5 Make each section of two steel cylinders separated by 51 mm (2 in.) of high temperature AES Wool insulation. Provide published clearance to combustibles that is the result of UL/ULC listing of the standard.
- .6 Connect and seal all section joints with a factory supplied locking band at the inner wall (flue) only. Use appropriate sealant as specified in the manufacturer's written installation manual. Provide each section joint outer wall (casing) with a closure band.
- .7 Provide all section joints with a self-centering sleeve to ensure proper alignment at the inner wall (flue).
- .8 Make connections to mufflers/silencers with matching ANSI flanges.
- .9 Include with system:
 - .1 Type 304 stainless steel inner liner 0.889 mm (0.035 in.) thick. Laser or plasma weld the inner wall (flue).
 - .2 Minimum 25 mm (1 in.) thick fireproof insulation.
 - .3 Type 304 stainless steel non-corrosive outer casing minimum 0.635 mm (0.025 in - 24 USS Gauge) thick up to 914 mm (36 in.) diameter and 0.9525 mm (0.0375 in - 20 USS Gauge) thick for all sizes above 914 mm (36 in.) diameter.
 - .4 All necessary braces, supports, cleanouts at the end of each horizontal section, roof flashings, storm collars, base support, and low loss rain caps.
 - .5 Provide excessive pressure relief valve (EPRV) for chimney system connected to natural gas or diesel power generator.
 - .6 Provide bellows sections as required for each horizontal and vertical chimney sections between supports.
- .10 Acceptable systems:
 - .1 Selkirk type IPS
 - .2 Schebler Co. model P1
 - .3 DuraVent DuraStack Pro Models DIS2
 - .4 Security Securestack Pro CIX2
 - .5 Van Packer Type DW-PLUS
 - .6 Chiminée Lining model IPPL2
- .4 Double Wall, positive pressure, condensing or non-condensing low heat applications
 - .1 Size vent and chimney system to suit natural gas appliance, factory built, suitable for Category I, II, III or IV condensing or non-condensing appliances or as specified by the appliance manufacturer. ULC Listed for maximum continuous flue gas temperature of 249 Deg. C. (480 Deg. F.) and a minimum positive pressure rating of 1.49 kPa (6 in. W.C.) and tested at 8.72 kPa (35 in. W.C.).
 - .2 Include with system:

POSITIVE PRESSURE VENT AND CHIMNEY SYSTEMS

- .1 Type AL29-4C stainless steel inner liner, with a minimum wall thickness of 0.381 mm (0.015 in.) for 76.2 mm (3 in.) through 228.6 mm (9 in.) diameter vents, 0.508 mm (0.020 in.) for 254 mm (10 in.) through 406.4 mm (16 in.) and 0.61 mm (0.024 in.) for 457 mm (18 in.) through 610 mm (24 in.) diameter vents.
- .2 Type 304 stainless steel non-corrosive outer casing, with a minimum wall thickness of 0.41 mm (0.016 in.) for 76.2 mm (3 in.) through 152 mm (6 in.), 0.61 mm (0.024 in.) for 178 mm (7 in.) through 406.4 mm (16 in.) for outdoor portion of system.
- .3 25 mm (1 in.) air space between the flue and jacket. For any venting lengths with 1200 mm (4 ft) exposed to the exterior, provide a 50 mm (2 in) gap filled with glass fiber insulation.
- .4 All section joints with a triple lipped directional silicone gasket for sealing and a built in mechanical locking band.
- .5 All necessary braces, supports, cleanouts at the end of each horizontal section, roof flashings, roof and wall penetrations, storm collars, base support, and flue termination.
- .6 Utilize low-loss rain cap or double cone rain cap terminations on non-condensing applications only. Utilize velocity cone or straight terminations on condensing systems.
- .3 ULC Listed for 50 mm (2 in.) clearance to combustibles.
- .4 Acceptable chimney and breeching systems:
 - .1 Selkirk type CI Plus
 - .2 Schebler Co. model eVent
 - .3 Duravent Duraseal
 - .4 Security Chimneys Secureseal
 - .5 Chiminée Lining model IPPL

PART 3 - EXECUTION

3.1 Installation

- .1 Route the vent system to maintain minimum clearance to combustibles as specified by the manufacturer.
- .2 Conform to the manufacturer's written installation instructions, ULC Listing and the requirements of the Authority Having Jurisdiction.
- .3 Inspect and clean the system before the final connection to the appliances.
- .4 Support any dampers or fans installed in conjunction with the vent system independently from the vent system. Protect the vent system from twisting or movement due to fan torque or vibration.
- .5 Provide chimney height of at least 900 mm (3 ft.) higher than any portion of the building within 3000 mm (10 ft.) and self-support up to 1800 mm (6 ft.) as appropriate to suit diameter.

POSITIVE PRESSURE VENT AND CHIMNEY SYSTEMS

- .6 Run guy wires, where required, from chimney to guy wire supports located approximately mid-span of beams. Refer to Structural Drawings for locations.
- .7 Provide drainage for rain/condensate in generator exhaust system, as required by CSA C282 "Emergency Electrical Power Supply for Buildings." Utilize Schedule 40 piping complete with high temperature shut-off valve rated for generator exhaust temperature and comply with other installation requirements of CSA C282.
- .1 High temperature shut-off valve: OMB Model 810-NPT, Gate valve, OS&Y, Class 800, ASTM A182 F316 stainless steel, #12 NACE, 3/4 in. size. MA Stewart Code 073-37516.

END OF SECTION

CONDENSING BOILERS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Submittals

- .1 Submit radiant and standby losses for each boiler for review.

1.3 Related Work Specified Elsewhere

- .1 Electrical hard wire supply [and connections to electrical components] - under Electrical Division.

PART 2 - PRODUCTS

2.1 Materials

- .1 Provide forced draft, natural gas fired, condensing type boiler(s):
 - .1 Minimum thermal efficiency of 92 % with a return water temperature of 27 Deg. C. (80 Deg. F.) at 100% output.
 - .2 ASME rated for maximum 550 kPa (80 psi) working pressure at 82 Deg. C. (180 Deg. F.).
 - .1 Acceptable manufacturers are Aerco Benchmark, Viessmann Vitocrossal, Patterson Kelley Solis, Lochinvar Crest, or Cleaver-Brooks ClearFire CE.
- .2 Provide each boiler complete with the following:
 - .1 Fully welded, 304 or 316 stainless steel heat exchanger
 - .2 High temperature limit control set at 82 Deg. C. (180 Deg. F.)
 - .3 Fully modulating flame control
 - .4 Positive pressure vent discharge connection
 - .5 Thermometer(s)
 - .6 Pressure gauge(s)
 - .7 ASME safety pressure relief valve
 - .8 ASME CSD-1 compliant gas train to burner with minimum:
 - .1 Gas pressure regulator for operation on natural gas supply pressure as shown on Schematics or Scheduled.
 - .2 Flame monitoring system shall incorporate CSA/UL combustion safeguard
 - .3 100% independent shut-off pilot control
 - .4 Manual and electric gas shut-off valve(s)
 - .9 Electric type low water fuel cut-off with test and manual reset in accordance with ASME Section IV and CSD-1 requirements. Low water fuel cut-out shall be

CONDENSING BOILERS

- pressure type suitable for lowest flow available to boiler with consistent repeatability.
- .10 Pre-wired control panel interconnected to all controls and wired to terminal strip.
- .11 Integral electric relay to isolate power from control panel/boiler and shut down boiler. Provide power failure restart upon reset of relay.
- .12 Neutralization kit supplied by manufacturer.
- .13 Natural gas burner with:
 - .1 Minimum 5:1 turndown
 - .2 Operation at no greater than 8.0 % excess O₂ over the entire modulation range.
 - .3 NOx emissions lower than 30 ppm over entire operating range.
- .3 Provide boiler as shown in the Boiler Schedule.
- .4 Provide boilers completely insulated for minimal radiant and standby losses and with easily removable stainless steel or baked enamelled casing designed for ease of inspection and maintenance of the heat exchanger.
- .5 Provide boilers with a single point power connection that powers all components including but not limited to:
 - .1 Blower motor
 - .2 Control Panel
 - .3 Safeties
- .6 Provide control panel to start, stop, cycle, and sequence boilers for maximum efficiency optimization or provide independent control panel and integrated as required.
 - .1 Equip each boiler with automatic temperature controller.
 - .2 Continuously monitor outlet temperature and total supply hot water in order to achieve set point temperature.
- .7 Provide boiler control panel based on open system communication protocol BACnet as defined by ANSI/ASHRAE Standard 135 for seamless integration with Section 23 09 00 - BUILDING AUTOMATION SYSTEM (BAS). Provide any necessary conversion utilities for a complete and operational system.
- .8 As a minimum, provide the following hardware points available for direct connection to Section 23 09 00 - BUILDING AUTOMATION SYSTEM (BAS):
 - .1 Boiler Enable
 - .2 Hot Water Supply Temperature Set-Point
 - .3 Boiler supply temperature at outlet
 - .4 Boiler status
 - .5 Boiler output firing rate
 - .6 Boiler General Alarm

CONDENSING BOILERS

PART 3 - EXECUTION

3.1 Installation

- .1 Install and label all fuel fired equipment to meet the requirements of:
 - .1 Natural Resources Canada (NRCan)
- .2 Install boilers in accordance with Section 20 05 48 - VIBRATION AND NOISE CONTROL. Where required, furnish anchor bolts and setting diagrams to the Work of Division 3 for correct setting in place.
- .3 Provide complete and operational vent and chimney system in accordance with Section 23 51 33 - POSITIVE PRESSURE VENT AND CHIMNEY SYSTEMS to suit the listed category of appliance.
- .4 Pipe condensate trap for each boiler and venting system separately to closest floor drain complete with inline neutralization kit.
- .5 Connect control panel power-off relay to emergency power off switch (EPO) supplied and located in accordance with Section 23 11 23 - NATURAL GAS PIPING SYSTEMS. Provide all interconnecting wiring to isolate all boilers with a single EPO switch.
- .6 Provide the following commissioning requirements executed by the manufacturer's representative:
 - .1 Efficiency check at the time of start-up
 - .2 A start-up report detailing all the Work undertaken
 - .3 Instruction to The City's operators on the care, operation and maintenance of the units.
 - .4 Final report that includes output from the gas analyzer: efficiency, related inlet and outlet temperatures, percentage of effluent contents, etc.
- .7 Report confirming operation of emergency power off switch and boiler restart.

END OF SECTION

HEAT EXCHANGERS - PLATE TYPE

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Materials

- .1 Plate type heat exchangers shall be Xylem, Alfa-Laval, Armstrong, Tranter, APV, Taco, GEA or AIC Inc. with fluids and performance in accordance with the Heat Exchanger Schedule.
- .2 Provide AHRI 400 certification for all fluids.
- .3 Construction shall consist of a carbon steel frame with one stationary cover and one moveable cover. The heat transfer plates and the moveable cover shall be suspended from an upper carrying bar and guided by a lower guiding bar, which are attached to the stationary frame plate and shall be easy to move after disconnection of the tightening bolts. The design shall permit ready access to the plate pack for inspection and cleaning and it shall permit removal of individual plates. Tightening bolts shall be galvanized carbon steel.
- .4 The frame parts shall be sandblasted and painted with a primer and a finishing paint.
- .5 The material for the heat transfer plates shall be stainless steel for all HVAC and potable water applications.
- .6 For potable water and pool applications, provide double wall heat exchanger with two plates pressed together to create two fluid leak paths to atmosphere. Provide 0.35 mm plate thickness for each plate and 0.7 mm total thickness of two plates pressed together.
- .7 Gaskets shall be Nitrile or EPDM and suitable for the given fluids, pressures and temperatures.
- .8 The design, construction, inspection and testing shall comply with the applicable Provincial pressure vessel regulations. Submit certificates to the Contract Administrator.
- .9 Provide CRN number and all required registration documentation for heat exchangers.
- .10 During manufacturing all tests and inspection required by applicable regulations and codes shall be performed to assure that material, workmanship, finish dimensions and markings are in accordance with the Specifications. The heat exchanger shall be subject to hydrostatic testing.
- .11 Provide two relief valves set at working pressure for each exchanger installed on headers to protect the plates. The pressure rating of the heat exchanger shall be greater than the working pressure noted in the Heat Exchanger Schedule assuming the one side is under pressure and the other side is empty of fluid. If nothing is noted, the rating shall be not less than 150 PSI. All units shall be tested to ASME standards and not less than 1.3 times the design pressure.
- .12 For units where both sides are part of a closed loop system, the heat exchangers shall be selected with a 0.0001 BTU/ft²hr.deg fouling factor for the unit (0.00005 BTU/ft²hr.deg.F. applied to each side) based on the capacities given in the Schedules.

HEAT EXCHANGERS - PLATE TYPE

- .13 For units where one or both sides are part of an open loop system, the heat exchangers shall be selected with a 0.00025 BTU/ft²hr.deg fouling factor for the unit (0.000125 BTU/ft²hr.deg on each of the open side(s)) based on the capacities given in the Schedules. Examples of 'open systems' are open condenser water loops, domestic water and all pool applications.

PART 3 - EXECUTION

3.1 Installation

- .1 Provide isolation valves and unions or flanges on all connections to the heat exchanger in locations to permit the disassembly without disrupting the system piping.
- .2 Ensure both sides of the heat exchanger are isolated when either side of the exchanger is drained in order to protect unit against an excessive pressure differential from damaging the unit.
- .3 The Contractor shall provide a lamacoid on each heat exchanger that reads as follows:
"WARNING: ISOLATE BOTH SIDES OF THE HEAT EXCHANGER WHEN DRAINING
EITHER SIDE OF THE UNIT"

END OF SECTION

AIR COOLED CONDENSING UNITS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 Provide low Global Warming Potential (GWP) refrigerant complying with the performance requirements stated within Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Submittals

- .1 Submit Shop Drawings in accordance with Section 20 05 03 - SHOP DRAWINGS. Ensure Shop Drawings include unit Short Circuit Current Rating (SCCR).

PART 2 - PRODUCTS

2.1 Materials

- .1 Air-cooled condensing units shall be with capacities shown in Schedule and as detailed on Drawings. Capacity ratings shall be based on tests in accordance with AHRI Standard 360. Condensing units shall consist of casings, compressors, condenser coils, condenser fans and motors and unit controls. Units shall be shipped from the factory complete as one unit and shall bear a CSA label.
- .2 Condensing unit shall be designed for outdoor application and shall provide complete protection for all components and controls.
 - .1 Casings shall have removable panels to provide complete access to compressors, controls, condenser fans, motors and drives.
 - .2 The unit shall ship complete in one section as a factory assembly.
 - .3 All exposed surfaces of the unit casing shall be of galvanized steel, phosphatized for maximum paint adhesion and finished with an air-dry paint coating.
 - .4 Lifting lugs shall be provided to facilitate lifting and rigging of unit.
 - .5 Unit shall be provided with factory installed louvred metal grilles providing protection for condenser coil during shipment, installation and operation.
 - .6 Unit shall have a hinged and gasketed control panel door.
- .3 Compressor shall be of the reciprocating hermetic-type, 1,750 rpm and designed for air-cooled condensing. Compressor motor shall be designed for part winding start.
 - .1 Compressor lubrication shall be provided by means of a centrifugal oil pump with crankcase sight glass and crankcase heater provided as standard.
 - .2 Back seating service access valves shall be provided on suction and discharge ports.
 - .3 Compressor shall provide capacity control through suction shut-off cylinder unloading.
 - .4 Compressor suction and discharge valves shall be of the non-flexing ring-type.

AIR COOLED CONDENSING UNITS

- .5 Compressor crankcase heater shall be installed in a well in the crankcase. Crankcase heater shall be easily removable for repair and/or replacement.
- .6 Steps of capacity control shall be provided.
 - .1 Three step (30 ton)
 - .2 Four step (50 ton)
- .7 Compressor shall be provided with loss of refrigerant charge protection. Manual reset of this safety shall be required.
- .8 Compressor capacity control shall be means of electric cylinder unloaders.
- .9 Compressors shall have hot gas mufflers.
- .10 Compressor shall have an integral suction line accumulator capable of storing the complete liquid refrigerant charge.
- .11 The compressor shall be manufactured by the unit manufacturer.
- .4 Condensing unit operating and safety controls shall include high and low pressure cut-outs, and compressor winding thermostat cut-out.
 - .1 Three-leg compressor overload protection shall be provided.
 - .2 Condenser fan motors shall be protected by inherent devices providing both thermal and overload protection.
 - .3 Control panel shall include magnetic Contactors for compressor and condenser fan motors.
 - .4 Control power shall be 120 volt.
 - .5 Control circuit shall include reset relay circuit to provide for manual resetting of high pressure control, compressor winding thermostats and/or compressor overloads at the room thermostat or On-off switch.
 - .6 Automatic non-recycling pump down shall be provided.
 - .7 Unit shall have a factory installed 120 volt control power.
 - .8 Unit shall have a single point power supply connection.
 - .9 Unit shall have a timing device to prevent excessive compressor cycling.
 - .10 All unit control wiring shall be numbered.
 - .11 Control panel door shall be hinged.
- .5 All unit controls shall be factory installed. Control system shall provide for shut-off control, supply air and outside air control with sensors to be mounted remotely. Controls shall operate to maintain the desired supply air temperature. Supply air temperature shall be capable to be reset based on outside ambient temperature. Reset ratio shall be 1:5 to a maximum of -12 deg. C. (10 deg. F.) above setpoint. Terminal strip hookups shall be provided at the condensing unit for interface with an airside economizer cycle.
- .6 System shall bear a minimum Short Circuit Current Rating (SCCR) listed by a Nationally Recognized Testing Lab, acceptable to the local Authority Having Jurisdiction, and shall be 25,000 A Lower SCCR listed units implying the use of current limiting fuses ahead of them in the field, in lieu of an actual appropriate SCCR rating, are not acceptable.

AIR COOLED CONDENSING UNITS

- .7 Condensing unit control panel shall be based on open system communication protocol BACnet as defined by ANSI/ASHRAE Standard 135 for seamless integration with Section 23 09 00 - BUILDING AUTOMATION SYSTEM (BAS).
- .8 As a minimum, the following hardware points shall be available for direct connection to Section 23 09 00 - BUILDING AUTOMATION SYSTEM (BAS):
 - .1 Condenser Start/Stop
 - .2 Supply Air Temperature Set-Point
- .9 Condenser coil shall be of seamless copper tubing mechanically bonded to heavy-duty, configured aluminum fins.
 - .1 Units with two compressors shall have completely separate and independent refrigeration circuits.
 - .2 A liquid accumulator and subcooling circuit shall be included as a standard part of the condensing section.
 - .3 Unit shall be equipped with a back seating liquid line service access valve.
 - .4 Condenser coils shall be factory tested 31.65 kg/cm (450 psi) air pressure and vacuum dehydrated.
 - .5 Condenser shall have factory installed coil guards.
- .10 Condenser fan shall be of the propeller type with all exposed fan and shaft surfaces suitable weatherproof.
 - .1 Condenser fan shall provide vertical air discharge.
 - .2 The condenser fan drive shall be of the direct type.
 - .3 All condenser fan motors shall have permanent lubricated ball bearings.
 - .4 Multiple fans, with separate fan motors for each, shall be provided.
 - .5 All condenser fan motors shall be of the three phase, constant speed type.
 - .6 All fan assemblies shall be dynamically and statically balanced.
- .11 Units shall have a factory supplied and mounted unfused disconnect switch.
 - .1 Provide a factory installed "T" stub fitting in the compressor discharge line for easy installation of the hot bypass valve.
 - .2 Provide hot gas bypass valves for compressor operation below the minimum stage of unloading. Hot gas bypass valve shall be factory installed.
 - .3 Provide factory mounted suction and discharge pressure gauges on each compressor.
 - .4 Spring isolators are specified under the "Vibration and Noise Control" section.
 - .5 Provide low ambient compressor lockout thermostats with variable set point for field installation on each compressor by the Contractor.
- .12 Provide a five year, non-prorated compressor warranty on each compressor to cover replacement of the compressor only and excluding labour.

AIR COOLED CONDENSING UNITS

PART 3 - EXECUTION

3.1 Installation

- .1 Set and install unit so it is level, properly supported and with sufficient clearances.
- .2 Install roof-mounted units on a 600 mm (24 in.) high heavy gauge galvanized steel mounting rail system for field assembly on the roof decking prior to unit shipment. Provide rail system that does not permit the accumulation of snow, water, or debris under the heat pump.
- .3 Provide vibration isolation in accordance with Section 20 05 48 – VIBRATION AND NOISE CONTROL.
- .4 Provide all refrigerant piping as detailed on plans and Specification.
- .5 Leak test of all piping, then dehydrate and charge according to following:
 - .1 Evacuate to 2.5 mm (0.1 in.) of mercury and hold vacuum for at least 8 hours.
 - .2 Break vacuum with dry nitrogen and re-evacuate to 2.5 mm (0.1 in.).
 - .3 Break vacuum with refrigerant and charge system in accordance with manufacturer's recommendations.
- .6 Electrical interlocks between condensing units and equipment provided under Section 23 72 23 - CUSTOM AIR CONDITIONING UNITS.
- .7 BAS connection to condensing unit control panel provided under Section 23 09 00 - BUILDING AUTOMATION SYSTEM (BAS).

END OF SECTION

REVERSE FLOW ENERGY RECOVERY DUAL CORES

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Submittals

- .1 Shop Drawings: Submit Shop Drawings in accordance with Section 20 05 03 - SHOP DRAWINGS.

PART 2 - PRODUCTS

2.1 Materials

- .1 Reverse flow energy recovery module acceptable manufacturers:
 - .1 Tempeff
 - .2 Solution Air
 - .3 Engineered Air
- .2 Efficiency: varies with face velocity, corrugation height and depth of core selected.
 - .1 Provide winter minimum efficiencies of 88% sensible and 73% latent.
 - .2 Provide summer minimum efficiencies of 85% sensible and 68% latent.
- .3 Provide frost free reverse flow energy recovery module. Energy recovery devices that require a defrost cycle are not acceptable.
- .4 Provide reverse flow modules comprised of two banks of corrugated aluminum cores between an upstream and downstream damper system. Construct modules for either top and bottom airflow or side by side airflow arrangement.
- .5 Construct casing of 16 gauge galvanized steel.
- .6 Provide removable aluminum cores that facilitate cleaning. Provide cores that are capable of being cleaned by soft brush, vacuum-cleaner, low-pressure compressed air, or a water wash.
- .7 Provide changeover dampers with a molded aluminum C-profile casing, aluminum damper shafts, and a galvanized steel drive shaft. Provide aluminum damper blades with permanently lubricated ball bearings.
- .8 Controls
 - .1 Provide an integral controller to modulate damper changeover based on supply air temperature. Control supply air temperature setpoint through a 0-10 V input signal from the BAS.
 - .2 Provide integral controller with an enable/disable contact and free cooling enable contact with BACnet MSTP protocol.

REVERSE FLOW ENERGY RECOVERY DUAL CORES

PART 3 - EXECUTION

3.1 Installation

- .1 Touch up all abrasions and other blemishes after installation with zinc rich paint.

END OF SECTION

CUSTOM AIR CONDITIONING UNITS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 Provide low Global Warming Potential (GWP) refrigerant complying with the performance requirements stated within Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Submittals

- .1 Submit Shop Drawings in accordance with Section 20 05 03 - SHOP DRAWINGS. Ensure Shop Drawings include unit Short Circuit Current Rating (SCCR).

PART 2 - PRODUCTS

2.1 Materials

- .1 Custom air handling units as described in the Air Plant Composition Schedules and associated Schedules.
- .2 Acceptable custom air handling unit manufacturers are as follows:
 - .1 Tempeff
 - .2 Engineered Air
 - .3 Scott Springfield
 - .4 Inginia
 - .5 TMI
 - .6 Ventrol
 - .7 Solution Air
- .3 Mafna may be used as a substitute manufacturer subject to approval.
- .4 Provide factory assembled air handling units in configuration as indicated on Drawings. Unit shall include all specified components installed at the factory. Field fabrication of units and their components will not be accepted. Provide sheet metal caps on all openings for on-site pressure testing.
- .5 Casings downstream of the heating coil shall be constructed of minimum 50 mm (2 in.) thick, acoustical thermal panels. Panels shall be minimum 1.6129 mm thick (0.0635 in. - 16 gauge) G90 galvanized or satin coat steel for the exterior wall. The inner wall shall be minimum 0.8534 mm thick (0.0336 in. - 22 GSG gauge) perforated G90 galvanized or satin coat steel. The insulation shall be 50 mm (2 in.), minimum 48 kg/cu.m. (3 lb/cu.ft.) density fibreglass complete with neoprene face. All flanged panel surfaces shall be sealed during assembly with strips of 3 mm (1/8 in.) thick sealer to provide an airtight unit. External caulking is not acceptable. All seams shall be turned inward to provide a clean flush exterior finish.

CUSTOM AIR CONDITIONING UNITS

- .6 Casings up to and including the heating coil shall be constructed of minimum 50 mm (2 in.) thick, acoustical thermal panels. Panels shall be minimum 1.6129 mm thick (0.0635 in. - 16 GSG gauge) G90 galvanized or satin coat steel for the exterior wall. The inner wall shall be minimum 0.8534 mm thick (0.0336 in. - 22 GSG gauge) solid G90 galvanized or satin coat steel. The insulation shall be 50 mm (2 in.), minimum 48 kg/cu.m. (3 lbs./cu.ft.) density fibreglass complete with neoprene face. All permanently joined flanged panel surfaces shall be sealed during assembly with strips of 3 mm (1/8 in.) thick sealer to provide an airtight unit. External caulking is not acceptable. All seams shall be turned inward to provide a clean flush exterior finish.
- .7 Provide insulation weld pins on 400 mm (16 in.) centers (maximum) or insulation shelves on 600 mm (24 in.) centers (maximum) to prevent insulation sag for units designed for 100% outdoor air and/or for units over 4719 L/s (10,000 cfm).
- .8 Base shall be constructed from perimeter structural steel channel frame with intermediate channel and structural angle supports or 3.5103 mm thick (0.1382 in. - 10 GSG gauge) G90 galvanized double formed metal overlapped to form a rigid structure. The base shall be sufficiently high to accommodate a deep seal trap external to the unit but above the Mechanical Room floor however in no case less than 150 mm (6 in.). A 1.8974 mm thick (0.0747 in. 14 MSG gauge) minimum thickness hot dip galvanized or 0.4826 mm thick (.019 in. - 10 B&S gauge) aluminum checker plate floor shall be installed on the base. Provide intermediate floor supports for zero deflection for service person and equipment. Floor seams shall be continuously welded and a 25 mm (1 in.) minimum perimeter collar shall be provided to ensure the unit is internally watertight. Base is to be provided with lifting lugs, minimum 4 per unit section. The base shall be externally insulated with 50 mm (2 in.) foil faced fiberglass insulation completely sealed, with a secondary sheet metal panel, to provide a continuous vapour barrier.
- .9 Access doors shall be manufactured from 1.6129 mm thick (0.0635 in. - 16 GSG gauge) G90 galvanized or satin coat steel. The doors shall be double wall construction with 48 kg/cu.m. (3.0 lbs.) density insulation (of thickness to match casing), and 0.8534 mm thick (0.0336 in. - 22 GSG gauge) internal corners of the doors shall be welded for rigidity. A 250 mm (10 in.) thermally broken double glazed tempered glass sealed window shall be provided in each door. Two Ventlock or Leverlock latches operable from either side of door shall be provided. Door opening shall be fully gasket with continuous self-gripping automotive type round black neoprene gasket with internal radius corners. Door frames shall be framed for 1.6129 mm thick (0.0635 in. - 16 GSG gauge) galvanized steel with the outside of the door flush to the unit. Minimum door opening size shall be 600 mm x 1500 mm (24 in. x 60 in.) (where unit height permits). Provide a minimum of two 127 mm x 127 mm (5 in. x 5 in.) strap or butt style hinges with removable pins or a continuous stainless steel piano hinge fastened to the unit with stainless steel screws to allow complete removal of doors. Doors shall be provided in each access section between components and shall open out for negative pressure sections and in for positive pressure sections.
- .10 Provide fans as specified in Section 23 34 13 – AXIAL FLOW FANS, MIXED FLOW FANS, AND CENTRIFUGAL FANS and in accordance with the Fan Schedule.
- .11 Provide coils as specified in Section 23 82 16 - COILS and in accordance with the Coil Schedule.

CUSTOM AIR CONDITIONING UNITS

- .12 Provide removable insulated double wall coil access panels to remove coils through casing wall. Coils shall be individually removable towards the access side. Water connections to the coils shall terminate 50 mm (2 in.) outside the unit and shall be sealed and gasketed to the casing wall to maintain continuity of the unit.
- .13 Cooling coil support racks and frame shall be Type 304L stainless steel.
- .14 Provide drain pans as specified in Section 23 82 16 - COILS.
- .15 Provide filters as specified in Section 23 41 16 - DISPOSABLE FILTERS and in accordance with the Air Plant Composition Schedule.
- .16 Provide vibration isolation as specified in Section 20 05 48 - VIBRATION AND NOISE CONTROL and in accordance with the Vibration Isolation Schedule. Isolators shall be positioned directly over base framing to prevent drumming.
- .17 Provide motors as specified in Section 20 05 13 - ELECTRIC MOTORS.
- .18 Provide variable speed drives as specified in Section 20 05 15 - VARIABLE SPEED DRIVES.
- .19 R-AHU-01, R-AHU-02, R-AHU-03, and R-AHU-04: Unit shall bear a minimum Short Circuit Current Rating (SCCR) listed by a Nationally Recognized Testing Lab, acceptable to the local Authority Having Jurisdiction, and shall be 35,000 A Lower SCCR listed units implying the use of current limiting fuses ahead of them in the field, in lieu of an actual appropriate SCCR rating, are not acceptable.
- .20 C-AHU-01: Unit shall bear a minimum Short Circuit Current Rating (SCCR) listed by a Nationally Recognized Testing Lab, acceptable to the local Authority Having Jurisdiction, and shall be 25,000 A Lower SCCR listed units implying the use of current limiting fuses ahead of them in the field, in lieu of an actual appropriate SCCR rating, are not acceptable.
- .21 Provide 38 mm (1-1/2 in.) threaded and capped drain connection(s) piped 25 mm (1 in.) out from the access side or the unit base for the following sections:
 - .1 Outside air plenums
 - .2 Humidifier sections
- .22 All galvanized metal surfaces shall be pre-painted with vinyl wash primer to ensure paint bond to metal, then coated with two component etch bond primer. All uncoated steel shall be painted with red oxide primer. Entire unit shall then be finish painted with thermo-setting alkyd enamel.
- .23 LED marine lights with protective metal cage and glass seals shall be installed on the wall opposite the access doors or where shown. A switch with an indicator light shall be installed on the exterior of the unit. Factory wire from one switch to each light. Electrical power shall be 120 V/1/60 from a single source at the access side of the fan section.
- .24 Vapour proof LED strip light fixtures shall be installed on the ceiling, the wall opposite the access doors, or where shown. A switch with an indicator light shall be installed on the exterior of the unit. Factory wire from one switch to each light. Electrical power shall be 120 V/1/60 from a single source at the access side of the fan section.
- .25 Provide a convenience GFI duplex receptacle in the fan section of each unit and where shown. Factory wire from one junction box to each duplex receptacle. Electrical power shall be 120 V/1/60 from a single source at the access side of the fan section.

CUSTOM AIR CONDITIONING UNITS

- .26 Manufactured stratification eliminators shall be fabricated from 1.52 mm thick (0.0598 in. - 16 gauge) satin coated steel (A653/A653M, Designation ZF75). The unit shall have fixed curved blades with no moving parts. The entire air blender shall be finished painted with alkyd enamel. Units shall be factory built and tested to give a maximum 3 deg. C. (6 deg. F.) mixed air temperature deviation from actual calculated temperature with a 50% mix and 15.6 deg. C. (60 deg. F.) return air temperature. The unit shall be efficient from 500 fpm to 2500 fpm. Maximum pressure drop shall be 0.2 in. wg. Modules shall be provided to ensure even air flow across the filters and coils.
- .27 Provide steam humidifiers as specified in Section 23 84 13 - HUMIDIFIERS and in accordance with the Humidifier Schedule.
- .28 Mount the steam distributor in the factory and pipe 50 mm (2 in.) out from the access side of the unit for connection to the humidifier piping.
- .29 Provide gauges as specified in Section 20 05 19 - INDICATING INSTRUMENTS.
- .30 Provide energy recovery modules as specified in Section 23 72 16 – REVERSE FLOW ENERGY RECOVERY DUAL CORES.
- .31 Provide units with casing air leakage of no more than of unit nameplate volume flow rate at 1.5 times the unit nameplate static pressure.

PART 3 - EXECUTION

3.1 Installation

- .1 Ensure all curbs, inserts and other mounting devices are correctly installed for the unit supplied. Allow a minimum of 250 mm (10 in.) from bottom of condensate drain connection to the floor.
- .2 Mount the unit and install all components required for a complete and operational unit.
- .3 Provide coil winterization connections in air handler and on cooling coil as per Standard Details.
- .4 Each air handling unit shall be factory pressure tested and virtually witnessed by the Independent Testing Agency for air balancing and the Contract Administrator or The City's representative. Facilitate virtual witnessing.
- .5 Test shall be conducted in accordance with SMACNA duct construction manual. A calibrated orifice shall be used to measure leakage airflow.
- .6 Notify Contract Administrator, Testing and Balancing trades, and/or The City to witness the pressure test.

END OF SECTION

EXPANSION TANKS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Submittals

- .1 Shop Drawings: Submit Shop Drawings of the tank support frames for structural review, and tank drawings, including details and catalogue cuts of any standard components being incorporated into the system.

PART 2 - PRODUCTS

2.1 Materials

- .1 Replaceable bladder type expansion tanks shall be pre-charged replaceable bladder type equal to Calefactio Explanflex Type 'AL', Xylem Series 'B', Armstrong Type 'L', or Amtrol Extrol Series 'L' stamped 800 kPa (125 psi) operating pressure.
 - .1 Tanks shall be constructed in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code.
 - .2 Tanks shall be all steel construction and replaceable bladder shall be heavy duty butyl rubber compound.
 - .3 Tank shall include 38 mm (1-1/2 in.) threaded bottom inlet, built in air pressure gauge, air inlet connection to facilitate adjusting of pre-charge air pressure to meet actual system conditions, and 19 mm (3/4 in.) drain connection.
 - .4 Tanks shall be complete with ring base, and lifting rings.
 - .5 Tanks shall have capacities as indicated in the Expansion Tank Schedule.
- .2 Diaphragm type expansion tanks shall be pre-charged diaphragm type equal to Calefactio Explanflex Type 'OT', Xylem Series 'D' or Armstrong Type 'AX' stamped 800 kPa (125 psi) operating pressure.
 - .1 Tanks shall be constructed in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code.
 - .2 Tanks shall be all steel construction with integral heavy duty butyl rubber diaphragm.
 - .3 Tanks shall be complete with lifting rings, NPT system connection, built in air pressure gauge, and air inlet connection to facilitate adjusting pre-charge pressure to meet actual system conditions.
 - .4 Tanks shall be complete with saddles.
 - .5 Tanks shall have capacities as indicated in the Expansion Tank Schedule.
- .3 Domestic water expansion tanks:
 - .1 Capacity as indicated in the Expansion Tank Schedule.
 - .2 Lead free.
 - .3 Fixed or replaceable bladder type, or diaphragm type.

EXPANSION TANKS

- .4 Steel tank in-line or stand type as indicated and as per the Drawings or Schedules.
- .5 Certified to NSF/ANSI Standard 61 "Drinking Water System Components – Health Effects."
- .6 Factory pressurized (adjustable) with permanent separation of air and water.
- .7 Suitable for a maximum working pressure of 1034 kPa (150 psi) at 116 deg. C (240 deg. F).
- .8 Constructed and stamped in accordance with the ASME Code Section VIII for Unfired Pressure Vessels.
- .9 Complete with a red oxide primer finish and the following:
 - .1 A NPT stainless steel system connection sized as shown on Drawings.
 - .2 A Schrader air charging valve.
 - .3 A heavy-duty butyl rubber bladder.
 - .4 A polypropylene liner.
 - .5 A built in air pressure gauge.
 - .6 Where replaceable bladder type expansion tank is provided, a tapping for installation of a drain valve.
- .10 Manufacturer:
 - .1 Calefactio, Armstrong, Xylem.
- .4 Water Pressure Reducing Valve: Watts, or Cash Acme, equal to Watts UB5, screwed with low lead bronze body for operating pressures up to 2070 kPa (300 psi) at 71 deg. C (160 deg. F.).
- .5 Upstream from pressure reducing valve, provide backflow prevention in accordance with Section 22 11 13 - PIPES, VALVES, AND FITTINGS (PLUMBING SYSTEMS). Downstream from pressure reducing valve, provide a pressure relief valve. All components of valves in contact with water shall be non-ferrous. Set pressure reducing valve and pressure relief valve in accordance with the system fill pressure and maximum system pressure in the Expansion Tank Schedule, respectively.
- .6 Expansion tanks used for Glycol systems shall not have a cold water make-up connection.

PART 3 - EXECUTION

3.1 Installation

- .1 Expansion tanks shall be self-supporting and shall be placed on 100 mm housekeeping pads.
- .2 Provide 19 mm (3/4 in.) drain line complete with valve to nearest floor drain for replaceable bladder type expansion tanks.
- .3 Pipe pressure relief valve to nearest floor or hub drain for water systems and to glycol make-up package for glycol systems.
- .4 Support expansion tank on angle iron frame welded to base plate anchored to floor with self drilling anchor bolts cross brace with angle irons.

END OF SECTION

UNITARY AIR CONDITIONING UNITS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 Provide low Global Warming Potential (GWP) refrigerant complying with the performance requirements stated within Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 submittals

- .1 Submit Shop Drawings in accordance with Section 20 05 03 - SHOP DRAWINGS. Ensure Shop Drawings include unit Short Circuit Current Rating (SCCR).

PART 2 - PRODUCTS

2.1 Materials

- .1 Provide unitary Air Conditioning Units (UACU) from the following companies, equal to Mitsubishi "Mr. Slim".
 - .1 Mitsubishi
 - .2 Daikin
 - .3 Carrier
 - .4 Samsung
- .2 Provide split system type UACU with minimum two speed indoor evaporator section and remote outdoor compressor/condensing unit.
- .3 Model arrangements shall be as shown, and specified in the Schedules.
- .4 The combination of the evaporator and condensing sections shall be provided with the capacities designated in Schedules.
- .5 Provide unit capable of cooling mode operation in ambient temperatures down to minus 34.4 deg. C. (30 deg. F.).
- .6 Provide unit with room thermostat. Dampers for right angle branch duct take-off from vertical riser shall be Air Vector, Vectrol, or other approved manufacturer.
- .7 Provide unit with filter.
- .8 Provide BACnet interface to the BAS system for monitoring and alarm purposes. At a minimum provide the following information to the BAS.
 - .1 Room temperature and set point
 - .2 System Start / Stop
 - .3 Alarm conditions.
- .9 Unit shall bear a minimum Short Circuit Current Rating (SCCR) listed by a Nationally Recognized Testing Lab, acceptable to the local Authority Having Jurisdiction, and shall be 10,000 A Lower SCCR listed units implying the use of current limiting fuses ahead of them in the field, in lieu of an actual appropriate SCCR rating, are not acceptable.

UNITARY AIR CONDITIONING UNITS

PART 3 - EXECUTION

3.1 Installation

- .1 Install complete refrigeration and controls in accordance with the manufacturer's recommendations.
- .2 Roof mounted condensers shall be complete with feet and secured to 750 mm x 750 mm (30 in. x 30 in.) precast concrete paving slabs.

END OF SECTION

MODULAR PACKAGED AIR-TO-WATER HEAT PUMPS

PART 1 - GENERAL

1.1 Work included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 Provide low Global Warming Potential (GWP) refrigerant complying with the performance requirements stated within Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Related Work Specified Elsewhere

- .1 Provide a galvanized steel structure to support the air-source heat pump(s). Retain the services of a Professional Engineer licenced in the Place of the Work to design the structure. Refer to the Structural Drawings for details of interface with building structure.

1.3 References

- .1 Comply with the following codes and standards:
 - .1 AHRI 550/590 - Performance Rating of Water-Chilling and Heat Pump Water-Heating Packages Using the Vapor Compression Cycle, latest edition.
 - .2 ANSI/ASHRAE Standard 15 - Safety Standard for Refrigeration Systems, latest edition.
 - .3 CSA B52 – Mechanical Refrigeration Code, latest edition.
 - .4 ASME Boiler and Pressure Vessel Code Section VIII, latest edition.
 - .5 ULc or ETLc or CSA listed.

1.4 Submittals

- .1 Submit Shop Drawings for heat pumps in accordance with Section 20 05 03 - SHOP DRAWINGS and incorporate the following information:
 - .1 Heat pump dimensional drawings with elevation overview. Provide required service clearances and location of all field installed piping and electrical connections.
 - .2 Complete unit specifications.
 - .3 A summary of all auxiliary utility requirements for normal system operation. Auxiliary utility requirements include: electrical, water, and air. Include with summary of auxiliary equipment quantity and quality of each specific auxiliary utility required.
 - .4 Shipping and operating weight.
 - .5 Heat pump control documentation: include heat pump control hardware layout, and wiring diagrams depicting factory installed wiring, field installed wiring with points of connection, and points of connection for BAS control/interface points.

MODULAR PACKAGED AIR-TO-WATER HEAT PUMPS

- .6 Provide overall "A" weighted sound pressure levels based on measurements taken 9.14 m (30 ft) from the side of the heat pump. Measurements taken at the control box, opposite to the control box end, or more than 9.14 m (30 ft) from the side of the unit are unacceptable.
- .7 Sequence of operation depicting overview of control logic used, including lead/lag sequencing for multi-unit installations.
- .8 Manufacturer certified performance data at full load and project-specific operating conditions.
- .9 Minimum system volume requirements for each hydronic system.
- .10 Unit Short Circuit Current Rating (SCCR).
- .2 Submit Drawings and Specifications sealed by a Professional Engineer for structural steel support infrastructure.

1.5 Quality Assurance

- .1 Run test the air-source heat pumps at the factory and provide all supporting documentation. Verify as operational all operations, safeties and starter functions.
- .2 Leak test coils at the factory.
- .3 Submit testing report as a Shop Drawing for Contract Administrator's review.

1.6 Delivery And Handling

- .1 Deliver heat pumps to the Place of the Work completely assembled and charged with refrigerant.
- .2 Comply with the manufacturer's instructions for transporting, rigging, and assembly of heat pumps.

1.7 Startup Service And Warranty

- .1 Commence the warranty period at the date of initial start-up, continuing for a period of two (2) years, not to exceed thirty (30) months from shipment. Provide manufacturer's warranty including all parts and labour to install parts. Do not include refrigerant in the warranty.
- .2 Provide parts only coverage for the heat pump compressors for a period of five (5) years from start-up, not to exceed sixty-six (66) months from shipment.
- .3 Provide two running inspections (eight hrs per visit) and one full annual service. Of the two running inspections, provide one during the cooling season and one during the heating season.

PART 2 - PRODUCTS

2.1 Materials

- .1 Provide reversable and single-function (heating-only or cooling-only) air-source heat pumps from JCI/York, MultiStack, Climacool, Aermec, or Trane.
- .2 Provide simultaneous heating and cooling air-source heat pumps from JCI/York, Trane, MultiStack, Aermec, or Climacool.

MODULAR PACKAGED AIR-TO-WATER HEAT PUMPS

- .3 Provide outdoor packaged air-to-water heat pumps with the capacity as noted in the Air-Source Heat Pump Schedule at elevation of the Place of the Work. Provide units complete with all necessary components and accessories to operate in the identified mode.
- .4 Provided independent power and refrigerant circuits for each module within the unit, such that failure or servicing of any one module does not affect the operation of other modules within the unit.
- .5 Assemble each module and components on a rugged steel base not requiring field supplied structural steel support.
- .6 Provide exposed steel surfaces with a powder coat paint finish providing minimum 500 hr salt spray resistance when tested in accordance with ASTM B117 "Standard Practice for Operating Salt Spray (Fog) Apparatus."
- .7 Ship unit with an operating charge of refrigerant.

2.2 Load Water Heat Exchangers:

- .1 Construct brazed plate heat exchangers of 316 stainless steel. Design, test, and stamp in accordance with the refrigerant working pressure and a liquid side pressure of 150 psig (1034 kPa).
- .2 Mount the load heat exchanger at an elevation equal to or lower than the compressor to prevent refrigerant migration.

2.3 Outdoor Heat Exchanger:

- .1 Construct air coils from seamless copper tubes mechanically expanded into aluminum fins with integral sub-cooling or aluminum microchannel coils.
- .2 Provide drain pans for outdoor coils to fully drain water during heating and defrost modes. Provide drain pans that are a sufficient distance from the coils to prevent ice backup. Configure drain pans to permit heat tracing.
- .3 Provide simultaneous heating and cooling units with the ability to operate only as a water to water heat pump, utilizing the outdoor heat exchanger for load imbalances.

2.4 Compressors:

- .1 Provide each module with two (2) hermetic scroll compressors mounted to the module with rubber-in-shear isolators.
- .2 Provide crankcase oil heater and suction strainer.
- .3 Provide high discharge pressure and low suction pressure safety cut-outs.
- .4 Provide factory installed compressor wraps.

2.5 Refrigerant Circuit(s)

- .1 Provide one or two independent refrigerant circuits per module.
- .2 Provide each circuit with an electronic expansion valve, compressor suction and discharge service valves, manual liquid line shutoff valve with charging connection, replaceable core filter drier, liquid line sight glass with moisture indicator, liquid solenoid valve, purge valves, and relief valves.

MODULAR PACKAGED AIR-TO-WATER HEAT PUMPS

- .3 Provide each circuit with two pressure transducers, one for the evaporator and one for the condenser. Output signal directly to the microprocessor control system. Calculated pressure readings are not permitted.
- .4 Provide all refrigerant specialties including a properly sized refrigerant receiver to provide reliable operation down to the design ambient temperature indicated on the Air Source Heat Pump Schedule for each refrigerant circuit.
- .5 Provide reversing valve(s) where required based on operating mode indicated in the Air Source Heat Pump Schedule.

2.6 Insulation

- .1 Insulate the following components with closed-cell, flexible, UV protected, thermal insulation:
 - .1 Refrigerant suction line
 - .2 Load water heat exchangers

2.7 Fans

- .1 Provide minimum one composite material multi-blade axial type fan per refrigeration circuit.
- .2 Provide direct drive fan motors capable of variable speed operation based on refrigerant pressure control.
- .3 Provide fan outlet guard.

2.8 Control And Electrical Panel

- .1 Design heat pumps to operate using 600/3/60 electrical power supply.
- .2 Provide heat pump system with a single point power connection. Include pre-engineered wiring for field installation and connection to a factory mounted heat pump panel. Include panel with individual circuit protection and individual isolation for each module set and provide a single point of connection from the panel to building power. Setup to allow module(s) to be taken out of service while the remainder continue to operate.
- .3 Provide the following power and starting components:
 - .1 Circuit breaker for each compressor and each fan
 - .2 Fusing for the control circuit
 - .3 Compressor and fan starting contactors
 - .4 Solid state compressor sequence start timer
 - .5 Compressor overload protection in all three phases
 - .6 Unit power terminal block for field connection to a single power supply and control power transformer.
- .4 Provide units bearing a minimum Short Circuit Current Rating (SCCR) listed by a Nationally Recognized Testing Lab, acceptable to the local Authority Having Jurisdiction, and rated for 65,000 A. Lower SCCR listed units implying the use of current limiting fuses ahead of them in the field, in lieu of an actual appropriate SCCR rating, are not acceptable.

MODULAR PACKAGED AIR-TO-WATER HEAT PUMPS

2.9 Transformer

- .1 Provide a step-down, dry-type, delta-wye isolation transformer from 600 V to 277/480 V, where required.
- .2 Provide transformer enclosure that is CSA Type 4.
- .3 Provide fused disconnect switch on primary side of the transformer. Provide fuses in accordance with Specification Section 26 28 14 – FUSES LOW VOLTAGE.

2.10 Central Control Systems

- .1 Utilize a microprocessor based control system for precise monitoring and control of the heat pumps based on the leaving load water temperature(s).
 - .1 Designate master and slave unit controllers where multiple modules are provided.
 - .2 Provide an easy to use digital display that provides access to temperatures, pressures, set points, operating states, schedules and alarm messages in plain English.
 - .3 Provide trending for heat pump operating conditions so that the operator can view them from a single keypad/display instead of reading external gauges, thermometers, potentiometers, etc.
 - .4 Provide password protection to guard against unauthorized or accidental set point or parameter changes.
 - .5 Display all temperatures with 0.1 deg C. (0.1 deg. F.) resolution.
 - .6 Display all pressures with 1 kPa (0.1 psi) resolution.
 - .7 Provide CSA Type 4 enclosure.
- .2 Provide master controller that monitors and reports the following for each refrigeration system:
 - .1 High- and low-pressure refrigerant alarms
 - .2 Flow switch alarms for each hydronic system connection
 - .3 Power quality alarm
 - .4 Compressor failure alarm
 - .5 Load water leaving temperature for each hydronic system connection
 - .6 Module operating mode (off, heating, cooling, simultaneous, defrost)
 - .7 Outside air temperature
 - .8 Electronic expansion valve operating position
 - .9 Programmed setpoints and operating states
 - .10 Alarm messages
- .3 Provide the following features for the microprocessor control system:
 - .1 Stage compressor circuits based on the system load via monitoring of load water inlet and outlet temperature. Prioritize simultaneous heating/cooling operation where available.

MODULAR PACKAGED AIR-TO-WATER HEAT PUMPS

- .2 Program individual monitoring of leaving load water temperatures on both heating and cooling heat exchangers from each refrigeration system to protect against freeze-up.
- .3 Alternate the lead compressor periodically to ensure even distribution of compressor run time.
- .4 Start-to-start and stop-to-start timers to limit the frequency of motor starting assuring longer motor life.
- .5 Auto restart after power failure with no external battery backup or auxiliary power supply required for maintaining program memory.
- .6 When a fault or alarm occurs, transfer the load to the next available compressor or circuit. Maintain a history of faults including date and time of day of each fault up to the last 20 occurrences.
- .7 Provide sequence to remove frost from condenser coils based on refrigerant pressure. Maximum of one circuit may enter defrost cycle across all modules at any given time to reduce heating capacity loss.
- .8 Flow switch interlock per load heat exchanger for individual module proof of flow and flow safety.
- .9 Output signal to motorized isolation valves on load heat exchangers.
- .10 Staging and modulation of primary pumps and modulation of load bypass valves to permit operation down to a single module.
- .4 Provide open system communication protocol BACnet as defined in ANSI/ASHRAE Standard 135 "BACnet – A Data Communication Protocol for Building Automation and Control Networks" for seamless integration with Section 23 09 00 – BUILDING AUTOMATION SYSTEM (BAS).
- .5 Provide as a minimum, the following hardware points for direct connection to Section 23 09 00 - BUILDING AUTOMATION SYSTEM (BAS):
 - .1 Heat Pump Enable/Disable
 - .2 Load Water Supply Temperature Set Point(s)
 - .3 Heat Pump General Alarm Status
- .6 Provide microprocessor control system that includes the following safeties and protective devices:
 - .1 Phase loss, phase reversal with under and over voltage protection
 - .2 Motor protection for each compressor
 - .3 Low refrigerant pressure
 - .4 Loss of water flow through the load water heat exchanger
 - .5 High refrigerant pressure
 - .6 High compressor motor temperature
 - .7 Low suction gas temperature
 - .8 Loss of refrigerant charge
 - .9 Expansion valve failure

MODULAR PACKAGED AIR-TO-WATER HEAT PUMPS

.10 Load leaving water temperature out of range

PART 3 - EXECUTION

3.1 Installation

- .1 Install heat pump system in accordance with manufacturer's written installation instructions. Ensure adequate clearances for servicing and maintenance. Provide ancillary components as required per manufacturer's written literature.
- .2 Install units on a flat surface, level within 0.125 mm (1/8 in.), and of sufficient strength to support concentrated loading.
- .3 Install roof-mounted units on a 600 mm (24 in.) high heavy gauge galvanized steel mounting rail system for field assembly on the roof decking prior to unit shipment. Provide rail system that does not permit the accumulation of snow, water, or debris under the heat pump.
- .4 Provide vibration isolation in accordance with Section 20 05 48 – VIBRATION AND NOISE CONTROL.
- .5 Provide all water piping so unit and water circuits are serviceable, without having to dismantle excessive lengths of pipe.
- .6 Provide a fine mesh strainer installed in the hydronic circuit upstream of the load water heat exchangers.
- .7 Provide isolation valves, balancing valves, and flexible connections in water piping connections to each heat exchanger.
- .8 Provide wells and taps for thermometers, sensors, and pressure gauges in water piping adjacent to inlet and outlet connections of each heat exchanger. Provide temperature and pressure gauges.
- .9 Provide drain valves and vent cocks for each heat exchanger.
- .10 Provide vapour proof flow switches in water piping interlocked to the control panel, if not provided by the heat pump manufacturer.
- .11 Provide control valves in water piping and wire to the heat pump control panel in accordance with Section 23 09 00 – BUILDING AUTOMATION SYSTEM (BAS), if not provided by the heat pump manufacturer.
- .12 Provide a galvanized steel structure to support the pipes, valves, etc. independent of the heat pump in accordance with Section 20 05 29 – HANGERS AND SUPPORTS.
- .13 Connect module pre-engineered field wiring as necessary. Provide interconnecting communication wiring between modules.
- .14 Pipe heat pump drain pans to nearest drain.
- .15 Provide electric heat tracing within heat pump drain pan and all drainage piping. Where power for electric heat tracing is not provided by the heat pump manufacturer, provide power from the closest available non-life safety emergency power source as required.
- .16 Provide certified wiring schematics for the heat pump, associated equipment, and controls to the Electrical Division.
- .17 Provide all necessary control wiring as per written requirement of the manufacturer.

MODULAR PACKAGED AIR-TO-WATER HEAT PUMPS

- .18 Provide BAS connection to heat pump control panel under Section 23 09 00 – BUILDING AUTOMATION SYSTEM (BAS).
- .19 Provide the services of a factory authorized service engineer to provide complete start-up supervision. After start-up, have manufacturer's representative provide a minimum of 8 hours of operator training to The City's designated representative(s).
- .20 Transformer, where required:
 - .1 Wire and install the transformer.
 - .2 Provide concrete house keeping pad for mounting of the transformer. Mount the transformer as close to the heat pump as possible.
 - .3 Comply with local Electrical Code rules for transformer installations, including working clearance, clearance from surfaces / objects, overcurrent protection, and primary and secondary conductor (wiring) sizing. Ground transformer X0 point.

END OF SECTION

COILS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 Provide low Global Warming Potential (GWP) refrigerant complying with the performance requirements stated within Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Materials

- .1 Coils: Daikin, Heatcraft, Engineered Air, Aerofin, JCI York or Greenheck, LJ Wing.
- .2 All coils shall have certified AHRI capacities.
- .3 All coils shall be of copper tube, aluminum fin construction with minimum 1.26 mm thick (0.048 in - 18 GSG gauge) galvanized sheet steel casing and galvanized steel angles for heating coils and 1.56 mm thick (0.0625 in - 16 USG gauge) Type 304L stainless steel casing and stainless steel angles for cooling coils. Header shall be copper tube or cast iron.
 - .1 Coils for mounting in ductwork shall have holes in frame for bolting to flanged ductwork.
 - .2 Cooling coils shall have fins spaced not closer than 3.175 mm OC (8 to the in.).
 - .3 Water coils shall have serpentine circuiting arranged for counter flow between the air and water.
 - .4 Coils shall be suitable for 860 kPa (125 psig) water pressure for low pressure systems and suitable for 1720 kPa (250 psi) water pressure for high pressure systems.
 - .5 Coils shall be complete with plugged drain and vent connection, readily accessible.
 - .6 Face velocity shall not exceed 3.81 m/s (750 fpm) for heating coils and 2.54 m/s (500 fpm) for cooling coils.
 - .7 Provide dielectric couplings to ensure galvanic action does not occur between dissimilar metals.
- .4 Refrigerant coils shall provide cooling by the direct expansion of refrigerant inside the tubes. The refrigerant shall be distributed to the various coil circuits through a venturi type distributor having a low pressure drop and arranged for down-feed having male sweat connection. A maximum of 12 refrigerant circuits shall be supplied from a single distributor.
 - .1 Provide two distributors when more than 12 circuits are required. The refrigerant shall be distributed from the multi-outlet distributor to the coil circuits through round seamless copper tubes, 8 mm OD or 6 mm OD (5/16 in. OD or 1/4 in. OD).

COILS

- .2 Refrigerant coils shall be tested at 2070 kPa (300 psi) air pressure under water, cleaned, dehydrated and sealed with a dry nitrogen charge. Coil shall be suitable for working pressures up to 125 kPa (250 psi).
- .3 Where indicated on Drawings, refrigeration coils shall be horizontally split to match the refrigerant system.
- .5 Provide cooling coils in accordance with the Cooling Coil Schedule. All air pressure drops shall be based on wet coils.
- .6 Provide heating coils in accordance with the Heating Coil Schedule.
- .7 Provide all coils with a maximum dry-coil pressure drop of 187 Pa (0.75 in. wg.) at 2.54 m/s (500 fpm).
- .8 Drain pans below each cooling coil shall be fabricated from minimum 0.9525 mm thick (0.0375 in - 20 USS gauge) Type 304L stainless steel sheet and formed stainless steel angles, and shall extend full length of coil, double sloped at a minimum of 2% to prevent standing water with pan projecting beyond the coil. Projections shall be 75 mm (3 in.) on the air inlet side and 300 mm (12 in.) on the air leaving side of the coil. Drain pans shall be welded construction with 50 mm (2 in.) diameter stainless steel nipple for drain connection.
- .9 Cooling coil support racks shall be Type 304L stainless steel.
- .10 Coils for installation with vertical airflow shall be suitable for this orientation. Cooling coils in the vertical airflow orientation to be A-frame and/or suitably angled to prevent condensate bypassing the drain pan.

PART 3 - EXECUTION

3.1 Installation

- .1 Coils shall be pitched and installed as required in the manufacturer's installation instructions. The lowest cooling coil shall be at least 150 mm (6 in.) above the floor of the unit so that it does not sit in water.
- .2 Install blank-off panels between coils and plenums to ensure no air by-pass occurs.
- .3 Install stainless steel drain pan below each cooling coil.

END OF SECTION

WALL FIN CONVECTORS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Submittals

- .1 Shop Drawings: Submit Shop Drawings of unit enclosures, including unit sizes, capacities, connections, and construction details. Clearly show amount of expansion on each section and method of control.
- .2 Mock-up: For each type of custom unit enclosure, install between structural column to structural column, the custom unit enclosure(s) with all piping, valves, finned element, and other incidentals for the Contract Administrator's review. This installation will represent the standard of quality for the remainder of the installed Product; modify as required at no additional cost. Obtain final review of general arrangement for both enclosure and hook-up connection in writing by the Contract Administrator before manufacturing the enclosure for installation.

PART 2 - PRODUCTS

2.1 Materials

- .1 Provide wall fin convectors by Sterling, Dunham-Bush, Engineered Air, Sigma, Rittling or Rosemex.
- .2 Provide wall fin convectors (bare fin or within enclosure) of capacity shown when supplied with water entering at 82.2 deg. C. (180 deg. F.), leaving at 71.1 deg. C. (160 deg. F.) and with air entering at 18.3 deg. C. (65 deg. F.).
- .3 Convector element in finished space within enclosure:
 - .1 Provide element, one or two tiers high, as required to meet capacity indicated on Drawings.
 - .2 Seamless drawn copper tube, 19 mm (3/4 in.), 25 mm (1 in.), or 32 mm (1-1/4 in.) nominal size as shown, expanded on one end for joining without couplings.
 - .3 Aluminum fins, mechanically fastened to copper tubing, maximum spacing 131 fins/m (40 fins/ft), minimum spacing 157 fins/m (48 fins/ft), minimum 0.5 mm (0.020 in.) thickness, size as required to suit enclosure and capacity shown.
 - .4 Common element and enclosure hangers with elements supported to allow for expansion without noise. Support tube and element on maximum 1220 mm (48 in.) centres.
- .4 Convector element in unfinished space, no enclosure:
 - .1 Provide element, one or two tiers high, as required to meet capacity indicated on Drawings.
 - .2 Schedule 40 steel tube, 32 mm (1-1/4 in.) nominal size as shown, threaded both ends.

WALL FIN CONVECTORS

- .3 Steel fins, mechanically fastened to steel tubing, maximum spacing 131 fins/m (40 fins/ft), 108 mm x 108 mm x 0.6 mm (4 in. x 4 in. x 0.024 in.).
- .5 Provide expansion couplings of Slant Fin Hydro - Tite or Amtrol.
- .6 Standard Unit Enclosure:
 - .1 1.2141 mm thick (0.0478 in. - 18 US gauge) prime coated steel for general use.
 - .2 1.52 mm thick (0.0598 in. - 16 US gauge) prime coated steel for use in gymnasiums, weight training rooms, or other similar areas where the room activity may damage the unit.
 - .3 Trim strips and end caps to ensure a neat appearance.
 - .4 Access doors or sections for access to valves, same thickness as enclosure.
 - .5 Louvered or punched type discharge grille continuous between trim strips and end caps.
 - .6 Provide enclosure with flat top unless indicated otherwise.
 - .7 Provide enclosure that is continuous between structural columns, with no space permitted between the column and the enclosure.
 - .8 Where piping connections are shown on the same end of convector, ensure there is sufficient height within the enclosure to be able to include a return pipe (above the fin) with brackets.
- .7 Type A: Enclosure equal to Rittling ETL506, 19mm (3/4 in) copper tube with aluminum fins.
- .8 Type B: Enclosure equal to Rittling ETL508, 19mm (3/4 in) copper tube with aluminum fins.
- .9 Type C: Enclosure equal to Rittling ETL10, 19mm (3/4 in) copper tube with aluminum fins.
- .10 Type D: Enclosure equal to Rittling ETL512, 19mm (3/4 in) copper tube with aluminum fins.
- .11 Type E: Enclosure equal to Rittling FTHL3, 19mm (3/4 in) copper tube with aluminum fins.
- .12 Type F: Custom Unit Enclosure:
 - .1 Suitably reinforce enclosures to withstand a loading of 223 kg/lin.m (150 lbs/lin.ft.). Provide minimum gauges as shown, but not less than 1.5189 mm thick (0.0598 in. - 16 MSG).
 - .2 Construct the enclosure in accordance with the details provided on the Drawings.
 - .3 Provide enclosure that is continuous between structural columns, with no space permitted between the column and the enclosure.
 - .4 Extend the discharge grille from structural column to structural column except for a space for partitioning or support as required and centred on window mullions.
 - .1 Provide discharge grill of linear bar type in accordance with Section 23 37 13 -DIFFUSERS, GRILLES AND REGISTERS.
 - .2 Provide discharge grill of custom shaped louvered or punched type.

WALL FIN CONVECTORS

- .5 Provide a sound barrier partition in the enclosure at each column.
- .6 Fold the sheet metal enclosure wherever possible and weld joints for all folds. Grind all welds smooth. Accurately form mitres, joints and other connections for a true, square and tight fit. Reinforce all corner joints with additional angle brackets so that no holes or imperfections appear after grinding. Fill all holes and remove all burrs or welds that could mar the finished surface.
- .7 Supply enclosure with factory applied finish, electrostatically applied baked epoxy in custom colour selected by the Contract Administrator. Finish enclosure before painting so that no spot welding, burrs and/or brake markings show.
- .8 Where piping connections are shown on the same end of convector, ensure there is sufficient height within the enclosure to be able to include a return pipe (above the fin) with brackets.

PART 3 - EXECUTION

3.1 Installation

- .1 For all spaces requiring heat, provide continuous perimeter heating.
- .2 Unless indicated otherwise, "convector element in finished space within enclosure" and "Standard Unit Enclosure" clauses above apply to perimeter heating.
- .3 Following review and acceptance of custom wall fin convector enclosure mock-up, commence installation of entire system and match quality of accepted mock-up for balance of Work.
- .4 Site measure for each section before fabrication and installation to ensure a correct fit of all components.
- .5 Provide supporting frame to rigidly secure the unit to the wall assembly. Where required, support the top edge from the window mullion as indicated on the Drawings. Coordinate support requirements. Do not perforate the vapour barrier.
- .6 Install finned elements within enclosures so that every section of the perimeter wall below glazing is covered and as required to suit the capacity. Take special care in locating control valves and other such equipment to ensure that the maximum fin element length is obtained.
- .7 Provide manually operated air vent, accessible through access door.

END OF SECTION

UNIT HEATERS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 SUBMITTALS

- .1 Submit Shop Drawings in accordance with Section 20 05 03 - SHOP DRAWINGS.

PART 2 - PRODUCTS

2.1 Materials

- .1 Unit Heaters shall be Dunham-Bush, Engineered Air, Trane, Sigma, Rittling, or Sterling for horizontal or downward air discharge as shown.
- .2 Provide each unit heater complete with:
 - .1 Direct driven propeller fan and motor.
 - .2 Heating coil with copper tubes and aluminum fins
 - .3 Adjustable air outlet diffuser or adjustable louver cone diffuser.
 - .4 Enamel finish prime coated.
 - .5 Manual starter on unit
- .3 Space temperature sensor and controls are specified under Section 23 09 00 BUILDING AUTOMATION SYSTEM (BAS).
- .4 Unit heaters shall have capacities as shown in the Unit Heater Schedule.

PART 3 - EXECUTION

3.1 Installation

- .1 Install in accordance with manufacturer's current installation guidelines.

END OF SECTION

CABINET HEATERS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Materials

- .1 Cabinet Heaters shall be Dunham-Bush, Engineered Air, Trane, Sigma, Rittling, or Sterling.
- .2 Cabinets shall be of type shown and shall be not less than 1.5189 mm thick (0.0598 in. - 16 MSG) steel, prime coated. Provide access to the control specified below with an access panel beside discharge grille.
- .3 Unit shall not vibrate or rattle at any speed.
- .4 Temperature sensor and controls are specified under Section 23 09 00 - BUILDING AUTOMATION SYSTEM.
- .5 Permanent type filters of cleanable aluminum shall be concealed from sight.
- .6 Cabinet heaters shall have capacities as shown (on Drawings) in the Cabinet Heater Schedule when supplied with water entering at 82.2 deg. C. (180 deg. F.) and leaving at 65.6 deg. C. (150 deg. F.) and with air entering at 15.6 deg. C. (60 deg. F.).
- .7 Provide electronically commutated motor (ECM) type motors.

PART 3 - EXECUTION

3.1 Installation

- .1 Install a two-speed fan switch and manual starter inside of wall and floor units. For ceiling mounted units install switch on wall adjacent to unit and install starter on unit. Provide all interconnecting wiring.
- .2 Install in accordance with manufacturer's current installation guidelines.

END OF SECTION

HUMIDIFIERS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 20 05 00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Related Work Specified Elsewhere

- .1 Electrical hard wire supply and primary connections to electrical components, under Electrical Division.

1.3 Submittals

- .1 Submit Shop Drawings in accordance with Section 20 05 03 - SHOP DRAWINGS. Ensure Shop Drawings include unit Short Circuit Current Rating (SCCR).

PART 2 - PRODUCTS

2.1 Materials

- .1 Steam humidifiers shall be of the type designed to inject steam into air handling units, or for injecting steam into ductwork as shown. Industrial applications may use atomizer humidifiers as required.
- .2 The humidifier shall provide absorption characteristics that preclude water accumulation on any surface within 900 mm (36 in.) downstream of the humidifier tube panel. Provide computer-based program confirming absorption distance.
- .3 Humidifiers shall bear a minimum Short Circuit Current Rating (SCCR) listed by a Nationally Recognized Testing Lab, acceptable to the local Authority Having Jurisdiction, and shall be 35,000 A Lower SCCR listed units implying the use of current limiting fuses ahead of them in the field, in lieu of an actual appropriate SCCR rating, are not acceptable.

PART 3 - EXECUTION

3.1 Installation

- .1 Install humidifier in accordance with manufacturers' instructions. Install the system in accordance with recognized industry practices to ensure that humidification systems comply with requirements and serve intended purposes.
- .2 Install all accessories provided with humidifiers in accordance with manufacturers' instructions.
- .3 Provide access space around humidification system components for service as indicated by manufacturer.
- .4 Install piping from automatic drain valve to nearest floor drain. Provide suitable back flow prevention devices as required by local Plumbing Code. Provide drain piping for overflow and drain on steam generators sloped 1 in 25, terminating over floor drain with an air gap.

HUMIDIFIERS

- .5 Provide steam / water coolers on each humidifier drain where condensate tempering is called for above.
- .6 Install flexible hose or rigid pipe between humidifier outlet and steam distribution pipes. Insulate the complete length.
- .7 Provide and install condensate piping from condensate separator to nearest floor drain.
- .8 Mount control cabinet adjacent to the humidifier.
- .9 For Humidifiers, BAS connection to humidifier provided under Section 23 09 00 - BUILDING AUTOMATION SYSTEM (BAS).

END OF SECTION

EQUIPMENT NO.			C-AHU-01		C-MUA-01											
Area Served			Child Care		Child Care											
Location			Roof		Crawlspace											
Supply Fan Designation			C-SF-AHU-01		C-SF-MUA-01											
Related Return Fan			C-RF-AHU-01		N/A											
Related Exhaust Fan			C-EF-AHU-01		N/A											
Related HRV			C-HRV-01		N/A											
Mixing Plenum Required			N/A		N/A											
Pre-filters			MERV 10		N/A											
Final filters			MERV 14		MERV 8											
Specialty filters			N/A		N/A											
Face and Bypass Section			N/A		N/A											
Auditorium Bypass Section			N/A		N/A											
Preheat Coil			N/A		N/A											
Heating Coil			C-EHC-AHU-01		C-EHC-MUA-01											
Reheat Coil			N/A		N/A											
Pre-Cooling Coil			N/A		N/A											
Cooling Coil			C-CC-AHU-01		N/A											
Humidifier			N/A		N/A											
Condensing Unit			C-CU-AHU-01		N/A											
GENERAL DIMENSIONS																
[Co-ordinate with drawings]																
Length	mm	in.	10607.7	418	2753.0	108		--		--		--		--		--
Width	mm	in.	4368.8	172	695.0	27		--		--		--		--		--
Height	mm	in.	1651.0	65	756.0	30		--		--		--		--		--
Equipment Weight	kg	lbs.	33000.0	15,000.0	259.5	572.0		--		--		--		--		--
Remarks																

C-AHU-01						
Ventilation Zone	Area (ft²):	Population:	CFM/Person	CFM/ft²	Ez	Outdoor Air (CFM):
pre-school 1	703	16	10	0.18	0.8	358
pre-school 2	710	16	10	0.18	0.8	360
pre-school 3	710	16	10	0.18	0.8	360
pre-school 4	744	16	10	0.18	0.8	367
pre-school 5	688	16	10	0.18	0.8	355
pre-school 6	700	16	10	0.18	0.8	358
pre-school 7	720	16	10	0.18	0.8	362
pre-school 8	737	16	10	0.18	0.8	366
Infant room 1	604	8	10	0.18	0.8	236
Infant room 2	602	8	10	0.18	0.8	235
Infant room 3	603	8	10	0.18	0.8	236
Infant room 4	597	8	10	0.18	0.8	234
Infant room 5	565	8	10	0.18	0.8	227
Infant room 6	577	8	10	0.18	0.8	230
general storage 104	196	0	5	0.06	0.8	15
general storage 144	73	0	5	0.06	0.8	5
staff room	532	12	5	0.06	0.8	115
childcare entry	392	0	0	0.06	0.8	29
admin office	267	2	5	0.06	0.8	33
director's office	140	1	5	0.06	0.8	17
corridor C101	1710	0	0	0.06	0.8	128
Corridor C140	1145	0	0	0.06	0.8	86
Kitchen Childcare	341	1	7.5	0.12	0.8	61
Kitchen storage	105	0	5	0.06	0.8	8
Total (80% Diversity Factor)						3824

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EQUIPMENT NO.			C-CC-AHU-01													
Location			C-AHU-01													
Airflow Rate	cfm	L/s	12,000	5,664		--		--		--		--		--		--
Number of Coils																
Width	In	mm	105	2,657		--		--		--		--		--		--
Height	In	mm	51	1,297		--		--		--		--		--		--
Area	ft²	m²	37.4	3.5		--		--		--		--		--		--
Face velocity	fpm	m/s	321.0	1.6		--		--		--		--		--		--
Type			DX													
Minimum Rows			3													
Fins per inch			9													
Series																
AIR SIDE																
Entering Air Temperature (db)	°F	°C	76.0	24.4		--		--		--		--		--		--
Entering Air Temperature (wb)	°F	°C	64.3	17.9		--		--		--		--		--		--
Leaving Air Temperature (db)	°F	°C	54.9	12.7		--		--		--		--		--		--
Leaving Air Temperature (wb)	°F	°C	52.6	11.4		--		--		--		--		--		--
Air Pressure Drop	In H2O	Pa	0.11	126.0		--		--		--		--		--		--
FLUID SIDE																
Fluid			R-454B													
Entering Fluid Temperature	°F	°C		--		--		--		--		--		--		--
Leaving Fluid Temperature	°F	°C		--		--		--		--		--		--		--
MINIMUM CAPACITY																
Total	MBH	kW	416.8	122.1		--		--		--		--		--		--
Sensible	MBH	kW	274.2	80.3		--		--		--		--		--		--
Latent	MBH	kW	142.6	41.8		--		--		--		--		--		--
Turbulators			No													
REMARKS																

EQUIPMENT NO.			C-DHWH-01		C-DHWH-02											
Make			AO Smith		AO Smith											
Model			DVE-52-18 Gold Xi		DVE-52-18 Gold Xi											
Size																
Storage Capacity	USgal	L	189	715	189	715		--		--		--		--		--
Recovery @ 100°F Rise	GPH	LPH	74.0	280	74.0	280		--		--		--		--		--
Entering Water Temperature	°F	°C	40.0	4.4	40.0	4.4		--		--		--		--		--
Leaving Water Temperature	°F	°C	140.0	60.0	140.0	60.0		--		--		--		--		--
Gas Pressure	psig	kPa		--		--		--		--		--		--		--
Steam Pressure	psig	kPa		--		--		--		--		--		--		--
Steam Flow Rate	Lb/hr	Kg/hr		--		--		--		--		--		--		--
ELECTRICAL DATA																
Number of Elements			3.0		3.0											
Max kW per Element	KW		6.0		6.0											
Total kW	KW		18		18											
Volt/Phase/Cycle			600/3/60		600/3/60											
Motor	hp	kW		--		--		--		--		--		--		--
Remarks																
EQUIPMENT NO.																
Make																
Model																
Size																
Storage Capacity	USgal	L		--		--		--		--		--		--		--
Recovery	GPH	LPH		--		--		--		--		--		--		--
Entering Water Temperature	°F	°C		--		--		--		--		--		--		--
Leaving Water Temperature	°F	°C		--		--		--		--		--		--		--
Gas Pressure	psig	kPa		--		--		--		--		--		--		--
Steam Pressure	psig	kPa		--		--		--		--		--		--		--
Steam Flow Rate	Lb/hr	Kg/hr		--		--		--		--		--		--		--
ELECTRICAL DATA																
Number of Elements																
Max kW per Element	KW															
Total kW	KW															
Volt/Phase/Cycle																
Motor	hp	kW		--		--		--		--		--		--		--
Remarks																

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EQUIPMENT NO.			C-SF-AHU-01		C-RF-AHU-01		C-EF-AHU-01		C-SF-MUA-01		C-EF-01		C-EF-02		C-EF-3		C-EF-A	
System			Supply Fan		Return Fan		Exhaust Fan		Crawlpace Supply Fan		Crawl Space Exhaust		Kitchen Exhaust Fan		Garbage Room Exhaus		Laundry Exhaust	
Location			C-AHU-01		C-AHU-01		C-AHU-01		C-MUA-01		Crawl Space		Roof		Garbage Room		Near Dryer	
Service													Kitchen Hood Exhaust		Garbage Exhaust		Laundry Booster	
Airflow Rate	cfm	L/s	12,000	5,664	8,000	3,776	4,000	1,888	1,200	566	1,200	566	196	93	300	142	196	93
External Static Pressure	In H2O	Pa	2.0	497	2.0	497	2.0	497	0.5	124	0.5	124	0.4	99	0.3	75	0.4	99
Total Static Pressure	In H2O	Pa	5.3	1,323	2.2	557	4.3	1,057	0.6	138	0.5	124		--	0.3	75		--
Brake	hp	kW	5.32	3.97	2.24	1.67	4.12	3.07	0.42	0.31	0.25	0.19		--	0.07	0.05		--
Motor	hp	kW	9.86	7.35	9.86	7.35	9.86	7.35	1.00	0.75	0.25	0.19	0.10	0.07	0.10	0.07	0.10	0.07
SOUND DATA																		
2nd Band	Inlet	Outlet	74	81	64	71	67	74	74		75	77						
3rd Band	Inlet	Outlet	80	85	70	75	73	78	73		74	68						
4th Band	Inlet	Outlet	80	88	70	78	73	81	69		72	66						
5th Band	Inlet	Outlet	82	88	72	78	75	81	67		67	62						
Make			Rosenberg		Rosenberg		Rosenberg		Thermotek		Greenheck				Greenheck		Reversomatic	
Model			GKHM-CII		GKHM-CII		GKHM-CII		T1-E.765-15D		SQ-100				CSP-A390-VG		TLD-200ES	
Type											Inline Exhaust Fan				Inline Exhaust Fan		Inline Dryer Fan	
Size			500		500		500										200ES	
RPM			1999		1449		1823		1418		1725				1202		2500	
Variable Inlet Vanes	Yes/No		No		No		No		No		No		No		No		No	
Variable Frequency Drive	Yes/No		Yes		Yes		Yes		Yes		No		No		No		No	
Fan Efficiency		%																
Remarks													Type 2 Exhaust Hood c/w Roof Curb and Isolation Kit		120/1/60		120/1/60 Disconnect Current Sensor to Appliance	

EQUIPMENT NO.			C-EHC-AHU-01		C-EHC-MUA-01											
Location																
Airflow Rate	cfm	L/s	12,000	5,664	1,200	566		--		--		--		--		--
Number of Coils																
Width	In	mm	105	2,657		--		--		--		--		--		--
Height	In	mm	51	1,297		--		--		--		--		--		--
Area	ft²	m²	37.4	3.5		--		--		--		--		--		--
Face velocity	fpm	m/s	321.0	1.6		--		--		--		--		--		--
Type			Electric		Electric											
Minimum Rows																
Fins per inch																
Series																
AIR SIDE																
Entering Air Temperature (db)	°F	°C	37.0	2.8	-31.0	-35.0		--		--		--		--		--
Leaving Air Temperature (db)	°F	°C	65.0	18.3	55.0	12.8		--		--		--		--		--
Air Pressure Drop	In H2O	KPa	0.1	0.02	0.1	0.02		--		--		--		--		--
FLUID SIDE																
Fluid			N/A		N/A											
Entering Fluid Temperature	°F	°C		--		--		--		--		--		--		--
Leaving Fluid Temperature	°F	°C		--		--		--		--		--		--		--
MINIMUM CAPACITY																
Total	MBH	kW	443.7	130.0	112.0	32.8		--		--		--		--		--
Turbulators	Yes/No		N/A		N/A											
REMARKS																

EQUIPMENT NO.			C-HRV-01															
System			Ventilation															
Location			Roof															
Service			Ventilation															
Airflow Rate	cfm	L/s	4,000		1,888													
Width	in	mm			--													
Height	in	mm			--													
Area	ft2	m2			--													
Face velocity	fpm	m/s	437		2.2													
			Supply															
			Summer				Winter											
Units			°F	°C	°F	°C												
Entering Air Temperature (db)			86.0	30.0	-31.0	-35.0												
Entering Air Temperature (wb)			73.0	22.8	-31.0	-35.0												
Leaving Air Temperature (db)			77.2	25.1	61.7	16.5												
Leaving Air Temperature (wb)			67.0	19.4	47.6	8.7												
			Exhaust															
			Summer				Winter											
Units			°F	°C	°F	°C												
Entering Air Temperature (db)			75.0	23.9	72.0	22.2												
Entering Air Temperature (wb)			62.6	17.0	54.0	12.2												
Leaving Air Temperature (db)			83.8	28.8	-20.7	-29.3												
Leaving Air Temperature (wb)			69.2	20.7	-20.7	-29.3												
Heat Recovery Effectiveness																		
Sensible	%		80.2		90.0													
Latent	%		50.4		78.6													
MINIMUM CAPACITY																		
			Supply															
			Summer		Winter													
Units			MBH	kW	MBH	kW												
Total			89.8	26.3	473.1	138.6												
Sensible			--		--													
Latent			--		--													
Air Pressure Drop	In H2O	Pa	0.40	99.5	0.40	99.5												
Make			Engineered Air															
Model			LM4/O/HRRF/MV															
Remarks																		

EQUIPMENT NO.			C-P-GW-01	C-P-GW-02	C-P-GW-03	C-P-GW-04	C-P-DHWR-01			
System			Ground Water	Ground Water	Ground Water	Ground Water	Domestic Water			
Location			Sump Pit 1	Sump Pit 1	Sump Pit 2	Sump Pit 2	Mechanical Room			
Service			Ground Water	Ground Water	Ground Water	Ground Water	DHW Recirc			
Fluid			Water	Water	Water	Water	Domestic Hot Water			
Fluid Flow	USgpm	L/min	18 68	18 68	18 68	18 68	20 76		--	--
Head	ft H2O	kPa	10.00 29.84	10.00 29.84	10.00 29.84	10.00 29.84	8.00 23.87		--	--
Brake	hp	kW	0.28 0.21	0.28 0.21	0.28 0.21	0.28 0.21	0.08 0.06		--	--
Motor	hp	kW	0.33 0.25	0.33 0.25	0.33 0.25	0.33 0.25	0.09 0.07		--	--
RPM			1750	1750	1750	1750	2480			
Make			Bell & Gosset	Bell & Gosset	Bell & Gosset	Bell & Gosset	Bell & Gossett			
Model			WIZE-FA56F312	WIZE-FA56F312	WIZE-FA56F312	WIZE-FA56F312	Ecocirc XL 46-45			
Variable Frequency Drives	Yes / No		No	No	No	No	No			
Pump Efficiency	%		48.1	48.1	48.1	48.1				
Remarks			Lead/lag Operation. Pumps operate from a single controller and float set		Lead/lag Operation. Pumps operate from a single controller and float set		ECM Circulator			
EQUIPMENT NO.										
System										
Location										
Service										
Fluid										
Fluid Flow	USgpm	L/min		--		--		--	--	--
Head	ft H2O	kPa		--		--		--	--	--
Brake	hp	kW		--		--		--	--	--
Motor	hp	kW		--		--		--	--	--
RPM										
Make										
Model										
Variable Frequency Drives	Yes / No									
Pump Efficiency	%									
Remarks										

EQUIPMENT NO.			C-AC-01		C-AC-02		C-AC-03		NOT USED		NOT USED		NOT USED		NOT USED		
Make			SAMSUNG		SAMSUNG		SAMSUNG										
Model			AC024DNADCG/AA		AC018DNADCG/AA		AC024DNADCG/AA										
Cooling Capacity	MBH	kW	24.0	7	18.0	5	24.0	7		--		--		--		--	
Heating Capacity	MBH	kW	N/A	0	N/A	0	N/A	0		--		--		--		--	
Working Fluid			R-32		R-32		R-32										
SEER2			19.1		21		19.1										
Airflow (L/M/H)			466/537/629		441/540/615		466/537/629										
REMARKS			Connected to/powerd by C-CU-01		Connected to/powerd by C-CU-02		Connected to/powerd by C-CU-03										
EQUIPMENT NO.			C-CU-01		C-CU-02		C-CU-03		NOT USED		NOT USED		NOT USED		NOT USED		
Make			SAMSUNG		SAMSUNG		SAMSUNG										
Model			AC024DXSCCF/AA		AC018DXSCCF/AA		AC024DXSCCF/AA										
Cooling Capacity	MBH	kW	24.0	7	18.0	5	24.0	7		--		--		--		--	
Heating Capacity	MBH	kW	N/A	0	N/A	0	N/A	0		--		--		--		--	
Working Fluid			R-32		R-32		R-32										
SEER2			19.1		19.1		19.1										
ELECTRICAL DATA																	
Volts/Phase/Cycle			208/1/60		208/1/60		208/1/60										
REMARKS			Connected to C-AC-01		Connected to C-AC-02		Connected to C-AC-03										

EQUIPMENT NO.			R-AHU-01		R-AHU-02		R-AHU-03		R-AHU-04							
Area Served			Gymnasium		Office Lobby /Multi Purpose		Fitness Centre		Changerooms							
Location																
Supply Fan Designation			R-SF-AHU-01		R-SF-AHU-02		R-SF-AHU-03		R-SF-AHU-04							
Related Return Fan			R-RF-AHU-01		R-RF-AHU-02		R-RF-AHU-03									
Related Exhaust Fan					R-EF-AHU-02		R-EF-AHU-03		R-EF-AHU-04							
Air Blender																
Mixing Plenum Required																
Pre-filters			MERV 10		MERV 10		MERV 10		MERV 10							
Final filters			MERV 14		MERV 14		MERV 14		MERV 14							
Specialty filters																
Face and Bypass Section			N/A		N/A		N/A		N/A							
Auditorium Bypass Section			N/A		N/A		N/A		N/A							
Preheat Coil			N/A		N/A		N/A		N/A							
Heating Coil			R-HC-AHU-01		R-HC-AHU-02		R-HC-AHU-03		R-HC-AHU-04							
Reheat Coil																
Pre-Cooling Coil			R-CCP-AHU-01		R-CCP-AHU-02		R-CCP-AHU-03		R-CC-AHU-04							
Post-Cooling Coil			R-CCS-AHU-01		R-CCS-AHU-02		R-CCS-AHU-03		N/A							
Humidifier			R-H-AHU-01		N/A		R-H-AHU-03		N/A							
GENERAL DIMENSIONS [Co-ordinate with drawings]																
Length	mm	in.	10312.4	406	9398.0	370	5664.2	223	9017.0	355		--		--		--
Width	mm	in.	2362.2	93	1752.6	69	1320.8	52	3378.2	133		--		--		--
Height	mm	in.	1676.4	66	1092.2	43	914.4	36	1651.0	65		--		--		--
Equipment Weight	kg	lbs.	6363.6	14,000.0	5909.1	13,000.0	3181.8	7,000.0	6818.2	15,000.0		--		--		--
Remarks																

EQUIPMENT NO.			R-ASHP-01				R-ASHP-02							
Make			AERMEC				AERMEC							
Model			NYP1000X°J80000°				NYP1000X°J80000°							
Unit Configuration			Simultaneous Heat/Cool				Simultaneous Heat/Cool							
Modules Per Unit (Modular Units)														
Compressors / Circuits Per Unit			4/2				4/2							
COP @ Design Conditions	Cooling	Heating	2.9		2.1		2.9		2.1					
Fluid Type			50% P. Glycol				50% P. Glycol							
COOLING CIRCUIT			Summer		Simultaneous		Summer		Simultaneous					
Design Ambient Temp	°F	°C	88.0	31.1	88.0	31.1	88.0	31.1	88.0	31.1		--		--
Capacity	Tons		77		70		77		70					
Input Power	kW	hp	92.4	125.0	88.8	119.0	92.4	125.0	88.8	119.0	--		--	
Water Flow Rate	USgpm	L/min	210.0	795	210.0	795	210.0	795	210.0	795		--		--
Entering Water Temperature	°F	°C	52.0	11.1	51.0	10.6	52.0	11.1	51.0	10.6		--		--
Leaving Water Temperature	°F	°C	42.0	5.6	42.0	5.6	42.0	5.6	42.0	5.6		--		--
Water Pressure Drop	Ft. H2O	kPa	12.5	37.3	12.5	37.3	12.5	37.3	12.5	37.3		--		--
Fouling Factor	°F.ft².h/Btu		0.0001		0.0001		0.0001		0.0001					
Pressure Rating	PSI	kPa	--		--		--		--		--		--	
HEATING CIRCUIT			Winter		Simultaneous		Winter		Simultaneous					
Design Ambient Temp	°F	°C	-4.0	-20.0	-4.0	-20.0	-4.0	-20.0	-4.0	-20.0		--		--
Capacity	MBH		646		1189		646		1189					
Input Power	kW	hp	90.1	120.9	88.8	119.0	90.1	120.9	88.8	119.0	--		--	
Water Flow Rate	USgpm	L/min	112	422	112	424	112	422	112	424		--		--
Entering Water Temperature	°F	°C	97.0	36.1	89.0	31.7	97.0	36.1	89.0	31.7		--		--
Leaving Water Temp	°F	°C	110.0	43.3	110.0	43.3	110.0	43.3	110.0	43.3		--		--
Water Pressure Drop	Ft. H2O	kPa	2.8	8.5	2.8	8.5	2.8	8.5	2.8	8.5		--		--
Fouling Factor	°F.ft².h/Btu		0.0001		0.0001		0.0001		0.0001					
Pressure Rating	PSI	kPa	--		--		--		--		--		--	
SOUND DATA	dB													
125 Hz	dB		97.5				97.5							
250 Hz	dB		86.2				86.2							
500 Hz	dB		88.6				88.6							
1000 Hz	dB		85.3				85.3							
2000 Hz	dB		79.6				79.6							
4000 Hz	dB		72.1				72.1							
8000 Hz	dB		66.1				66.1							
ELECTRICAL DATA														
Voltage			575/3/60				575/3/60							
FLA	Amp													
MCA	Amp		175				175							
MOCP	Amp		175				175							
Harmonic Filter	Yes/No		No				No							
Length	mm	in.	3970		156		3970		156					
Width	mm	in.	2200		87		2200		87					
Height	mm	in.	2450		96		2450		96					
Operating Weight	kg	lbs.	3610		7959		3610		7959					
REMARKS			c/w vibration isolation, drain pan heater, and				c/w vibration isolation, drain pan heater, and							
			trace for condensate piping				trace for condensate piping							

R-AHU-01

Ventilation Zone	Area (ft^2):	Population:	CFM/Person	CFM/ft^2	Ez	Outdoor Air (CFM):
z101-p gym storage 4	1226	0	0	0.12	0.8	184
z102-p court 1	216	0	20	0.18	0.8	49
z103-p gym storage 3	529	0	0	0.12	0.8	79
z104-p court 3	386	0	20	0.18	0.8	87
z106 - court 1	8664	50	20	0.18	0.8	3199
z107 court 2	8620	50	20	0.18	0.8	3190
z108 court 3	8758	50	20	0.18	0.8	3221
z109 gym storage 2	160	0	0	0.12	0.8	24
z110 bench storage	1190	0	0	0.12	0.8	179
z111 gym storage 1	311	0	0	0.12	0.8	47
z112 gym show/coats	3420	0	20	0.18	0.8	770
z201-p Running track	3875	3	20	0.18	0.8	947
z202-p Running track	1353	0	20	0.18	0.8	304
z203-p Running track storage	202	0	0	0.12	0.8	30
z204 Running track	3769	3	20	0.18	0.8	923
z205 Running Track	1602	3	20	0.18	0.8	435
Total: (80% Diversity Factor)						10934

R-AHU-03

Ventilation Zone	Area (ft^2):	Population:	CFM/Person	CFM/ft^2	Ez	Outdoor Air (CFM):
z221-p Fitness room	224	1	20	0.06	0.8	42
z222-p Fitness room	275	1	20	0.06	0.8	46
z223-p Fitness room maintenance	195	1	5	0.06	0.8	21
z224-p Fitness room	1161	17	20	0.06	0.8	512
z225-p Fitness room	780	14	20	0.06	0.8	409
z226-p Corridor	128	0	0	0.06	0.8	10
z227-p Prayer Wellness room	210	1	5	0.06	0.8	22
z228-p Movement Studio Storage	136	0	5	0.06	0.8	10
z229-p Movement studio	863	6	20	0.06	0.8	215
z230- Movement Studio	542	4	20	0.06	0.8	141
z231 Prayer Wellness room	142	1	5	0.06	0.8	17
z232 Elevator lobby	662	0	0	0.06	0.8	50
z233 Corridor	399	0	0	0.06	0.8	30
z235 Fitness room Shoe coats	799	1	5	0.06	0.8	66
z236 Fitness room	1367	9	20	0.06	0.8	328
z237 - Fitness room	2041	14	20	0.06	0.8	503
z242-p Fitness room shoe coats	732	5	5	0.06	0.8	86
Total (90% Diversity Factor):						2004

R-AHU-02

Ventilation Zone	Area (ft^2):	Population:	CFM/Person	CFM/ft^2	Ez	Outdoor Air (CFM):
z113-p L MPR Storage	122	0	0	0.12	0.8	18
z114-p L MPR 1	560	24	5	0.06	0.8	192
z115-p L MPR 2	874	36	5	0.06	0.8	291
z116-p L MPR servery	220	1	5	0.06	0.8	23
z117-p Family space	228	2	5	0.06	0.8	30
z118 Family space	247	2	5	0.06	0.8	31
z119 MPR Servery	227	1	5	0.06	0.8	23
z120 LMPR 2	1266	60	5	0.06	0.8	470
z121 L MPR Storage 2	400	0	0	0.12	0.8	60
z122 L MPR Partition Storage	46	0	0	0.12	0.8	7
z123 L MPR 1	734	24	5	0.06	0.8	205
z124 Food concession	205	1	7.5	0.12	0.8	40
z125 Food concession storage	110	0	0	0.12	0.8	17
z128-p Lobby	430	1	5	0.06	0.8	39
z130-p Lobby	307	1	5	0.06	0.8	29
z147- Lobby	600	4	5	0.06	0.8	70
z146- Reception/cash office	488	3	5	0.06	0.8	55
z145-Corridor L1	640	0	0	0.06	0.8	48
z126-Corridor L1	1592	0	0	0.06	0.8	119
z138-Corridor L1	1577	0	0	0.06	0.8	118
z131-131-p Recreation Staff Room	341	6	5	0.06	0.8	63
z132-Admin Entry/storage	444	0	0	0.06	0.8	33
z132-Recreation services offices	667	8	5	0.06	0.8	100
z136-Child care connection	138	0	0	0.06	0.8	10
z137 -Corridor L1	1595	0	0	0.06	0.8	120
135-MPR Team Room	869	24	5	0.06	0.8	215
z206-p MPR Craft Room L2	466	12	10	0.12	0.8	220
z207-p MPR Classroom L2	415	13	10	0.12	0.8	225
z210-p MPR Living room L2	435	6	5	0.06	0.8	70
z211 MPR Living room L2	406	6	5	0.06	0.8	68
z214 Classroom L2	390	12	10	0.12	0.8	209
z215 Craft Room L2	475	12	10	0.12	0.8	221
z219-p Corridor L2	163	0	0	0.06	0.8	12
z220 Corridor L2	1160	0	0	0.06	0.8	87
Total: (80% Diversity Factor)						2830

EQUIPMENT NO.			R-BLR-01		R-BLR-02		R-BLR-03									
Make			Viessmann		Viessmann		Viessmann									
Model			Vitocrossal 200 CL2		Vitocrossal 200 CL2		Vitocrossal 200 CL2									
Output	MBh		980		980		980									
Working Pressure	psig	kPa	80	552	80	552	80	552		--		--		--		--
Entering Water Temperature	°F	°C	110.0	43.3	110.0	43.3	110.0	43.3		--		--		--		--
Leaving Water Temperature	°F	°C	95.0	35.0	95.0	35.0	95.0	35.0		--		--		--		--
FUEL																
Gas Pressure	psig	kPa	4-14" WC	0	4-14" WC	0	4-14" WC	0		--		--		--		--
Equipment Weight	Lbs	kg	963	437	963	437	963	437		--		--		--		--
EFFICIENCY																
Thermal Efficiency	%		98.00		98.00		98.00									
Remarks			10:1 Turndown		10:1 Turndown		10:1 Turndown									
			Back-up Heat		Back-up Heat		Back-up Heat									
			Direct Vent		Direct Vent		Direct Vent									
			c/w acid neutralizer kit		c/w acid neutralizer kit		c/w acid neutralizer kit									
EQUIPMENT NO.																
Make																
Model																
Output																
Working Pressure	psig	kPa		--		--		--		--		--		--		--
Entering Water Temperature	°F	°C		--		--		--		--		--		--		--
Leaving Water Temperature	°F	°C		--		--		--		--		--		--		--
FUEL																
Gas Pressure	psig	kPa		--		--		--		--		--		--		--
Equipment Weight	Lbs	kg		--		--		--		--		--		--		--
EFFICIENCY																
Thermal Efficiency	%															
Remarks																

EQUIPMENT NO.			R-CCP-AHU-01		R-CCP-AHU-02		R-CCP-AHU-02		R-CCP-AHU-03		R-CCP-AHU-03		R-CC-AHU-04			
Location			R-AHU-01		R-AHU-02		R-AHU-02		R-AHU-03		R-AHU-03		R-AHU-04			
Airflow Rate	cfm	L/s	21,000	9,912	17,000	8,024	17,000	8,024	8,700	4,106	8,700	4,106	4,000	1,888	--	--
Number of Coils			2		1		1		1		1		1			
Width	In	mm	70	1,778	109	2,769	109	2,769	62	1,575	62	1,575	35	889	--	--
Height	In	mm	44	1,105	45	1,143	45	1,143	41	1,029	41	1,029	35	876	--	--
Area	ft²	m²	21.1	2.0	34.1	3.2	34.1	3.2	17.4	1.6	17.4	1.6	8.4	0.8	--	--
Face velocity	fpm	m/s	497.0	2.5	499.0	2.5	499.0	2.5	499.0	2.5	499.0	2.5	477.0	2.4	--	--
Type			Hydronic		Hydronic		Hydronic		Hydronic		Hydronic		Hydronic			
Minimum Rows			8		2		5		12		12		8			
Fins per inch			11		13		13		8		9		9			
Series																
AIR SIDE																
Entering Air Temperature (db)	°F	°C	76.7	24.8	75.4	24.1	65.0	18.3	75.8	24.3	53.0	11.7	77.7	25.4	--	--
Entering Air Temperature (wb)	°F	°C	65.8	18.8	63.6	17.6	60.0	15.5	67.7	19.8	53.0	11.7	67.1	19.5	--	--
Leaving Air Temperature (db)	°F	°C	55.0	12.8	65.0	18.3	54.2	12.3	53.0	11.7	48.0	8.9	55.0	12.8	--	--
Leaving Air Temperature (wb)	°F	°C	55.0	12.8	60.0	15.5	54.1	12.3	53.0	11.7	48.0	8.9	54.9	12.7	--	--
Air Pressure Drop	In H2O	Pa	1.40	348.2	0.19	47.3	1.08	268.6	1.72	427.8	1.87	465.1	1.17	291.0	--	--
FLUID SIDE																
Fluid			50% P. Glycol		50% P. Glycol		50% P. Glycol		50% P. Glycol		50% P. Glycol		50% P. Glycol			
Fluid Flow Rate	USgpm	L/min	79.7	301.8	44.5	168.4	65.4	247.5	90.2	341.4	30.0	113.6	35.6	134.8	--	--
Entering Fluid Temperature	°F	°C	42.0	5.6	42.0	5.6	42.0	5.6	42.0	5.6	42.0	5.6	42.0	5.6	--	--
Leaving Fluid Temperature	°F	°C	52.0	11.1	52.0	11.1	52.0	11.1	52.0	11.1	52.0	11.1	52.0	11.1	--	--
Fluid Pressure Drop	ft H2O	kPa	16.0	48	12.9	39	46.4	139	19.5	58	19.1	57	19.2	57	--	--
MINIMUM CAPACITY																
Total	MBH	kW	349.0	102.3	195.0	57.1	284.0	83.2	395.0	115.7	109.5	32.1	151.7	44.4	--	--
Sensible	MBH	kW	251.5	73.7	195.0	57.1	203.0	59.5	220.0	64.5	47.8	14.0	100.4	29.4	--	--
Latent	MBH	kW	97.5	28.6	0.0	--	81.0	23.7	175.0	51.3	61.7	18.1	51.3	15.0	--	--
Turbulators			Yes		Yes		Yes		Yes		Yes		Yes			
REMARKS			AHU-01 Cooling Coil		AHU-02 Primary cooling coil		AHU-02 Secondary cooling coil		AHU-03 Primary cooling coil		AHU-03 Secondary cooling coil		AHU-04 Cooling Coil			

EQUIPMENT NO.			R-DHWH-01		R-DHWH-02		R-DHWH-03									
Make			AO Smith		AO Smith		AO Smith									
Model			DVE-120-24 Gold Xi		DVE-120-24 Gold Xi		DVE-120-24 Gold Xi									
Size			450L		450L		450L									
Storage Capacity	USgal	L	450	1,703	450	1,703	450	1,703		--		--		--		--
Recovery @ 100°F Rise	GPH	LPH	98.0	29	98.0	29	98.0	29		--		--		--		--
Entering Water Temperature	°F	°C	40.0	4.4	40.0	4.4	40.0	4.4		--		--		--		--
Leaving Water Temperature	°F	°C	140.0	60.0	140.0	60.0	140.0	60.0		--		--		--		--
Gas Pressure	psig	kPa		--		--		--		--		--		--		--
Steam Pressure	psig	kPa		--		--		--		--		--		--		--
Steam Flow Rate	Lb/hr	Kg/hr		--		--		--		--		--		--		--
ELECTRICAL DATA																
Number of Elements			6.0		6.0		6.0									
Max kW per Element	KW		4.0		4.0		4.0									
Total kW	KW		24		24		24									
Volt/Phase/Cycle			600/3/60		600/3/60		600/3/60									
Motor	hp	kW		--		--		--		--		--		--		--
Remarks			Electric		Electric		Electric									
EQUIPMENT NO.																
Make																
Model																
Size																
Storage Capacity	USgal	L		--		--		--		--		--		--		--
Recovery	USgal	L		--		--		--		--		--		--		--
Entering Water Temperature	°F	°C		--		--		--		--		--		--		--
Leaving Water Temperature	°F	°C		--		--		--		--		--		--		--
Gas Pressure	psig	kPa		--		--		--		--		--		--		--
Steam Pressure	psig	kPa		--		--		--		--		--		--		--
Steam Flow Rate	Lb/hr	Kg/hr		--		--		--		--		--		--		--
ELECTRICAL DATA																
Number of Elements																
Max kW per Element	KW															
Total kW	KW															
Volt/Phase/Cycle																
Motor	hp	kW		--		--		--		--		--		--		--
Remarks																

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EQUIPMENT NO.			R-SF-AHU-01		R-SF-AHU-02		R-SF-AHU-03		R-SF-AHU-04		R-RF-AHU-01		R-RF-AHU-02		R-RF-AHU-03		R-EF-AHU-02	
System			Supply Fan		Supply Fan		Supply Fan		Supply Fan		Return Fan		Return Fan		Return Fan		Exhaust Fan	
Location			R-AHU-01		R-AHU-02		R-AHU-03		R-AHU-04		R-AHU-01		R-AHU-02		R-AHU-03		R-AHU-02	
Service																		
Airflow Rate	cfm	L/s	21,000	9,912	17,000	8,024	8,700	4,106	4,000	1,888	21,000	9,912	17,000	8,024	6,700	3,162	2,300	1,086
External Static Pressure	In H2O	Pa	2.5	622	2.5	622	2.0	497	2.0	497	2.5	622	2.5	622	2.0	497	2.5	622
Total Static Pressure	In H2O	Pa	7.4	1,830	6.9	1,711	8.8	2,194	6.0	1,497	4.4	1,092	3.0	741	2.1	525	4.5	1,107
Brake	hp	kW	7.89	5.88	7.41	5.53	7.47	5.57	6.20	4.62	5.50	4.10	2.84	2.12	4.34	3.24	2.86	2.13
Motor	hp	kW	9.86	7.35	9.86	7.35	8.85	6.60	8.85	6.60	9.86	7.35	9.86	7.35	8.85	6.60	9.86	7.35
SOUND DATA																		
2nd Band	Inlet	Outlet	80	87	78	86	60	65	53	58	75	82	74	81	70	82	54	60
3rd Band	Inlet	Outlet	86	91	84	90	88	96	81	89	81	86	80	85	78	86	74	80
4th Band	Inlet	Outlet	86	94	84	92	88	94	81	87	81	89	80	88	82	86	76	81
5th Band	Inlet	Outlet	88	94	86	92	87	93	80	86	83	89	82	88	80	90	78	85
Make			Rosenberg		Rosenberg		Rosenberg		Rosenberg		Rosenberg		Rosenberg		Rosenberg		Rosenberg	
Model			GKHM -CII		GKHM -CII		GKHM -CII		GKHM -CII		GKHM -CII		GKHM -CII		GKHM -CIB		GKHM -CIB	
Type																		
Size			500		500		400		400		500		500		500		355	
RPM			2310		2249		3290		3078		1990		2647		1773		2650	
Variable Inlet Vanes	Yes/No																	
Variable Frequency Drive	Yes/No		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Fan Efficiency		%																
Remarks			Qty of 5		Qty of 4		Qty of 3				Qty of 4		Qty of 2					

EQUIPMENT NO.			R-EF-AHU-03		R-EF-AHU-04		R-EF-01		R-EF-02		R-EF-03		R-EF-4		R-EF-A		R-EF-K	
System			Exhaust Fan		Exhaust Fan		Exhaust Fan		Exhaust Fan		Exhaust Fan		Exhaust Fan		Laundry Exhaust		Exhaust Fan	
Location			R-AHU-03		R-AHU-04		Roof		Roof		West Mech Room		Garbage room		Near Dryer		MPR Servery	
Service							Smudging Exhaust		Smudging Exhaust		Mech Room Exhaust		Trash Room Ventilation		Laundry Booster		Kitchen Exhaust	
Airflow Rate	cfm	L/s	2,000	944	4,000	1,888	5,000	2,360	2,500	1,180	660	312	400	189	196	93	150	71
External Static Pressure	In H2O	Pa	2.0	497	2.0	497	0.4	99	0.4	99	0.3	75	0.3	75	0.4	99	0.3	62
Total Static Pressure	In H2O	Pa	4.0	1,005	3.9	967	0.4	99	0.4	99	0.3	75	0.3	75		--		--
Brake	hp	kW	2.68	2.00	4.14	3.09	0.87	0.65	0.66	0.49	0.12	0.09	0.10	0.07		--		--
Motor	hp	kW	8.85	6.60	8.85	6.60	2.00	1.49	1.00	0.75	0.12	0.09	0.10	0.07	0.10	0.07		--
SOUND DATA																		
2nd Band	Inlet	Outlet	64	77	50	55	84		79									
3rd Band	Inlet	Outlet	73	80	78	86	75		83									
4th Band	Inlet	Outlet	76	81	78	84	68		75									
5th Band	Inlet	Outlet	74	84	77	83	63		70									
Make			Rosenberg		Rosenberg		Greenheck		Greenheck		Greenheck		Greenheck		Reversomatic		BROAN	
Model			GKHM -CIB		GKHM -CII		G-240-VG		G-140-VG		CSP-A1050-VG		CSP-A510		TLD-200ES		HPFAMM30	
Type															Inline Dryer Fan		Range hood	
Size			500		400										200ES			
RPM			1638		2681		688		1490		956		1070		2500			
Variable Inlet Vanes	Yes/No						No		No		No		No		No			
Variable Frequency Drive	Yes/No		Yes		Yes		Yes		Yes		Yes		No		No			
Fan Efficiency		%																
Remarks							c/w Roof Curb and isolators		c/w Roof Curb and isolators		208/1/60		120/1/60		120/1/60		120/1/60	
															Disconnect		Round Duct	
															Current Sensor		Configuration	
															to Appliance			

EQUIPMENT NO.			R-FFH-1		R-FFH-2		R-FFH-3		R-FFH-4		R-FFH-5		R-FFH-6		R-FFH-7		R-FFH-8	
Make			SIGMA		SIGMA		SIGMA		SIGMA		SIGMA		SIGMA		SIGMA		SIGMA	
Model			SFF-A-15		SFF-A-02		SFF-A-02		SFF-A-02		SFF-A-02		SFF-A-02		SFF-A-03		SFF-A-06	
Size			15		2		2		2		2		2		3		6	
Maximum Air Flow Rate	cfm	L/s	1500.0	708	220.0	104	220.0	104	220.0	104	220.0	104	220.0	104	300.0	142	600.0	283
Air Pressure Drop	In H2O	Pa		--		--		--		--		--		--		--		--
HEATING CAPACITY	MBH	kW	43.9	12.9	5.8	1.7	7.2	2.1	7.2	2.1	4.4	1.3	4.4	1.3	9.6	2.8	19.9	5.8
Entering Water Temperature	°F	°C	110.0	43.3	110.0	43.3	110.0	43.3	110.0	43.3	110.0	43.3	110.0	43.3	110.0	43.3	110.0	43.3
Water Flow Rate	USgpm	L/min	7.4	28.0	1.0	3.7	1.2	4.5	1.2	4.5	0.7	2.8	1.0	3.7	1.6	6.1	3.3	12.7
Water Pressure Drop	ft H2O	kPa	3.0	9	0.1	0	0.1	0	0.1	0	0.3	1	0.1	0	0.5	2	0.9	3
COOLING CAPACITY	MBH	kW		--		--		--		--		--		--		--		--
Entering Air Temperature (db)	°F	°C		--		--		--		--		--		--		--		--
Entering Air Temperature (wb)	°F	°C		--		--		--		--		--		--		--		--
Leaving Air Temperature (db)	°F	°C		--		--		--		--		--		--		--		--
Leaving Air Temperature (wb)	°F	°C		--		--		--		--		--		--		--		--
Entering Water Temperature	°F	°C		--		--		--		--		--		--		--		--
Water Flow Rate	USgpm	L/min		--		--		--		--		--		--		--		--
Water Pressure Drop	ft H2O	kPa		-		-		-		-		-		-		-		-
Motor	hp	kW	2 x 0.17	0.00	0.10	0.07	0.10	0.07	0.10	0.07	0.10	0.07	0.10	0.07	0.10	0.07	0.10	0.07
REMARKS			Ceiling mounted, FI FO		Ceiling mounted, FI FO		Ceiling mounted, FI FO		Ceiling mounted, FI FO		Ceiling mounted, FI FO		Wall mounted, FI FO		Ceiling mounted, FI FO		Ceiling mounted, FI FO	
EQUIPMENT NO.			R-FFH-09		R-FFH-10		R-FFH-11		R-FFH-12		R-FC-01		R-FC-02		R-UH-01		R-UH-02	
Make			SIGMA		SIGMA		SIGMA		SIGMA		PRICE		PRICE		Rittling		Rittling	
Model			SFF-A-10		SFF-A-04		SFF-A-02		SFF-A-02		FHP		FHP		RH-340		RH-108	
Size			10		4		2		2		10		10					
Maximum Air Flow Rate	cfm	L/s	1000.0	472	400.0	189	220.0	104	220.0	104	461.0	218	630.0	297	5130.0	2,421	1550.0	732
Air Pressure Drop	In H2O	Pa		--		--		--		--		--		--		--		--
HEATING CAPACITY	MBH	kW	28.2	8.3	12.0	3.5	4.4	1.3	5.8	1.7	9.6	2.8	12.3	3.6	66.5	19.5	19.7	5.8
Entering Water Temperature	°F	°C	110.0	43.3	110.0	43.3	110.0	43.3	110.0	43.3	110.0	43.3	110.0	43.3	110.0	43.3	110.0	43.3
Water Flow Rate	USgpm	L/min	4.7	17.9	2.0	7.6	0.7	2.8	1.0	3.7	1.5	5.6	1.9	7.1	8.9	33.7	2.6	9.8
Water Pressure Drop	ft H2O	kPa	0.9	3	0.7	2	0.3	1	0.1	0	1.9	6	2.9	9	0.3	1	0.1	0
COOLING CAPACITY	MBH	kW		--		--		--		--		--		--		--		--
Entering Air Temperature (db)	°F	°C		--		--		--		--		--		--		--		--
Entering Air Temperature (wb)	°F	°C		--		--		--		--		--		--		--		--
Leaving Air Temperature (db)	°F	°C		--		--		--		--		--		--		--		--
Leaving Air Temperature (wb)	°F	°C		--		--		--		--		--		--		--		--
Entering Water Temperature	°F	°C		--		--		--		--		--		--		--		--
Water Flow Rate	USgpm	L/min		--		--		--		--		--		--		--		--
Water Pressure Drop	ft H2O	kPa		-		-		-		-		-		-		-		-
Motor	hp	kW	0.17	0.12	0.10	0.07	0.10	0.07	0.10	0.07	0.50	0.37	0.50	0.37	0.50	0.37	0.13	0.09
REMARKS			Ceiling mounted, FI FO		Ceiling mounted, FI FO		Ceiling mounted, FI FO		Wall mounted, FI FO						Hydronic Unit Heater in North Mech Room		Hydronic Unit Heater in West Mech Room	

EQUIPMENT NO.			R-UH-03															
Make			Rittling															
Model			RH-108															
Size																		
Maximum Air Flow Rate	cfm	L/s	1240.0	585		--												
Air Pressure Drop	In H2O	Pa		--		--												
HEATING CAPACITY	MBH	kW	16.2	4.7		--												
Entering Water Temperature	°F	°C	110.0	43.3		--												
Water Flow Rate	USgpm	L/min	8.9	33.7		--												
Water Pressure Drop	ft H2O	kPa	0.1	0		--												
COOLING CAPACITY	MBH	kW		--		--												
Entering Air Temperature (db)	°F	°C		--		--												
Entering Air Temperature (wb)	°F	°C		--		--												
Leaving Air Temperature (db)	°F	°C		--		--												
Leaving Air Temperature (wb)	°F	°C		--		--												
Entering Water Temperature	°F	°C		--		--												
Water Flow Rate	USgpm	L/min		--		--												
Water Pressure Drop	ft H2O	kPa		-		-												
Motor	hp	kW	0.13	0.09		--												
REMARKS			Hydronic Unit Heater in Garbage/ Storage															
EQUIPMENT NO.																		
Make																		
Model																		
Size																		
Maximum Air Flow Rate	cfm	L/s		--														
Air Pressure Drop	In H2O	Pa		--														
HEATING CAPACITY	MBH	kW		--														
Entering Water Temperature	°F	°C		--														
Water Flow Rate	USgpm	L/min		--														
Water Pressure Drop	ft H2O	kPa		--														
COOLING CAPACITY	MBH	kW		--														
Entering Air Temperature (db)	°F	°C		--														
Entering Air Temperature (wb)	°F	°C		--														
Leaving Air Temperature (db)	°F	°C		--														
Leaving Air Temperature (wb)	°F	°C		--														
Entering Water Temperature	°F	°C		--														
Water Flow Rate	USgpm	L/min		--														
Water Pressure Drop	ft H2O	kPa		-														
Motor	hp	kW		--														
REMARKS																		

EQUIPMENT NO.			R-HC-AHU-01		R-HC-AHU-02		R-HC-AHU-03		R-HC-AHU-04		R-RHC-01		R-RHC-02		R-RHC-03		R-RHC-04	
Location			R-AHU-01		R-AHU-02		R-AHU-03		R-AHU-04		MPR 1		MPR 2		MPR SERVERY		FAMILY SPACE	
Airflow Rate	cfm	L/s	21,000	9,912	17,000	8,024	8,700	4,106	4,000	1,888	781	369	985	465	467	220	110	52
Number of Coils			1		1		1		1									
Width	In	mm		--		--		--		--		--	59	1,499		--		--
Height	In	mm		--		--		--		--		--	15	381		--		--
Area	ft²	m²		--		--		--		--		--	5	0		--		--
Face velocity	fpm	m/s	494	3	499	3	499	3	499	3		--	211	1		--		--
Type																		
Minimum Rows			4		1		2		3				2					
Fins per inch			14		7		7		13				8					
Series																		
AIR SIDE																		
Entering Air Temperature (db)	°F	°C	3.0	-16.1	55.0	12.8	44.0	6.7	-31.0	-35.0	65.0	18.3	65.0	18.3	65.0	18.3	65.0	18.3
Leaving Air Temperature (db)	°F	°C	85.0	29.4	65.0	18.3	64.8	18.2	65.0	18.3	85.0	29.4	85.0	29.4	85.0	29.4	88.0	31.1
Air Pressure Drop	In H2O	KPa	0.4	0.10	0.1	0.01	0.1	0.03	0.3	0.07	0.3	0.08	0.1	0.01	0.2	0.06	0.3	0.07
FLUID SIDE																		
Fluid			50% P. Glycol		50% P. Glycol		50% P. Glycol		50% P. Glycol		50% P. Glycol		50% P. Glycol		50% P. Glycol		50% P. Glycol	
Fluid Flow Rate	USgpm	L/min	278.3	1053.5	27.7	104.8	29.3	110.9	62.0	234.8	2.7	10.4	3.2	12.1	1.6	6.0	0.4	1.6
Entering Fluid Temperature	°F	°C	110.0	43.3	110.0	43.3	110.0	43.3	110.0	43.3	110.0	43.3	110.0	43.3	110.0	43.3	110.0	43.3
Leaving Fluid Temperature	°F	°C	95.0	35.0	95.0	35.0	95.0	35.0	95.0	35.0	95.0	35.0	95.0	35.0	95.0	35.0	95.0	35.0
Fluid Pressure Drop	ft H2O	kPa	9.1	27	18.4	55	7.2	21	12.5	37	4.2	13	15.3	46	6.9	21	0.1	0
MINIMUM CAPACITY																		
Total	MBH	kW	1865.3	546.5	185.5	54.4	196.7	57.6	415.7	121.8	9.7	2.8	21.4	6.3	10.6	3.1	2.4	0.7
Turbulators	Yes/No		No		No		No		No		No		No		No		No	
REMARKS											Integral to size 12 VAV		Duct mounted RHC @2800 cfm,0.22 in PD		Integral to size 06 VAV		Integral to size 07 VAV	

EQUIPMENT NO.			R-HRV-01				R-HRV-02				R-HRV-03				R-HRV-04			
System																		
Location			L02 AHU Mechanical Room				R-AHU-02				R-AHU-03				R-AHU-04			
Service																		
Airflow Rate	cfm	L/s	13,000		6,136		2,300		1,086		2,000		944		4,000		1,888	
Width	In	mm			--				--				--				--	
Height	In	mm			--				--				--				--	
Area	ft2	m2			--				--				--				--	
Face velocity	fpm	m/s	419		2.1		437		2.2		477		2.4		437		2.2	
			Supply				Supply				Supply				Supply			
			Summer		Winter		Summer		Winter		Summer		Winter		Summer		Winter	
Units			°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C
Entering Air Temperature (db)			86.0	30.0	-31.0	-35.0	86.0	30.0	-31.0	-35.0	86.0	30.0	-31.0	-35.0	86.0	30.0	-31.0	-35.0
Entering Air Temperature (wb)			73.4	23.0	-31.0	-35.0	73.0	22.8	-31.0	-35.0	73.4	23.0	-31.0	-35.0	73.0	22.8	-31.0	-35.0
Leaving Air Temperature (db)			77.7	25.4	63.0	17.2	77.8	25.4	67.9	20.0	72.7	22.6	64.2	17.9	81.2	27.3	64.4	18.0
Leaving Air Temperature (wb)			67.4	19.7	46.4	8.0	67.6	19.8	48.6	9.2	63.0	17.2	47.1	8.4	69.6	20.9	48.4	9.1
			Exhaust				Exhaust				Exhaust				Exhaust			
			Summer		Winter		Summer		Winter		Summer		Winter		Summer		Winter	
Units			°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C
Entering Air Temperature (db)			75.0	23.9	72.0	22.2	75.0	23.9	72.0	22.2	75.0	23.9	72.0	22.2	77.7	25.4	62.3	16.8
Entering Air Temperature (wb)			62.6	17.0	54.0	12.2	62.6	17.0	54.0	12.2	62.6	17.0	54.0	12.2	67.1	19.5	46.2	7.9
Leaving Air Temperature (db)				--		--		--		--		--		--		--		--
Leaving Air Temperature (wb)				--		--		--		--		--		--		--		--
Heat Recovery Effectiveness																		
Sensible	%		75.4		91.3		74.9		91.1		74.1		92.9		75.6		90.5	
Latent	%		53.1		60.5		51.3		59.1		48.7		57.0		53.8		61.0	
MINIMUM CAPACITY																		
			Supply				Supply				Supply				Supply			
			Summer		Winter		Summer		Winter		Summer		Winter		Summer		Winter	
Units			MBH	kW	MBH	kW	MBH	kW	MBH	kW	MBH	kW	MBH	kW	MBH	kW	MBH	kW
Total			291.0	85.3	1,508.9	442.1	50.4	14.8	278.5	81.6	74.2	21.8	235.1	68.9	93.7	27.5	461.7	135.3
Sensible			116.5	34.1	1,319.8	386.7	20.5	6.0	245.8	72.0	28.8	8.4	205.5	60.2	35.9	10.5	402.9	118.0
Latent			174.5	51.1	189.2	55.4	29.9	8.8	32.7	9.6	45.4	13.3	29.6	8.7	57.8	16.9	58.8	17.2
Air Pressure Drop	In H2O	Pa	1.32	328.3	1.32	328.3	1.36	338.2	1.36	338.2	1.43	355.6	1.43	355.6	1.30	323.3	1.30	323.3
Make			TEMPEFF				TEMPEFF				TEMPEFF				TEMPEFF			
Model			RG-L-12000				RG-L-2000				RG-L-1500				RG-4000			
Remarks																		

EQUIPMENT NO.			R-H-AHU-01		R-H-AHU-03										
Make			CONDAIR		CONDAIR										
Model															
Air Handler Served			R-AHU-01		R-AHU-03										
Airflow Rate	cfm	L/s	21,000	9,912	8,700	4,106		--		--		--		--	--
Outdoor Airflow Rate	cfm	L/s	13,000	6,136	8,700	4,106		--		--		--		--	--
Winter Space Temperature	°F	°C	72.0	22.2	72.0	22.2		--		--		--		--	--
Winter Space Humidity	% RH		30		41										
Summer Space Temperature	°F	°C	75.0	23.9	75.0	23.9		--		--		--		--	--
Summer Space Humidity	% RH		50		50										
Water Requirements	Lb/hr	Kg/hr	180	82	90	41		--		--		--		--	--
Steam Pressure	psia	kPa		--		--		--		--		--		--	--
Power Requirements	MBH	kW	219	64.10	109	32.00		--		--		--		--	--
Remarks															
EQUIPMENT NO.															
Make															
Model															
Air Handler Served															
Airflow Rate	cfm	L/s		--		--		--		--		--		--	--
Outdoor Airflow Rate	cfm	L/s		--		--		--		--		--		--	--
Winter Space Temperature	°F	°C		--		--		--		--		--		--	--
Winter Space Humidity	% RH														
Summer Space Temperature	°F	°C		--		--		--		--		--		--	--
Summer Space Humidity	% RH														
Water Requirements	Lb/hr	Kg/hr		--		--		--		--		--		--	--
Steam Pressure	psia	kPa		--		--		--		--		--		--	--
Power Requirements	hp	kW		--		--		--		--		--		--	--
Remarks															

EQUIPMENT NO.			R-P-HTG-01		R-P-HTG-02		R-P-HTG-03		R-P-HTG-04		R-P-HTG-05		R-P-HTG-06		R-P-HTG-07		R-P-HTG-08	
System			Heating		Heating		Heating		Heating		Heating		Heating		Heating		Heating	
Location			L02 Mech Room		L02 Mech Room		L02 Mech Room		L02 Mech Room		L02 Mech Room		L02 Mech Room		L02 Mech Room		L02 Mech Room	
Service			Primary Pump		Primary Pump		Primary Pump		Secondary Pump		Secondary Pump		Secondary Pump		Boiler Circulator		Boiler Circulator	
Fluid			50% P. Glycol		50% P. Glycol		50% P. Glycol		50% P. Glycol		50% P. Glycol		50% P. Glycol		50% P. Glycol		50% P. Glycol	
Fluid Flow	USgpm	L/min	168	636	168	636	168	636	263	996	263	996	263	996	116	439	116	439
Total System Flow	USgpm	L/min	224	848	224	848	224	848	789	2,987	789	2,987	789	2,987	--		--	
Head	ft H2O	kPa	15.00	44.76	15.00	44.76	15.00	44.76	50.00	149.20	50.00	149.20	50.00	149.20	10.00	29.84	10.00	29.84
Brake	hp	kW		--		--		--		--		--		--		--		--
Motor	hp	kW	3.00	2.24	3.00	2.24	3.00	2.24	5.00	3.73	5.00	3.73	5.00	3.73	1.50	1.12	1.50	1.12
RPM			1890		1890		1890		2800		2800		2800		1835		1835	
Make			Armstrong		Armstrong		Armstrong		Armstrong		Armstrong		Armstrong		Armstrong		Armstrong	
Model			Series 4380 3x3x5		Series 4380 3x3x5		Series 4380 3x3x5		Series 4380 3x3x5		Series 4380 3x3x5		Series 4380 3x3x5		Series 4380 2.5x2.5x5		Series 4380 2.5x2.5x5	
Variable Frequency Drives	Yes / No		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
System Redundancy	%		87.9		87.9		87.9		85.8		85.8		85.8					
Remarks			575/3/60		575/3/60		575/3/60		575/3/60		575/3/60		575/3/60		575/3/60		575/3/60	
EQUIPMENT NO.			R-P-CLG-01		R-P-CLG-02		R-P-CLG-03		R-P-CLG-04		R-P-DHWR-01		R-P-SAN-01		R-P-SAN-02		Not Used	
System			Cooling		Cooling		Cooling		Cooling		Domestic Water		Sanitary		Sanitary		Intentionally	
Location			L02 Mech Room		L02 Mech Room		L02 Mech Room		L02 Mech Room		L02 Mech Room		Elevator Sump Pit		Elevator Sump Pit		Left	
Service			Primary Pump		Primary Pump		Secondary Pump		Secondary Pump		Recirculation		Elevator		Elevator		Blank	
Fluid			50% P. Glycol		50% P. Glycol		50% P. Glycol		50% P. Glycol		Water		Water		Water			
Fluid Flow	USgpm	L/min	301.00	1139.41	301.00	1139.41	213	804	213	804	14	53	50	189	50	189.27		--
Total System Flow	USgpm	L/min	456.00	1726.14	456.00	1726.14	425	1,609	425	1,609	--		--		--		--	
Head	ft H2O	kPa	20.00	59.68	20.00	59.68	61.00	182.02	61.00	182.02	11.00	32.82	15.00	44.76	15.00	44.76		--
Brake	hp	kW		--		--		--		--		--		--		--		--
Motor	hp	kW	3.00	2.24	3.00	2.24	5.00	3.73	5.00	3.73	0.11	0.08	0.33	0.25	0.33	0.25		--
RPM			1050		1050		2933		2933		2570		1750		1750			
Make			Armstrong		Armstrong		Armstrong		Armstrong		Bell & Gossett		Bell & Gossett		Bell & Gossett			
Model			Series 4380 4x4x8		Series 4380 4x4x8		Series 4380 3x3x5		Series 4380 3x3x5		Ecocirc XL 20-35		2EC0311L		2EC0311L			
Variable Frequency Drives	Yes / No		Yes		Yes		Yes		Yes		ECM		No		No			
System Redundancy	%		85.7		85.7		84.5		84.5									
Remarks			575/3/60		575/3/60		575/3/60		575/3/60		120/1/60		120/1/60		120/1/60			
			Lead/Lag				Lead/Lag				Suitable for potable water		Lead/Lag					

EQUIPMENT NO.			R-P-GW-01	R-P-GW-02	R-P-GW-03	R-P-GW-04				
System			Ground Water	Ground Water	Ground Water	Ground Water				
Location			Ground Water Sump	Ground Water Sump	Ground Water Sump	Ground Water Sump				
Service			Pit 1	Pit 1	Pit 2	Pit 2				
			Ground Water	Ground Water	Ground Water	Ground Water				
Fluid			Water	Water	Water	Water				
Fluid Flow	USgpm	L/min	18 68	18 68	18 68	18 68	--	--	--	--
Total System Flow	USgpm	L/min	--	--	--	--	--	--	--	--
Head	ft H2O	kPa	15.00 44.76	15.00 44.76	15.00 44.76	15.00 44.76	--	--	--	--
Brake	hp	kW	--	--	--	--	--	--	--	--
Motor	hp	kW	0.33 0.25	0.33 0.25	0.33 0.25	0.33 0.25	--	--	--	--
RPM			1750	1750	1750	1750				
Make			Bell & Gossett	Bell & Gossett	Bell & Gossett	Bell & Gossett				
Model			2EC0311L	2EC0311L	2EC0311L	2EC0311L				
Variable Frequency Drives	Yes / No		No	No	No	No				
System Redundancy	%									
Remarks			120/1/60	120/1/60	120/1/60	120/1/60				
			Lead/Lag	Lead/Lag	Lead/Lag	Lead/Lag				
EQUIPMENT NO.										
System										
Location										
Service										
Fluid										
Fluid Flow	USgpm	L/min	--	--	--	--	--	--	--	--
Total System Flow	USgpm	L/min	--	--	--	--				
Head	ft H2O	kPa	--	--	--	--	--	--	--	--
Brake	hp	kW	--	--	--	--	--	--	--	--
Motor	hp	kW	--	--	--	--	--	--	--	--
RPM										
Make										
Model										
Variable Frequency Drives	Yes / No									
System Redundancy	%									
Remarks										

REHEAT COIL SCHEDULE																		
EQUIPMENT NO.			R-RHC-01		R-RHC-02		R-RHC-03		R-RHC-04		R-RHC-05		R-RHC-06		R-RHC-07		R-RHC-08	
Location			MPR 1		MPR 2		MPR SERVERY		FAMILY SPACE		WEST LOBBY		NORTH LOBBY		REC STAFF ROOM		REC SERVICE STAFF	
Airflow Rate	cfm	L/s	781	369	985	465	467	220	110	52	160	76	60	28	254	120	242	114
Width	In	mm		--	59	1,499		--		--		--		--		--		--
Height	In	mm		--	15	381		--		--		--		--		--		--
Area	ft²	m²		--	5	0		--		--		--		--		--		--
Face velocity	fpm	m/s		--	211	1		--		--		--		--		--		--
Minimum Rows					2													
Fins per inch					8													
Series																		
AIR SIDE																		
Entering Air Temperature (db)	°F	°C	65.0	18.3	65.0	18.3	65.0	18.3	65.0	18.3	65.0	18.3	65.0	18.3	65.0	18.3	65.0	18.3
Leaving Air Temperature (db)	°F	°C	85.0	29.4	85.0	29.4	85.0	29.4	88.0	31.1	89.0	31.7	75.0	23.9	86.0	30.0	92.0	33.3
Air Pressure Drop	In H2O	kPa	0.3	0.08	0.1	0.01	0.2	0.06	0.3	0.07	0.3	0.08	0.0	0.01	0.2	0.04	0.1	0.03
FLUID SIDE																		
Fluid			50% PG		50% PG		50% PG		50% PG		50% PG		50% PG		50% PG		50% PG	
Fluid Flow Rate	USgpm	L/min	2.7	10.4	3.2	12.1	1.6	6.0	0.4	1.6	0.6	2.3	0.1	0.4	0.9	3.2	1.1	4.1
Entering Fluid Temperature	°F	°C	110.0	43.3	110.0	43.3	110.0	43.3	110.0	43.3	110.0	43.3	110.0	43.3	110.0	43.3	110.0	43.3
Leaving Fluid Temperature	°F	°C	95.0	35.0	95.0	35.0	95.0	35.0	95.0	35.0	95.0	35.0	95.0	35.0	95.0	35.0	95.0	35.0
Fluid Pressure Drop	ft H2O	kPa	4.2	13	15.3	46	6.9	21	0.1	0	0.2	1	0.0	0	1.8	5	0.3	1
MINIMUM CAPACITY																		
Total	MBH	kW	9.7	2.8	21.4	6.3	10.6	3.1	2.4	0.7	3.5	1.0	0.7	0.2	5.5	1.6	6.6	1.9
REMARKS			Integral to size 12 VAV		Duct mounted RHC		Integral to size 06 VAV		Integral to size 07 VAV		Integral to size 09 VAV		Integral to size 05 VAV		Integral to size 06 VAV		Integral to size 06 VAV	
					@2800 cfm,0.22 in PD													

REHEAT COIL SCHEDULE

EQUIPMENT NO.			R-RHC-09		R-RHC-10		R-RHC-11		R-RHC-12		R-RHC-13		R-RHC-14		R-RHC-15		R-RHC-16	
Location			MPR TEAM ROOM		MPR CRAFT ROOM		MPR CLASSROOM		MPR LIVING ROOM		MOVEMENT STUDIO		WELLNESS ROOM		ELEVATOR LOBBY		FITNESS ROOM SHOE/COATS	
Airflow Rate	cfm	L/s	279	132	696	329	622	294	453	214	1,048	495	209	99	254	120	475	224
Width	In	mm		--		--		--		--		--		--		--	15	381
Height	In	mm		--		--		--		--		--		--		--	15	381
Area	ft²	m²		--		--		--		--		--		--		--	1	0
Face velocity	fpm	m/s		--		--		--		--		--		--		--	475	2
Minimum Rows																	2	
Fins per inch																	10	
Series																		
AIR SIDE																		
Entering Air Temperature (db)	°F	°C	65.0	18.3	65.0	18.3	65.0	18.3	65.0	18.3	65.0	18.3	65.0	18.3	65.0	18.3	65.0	18.3
Leaving Air Temperature (db)	°F	°C	91.0	32.8	85.7	29.8	86.2	30.1	90.8	32.7	85.8	29.9	86.4	30.2	74.0	23.3	78.8	26.0
Air Pressure Drop	In H2O	kPa	0.1	0.03	0.3	0.07	0.3	0.08	0.1	0.03	0.3	0.08	0.1	0.02	0.0	0.01	0.2	0.04
FLUID SIDE																		
Fluid			50% PG		50% PG		50% PG		50% PG		50% PG		50% PG		50% PG		50% PG	
Fluid Flow Rate	USgpm	L/min	1.2	4.5	2.3	8.8	2.1	8.0	1.9	7.2	3.5	13.2	0.7	2.7	0.3	1.1	1.1	4.2
Entering Fluid Temperature	°F	°C	110.0	43.3	110.0	43.3	110.0	43.3	110.0	43.3	110.0	43.3	110.0	43.3	110.0	43.3	110.0	43.3
Leaving Fluid Temperature	°F	°C	95.0	35.0	95.0	35.0	95.0	35.0	95.0	35.0	95.0	35.0	95.0	35.0	95.0	35.0	95.0	35.0
Fluid Pressure Drop	ft H2O	kPa	0.3	1	13.6	41	11.6	35	0.9	3	6.6	20	1.3	4	0.1	0	12.6	38
MINIMUM CAPACITY																		
Total	MBH	kW	7.6	2.2	15.1	4.4	13.5	4.0	12.3	3.6	22.7	6.7	4.5	1.3	2.2	0.6	5.2	1.5
REMARKS			Integral to size 7 VAV		Integral to size 8 VAV		Integral to size 8 VAV		Integral to size 9 VAV		Integral to size 12 VAV		Integral to size 5 VAV		Integral to size 5 VAV		Duct mounted RHC	
																	@550 cfm, 0.19 in PD	

REHEAT COIL SCHEDULE

EQUIPMENT NO.			R-RHC-17		R-RHC-18		R-RHC-19		R-RHC-20		R-RHC-21		R-RHC-22			
Location			WEST GYM		CARDIO ZONE		CARDIO ZONE		WOMEN'S CHANGE		UNIVERSAL CHANGE		MENS CHANGE			
Airflow Rate	cfm	L/s	587	277	515	243	515	243	772	364	1,708	806	725	342	--	--
Width	In	mm		--		--		--	25	635	33	838	25	635	--	--
Height	In	mm		--		--		--	15	381	21	533	15	381	--	--
Area	ft ²	m ²		--		--		--	2	0	4	0	2	0	--	--
Face velocity	fpm	m/s		--		--		--	421	2	455	2	395	2	--	--
Minimum Rows									3		3		3			
Fins per inch									9		9		9			
Series																
AIR SIDE																
Entering Air Temperature (db)	°F	°C	65.0	18.3	65.0	18.3	65.0	18.3	65.0	18.3	65.0	18.3	65.0	18.3	--	--
Leaving Air Temperature (db)	°F	°C	80.0	26.7	88.2	31.2	88.2	31.2	85.3	29.6	85.1	29.5	85.6	29.8	--	--
Air Pressure Drop	In H2O	kPa	0.3	0.08	0.3	0.08	0.3	0.08	0.2	0.06	0.3	0.06	0.2	0.05	--	--
FLUID SIDE																
Fluid			50% PG		50% PG		50% PG		50% PG		50% PG		50% PG			
Fluid Flow Rate	USgpm	L/min	0.8	3.0	1.9	7.3	1.9	7.3	2.5	9.5	5.6	21.2	2.4	9.1	--	--
Entering Fluid Temperature	°F	°C	110.0	43.3	110.0	43.3	110.0	43.3	110.0	43.3	110.0	43.3	110.0	43.3	--	--
Leaving Fluid Temperature	°F	°C	95.0	35.0	95.0	35.0	95.0	35.0	95.0	35.0	95.0	35.0	95.0	35.0	--	--
Fluid Pressure Drop	ft H2O	kPa	0.4	1	2.3	7	2.3	7	7.7	23	9.1	27	7.1	21	--	--
MINIMUM CAPACITY																
Total	MBH	kW	8.1	2.4	11.2	3.3	11.2	3.3	16.8	4.9	37.1	10.9	15.7	4.6	--	--
REMARKS			Integral to size 12 VAV		Integral to size 12 VAV		Integral to size 12 VAV		Duct mounted RHC		Duct mounted RHC		Duct mounted RHC			

EQUIPMENT NO.			R-SL-01		R-SL-02											
Fan Served			R-AHU-01		R-AHU-01											
			SUPPLY		RETURN											
Airflow Rate	cfm	L/s	21,000	9,912	21,000	9,912		--		--		--		--		--
Type			Ducted		Ducted											
Width	In	mm	52	1,321	52	1,321		--		--		--		--		--
Height	In	mm	47	1,194	47	1,194		--		--		--		--		--
Length	In	mm	70	1,778	24	610		--		--		--		--		--
INSERT LOSS																
2nd Band			11		4											
3rd Band			19		7											
4th Band			35		14											
Pressure Class			8 in wg		8 in wg											
Air Pressure Drop	In H2O	Pa	0.20	50	0.04	10		--		--		--		--		--
Remarks			VAW Model		VAW Model											
			RSA-12V50		RSA-18V80											
			Approx Weight 502 lbs		Approx Weight 151 lbs											
EQUIPMENT NO.																
Fan Served																
Airflow Rate	cfm	L/s		--		--		--		--		--		--		--
Type																
Width	In	mm		--		--		--		--		--		--		--
Height	In	mm		--		--		--		--		--		--		--
Length	In	mm		--		--		--		--		--		--		--
INSERT LOSS																
2nd Band																
3rd Band																
4th Band																
Class																
Air Pressure Drop	In H2O	Pa		--		--		--		--		--		--		--
Remarks																

EQUIPMENT NO.			R-AC-01A		R-AC-01B		R-AC-02		R-AC-03		R-AC-04		R-AC-05A		R-AC-05B		
Make			SAMSUNG		SAMSUNG		SAMSUNG		SAMSUNG		SAMSUNG		SAMSUNG		SAMSUNG		
Model			AC024DNADCG/AA		AC024DNADCG/AA		AC018DNADCG/AA		AC024DNADCG/AA		AC024DNADCG/AA		AC024DNADCG/AA		AC018DNADCG/AA		
Cooling Capacity	MBH	kW	24.0	7	24.0	7	18.0	5	24.0	7	24.0	7	24.0	7	18.0	5	--
Heating Capacity	MBH	kW	N/A	0	N/A	0	N/A	0	N/A	0	N/A	0	N/A	0	N/A	0	
Working Fluid			R-32		R-32		R-32		R-32		R-32		R-32		R-32		
SEER2			19.1		19.1		21		19.1		19.1		19.1		21		
Airflow (L/M/H)			466/537/629		466/537/629		441/540/615		466/537/629		466/537/629		466/537/629		441/540/615		
REMARKS			Connected to/powerd by R-CU-01A		Connected to/powerd by R-CU-01B		Connected to/powerd by R-CU-02		Connected to/powerd by R-CU-03		Connected to/powerd by R-CU-04		Connected to/powerd by R-CU-05		Connected to/powerd by R-CU-05		
EQUIPMENT NO.			R-CU-01A		R-CU-01B		R-CU-02		R-CU-03		R-CU-04		R-CU-05A		R-CU-05B		
Make			SAMSUNG		SAMSUNG		SAMSUNG		SAMSUNG		SAMSUNG		SAMSUNG		SAMSUNG		
Model			AC024DXSCCF/AA		AC024DXSCCF/AA		AC018DXSCCF/AA		AC024DXSCCF/AA		AC024DXSCCF/AA		AC024DXSCCF/AA		AC018DXSCCF/AA		
Cooling Capacity	MBH	kW	24.0	7	24.0	7	18.0	5	24.0	7	24.0	7	24.0	7	18.0	5	--
Heating Capacity	MBH	kW	N/A	0	N/A	0	N/A	0	N/A	0	N/A	0	N/A	0	N/A	0	
Working Fluid			R-32		R-32		R-32		R-32		R-32		R-32		R-32		
SEER2			19.1		19.1		19.1		19.1		19.1		19.1		19.1		
ELECTRICAL DATA																	
Volts/Phase/Cycle			208/1/60		208/1/60		208/1/60		208/1/60		208/1/60		208/1/60		208/1/60		
REMARKS			Connected to R-AC-01A		Connected to R-AC-01B		Connected to R-AC-02		Connected to R-AC-03		Connected to R-AC-04		Connected to R-AC-05		Connected to R-AC-05B		

EQUIPMENT NO.			4		5		6		7		8		9		10		12	
Make			E.H.Price		E.H.Price		E.H.Price		E.H.Price		E.H.Price		E.H.Price		E.H.Price		E.H.Price	
Model			SDVQ		SDVQ		SDVQ		SDVQ		SDVQ		SDVQ		SDVQ		SDVQ	
Inlet Size (Diameter)	In	mm	4	102	5	127	6	152	7	178	8	203	9	229	10	254	12	305
Maximum Airflow	cfm	L/s	150	71	250	118	400	189	550	260	700	330	900	425	1,100	519	1,600	755
Minimum Airflow	cfm	L/s	45	21	60	28	65	31	95	45	125	59	160	76	210	99	300	142
Fan Airflow	cfm	L/s		--		--		--		--		--		--		--		--
Fan Motor	hp	kW		--		--		--		--		--		--		--		--
Air Pressure Drop	In H2O	Pa	0.01	2	0.01	2	0.16	40	0.07	17	0.01	2	0.01	2	0.01	2	0.01	2
SOUND DATA																		
Inlet Static Pressure	In H2O	Pa	1.50	373	1.50	373	1.50	373	1.50	373	1.50	373	1.50	373	1.50	373	1.50	373
2nd Band	Discharge	Radiated	61	54	63	57	64	58	64	62	65	61	68	60	67	61	71	62
3rd Band	Discharge	Radiated	61	50	61	50	64	51	66	53	66	53	68	53	66	55	68	56
4th Band	Discharge	Radiated	56	45	56	46	58	47	61	47	60	47	61	48	60	49	66	51
Outlet Width	In	mm	12.0	305	12.0	305	12.0	305	12.0	305	12.0	305	14.0	356	14.0	356	16.0	406
Outlet Height	In	mm	8.0	203	8.0	203	8.0	203	10.0	254	10.0	254	12.5	318	12.5	318	15.0	381
Return Width	In	mm		--		--		--		--		--		--		--		--
Return Height	In	mm		--		--		--		--		--		--		--		--
Remarks			Includes discharge silencer		Includes discharge silencer		Includes discharge silencer		Includes discharge silencer		Includes discharge silencer		Includes discharge silencer		Includes discharge silencer		Includes discharge silencer	
EQUIPMENT NO.			14		16													
Make			E.H.Price		E.H.Price													
Model			SDVQ		SDVQ													
Inlet Size (Diameter)	In	mm	14	356	12	305												
Maximum Airflow	cfm	L/s	2,100	991	2,800	1,322												
Minimum Airflow	cfm	L/s	430	203	575	271												
Fan Airflow	cfm	L/s		--		--												
Fan Motor	hp	kW		--		--												
Air Pressure Drop	In H2O	Pa	0.01	2	0.01	2												
SOUND DATA																		
Inlet Static Pressure	In H2O	Pa	1.50	373	1.50	373												
2nd Band	Discharge	Radiated	74	62	74	62												
3rd Band	Discharge	Radiated	67	57	67	59												
4th Band	Discharge	Radiated	65	50	64	53												
Outlet Width	In	mm	12.0	305	38.0	965												
Outlet Height	In	mm	18.0	457	18.0	457												
Return Width	In	mm		--		--												
Return Height	In	mm		--		--												
Remarks			Includes discharge silencer		Includes discharge silencer													

OPERATING AND MAINTENANCE INSTRUCTIONS

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 03 – AS-BUILT DRAWINGS.
- .3 Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
- .4 Section 26 08 00 – COMMISSIONING.

1.2 Related Work Specified Elsewhere

- .1 Refer to 01 78 00 – CLOSEOUT SUBMITTALS.

PART 2 - PRODUCTS

2.1 Not Used

PART 3 - EXECUTION

3.1 Requirements For Manuals

- .1 A minimum of three copies of complete and approved operating and maintenance instructions for all electrical equipment and systems shall be supplied before substantial completion. Provide additional copies if required under the General Requirements. In addition to the three copies of manuals, the Contractor to provide a manual in a searchable PDF format on USB stick or sent via electronic transfer. As-Built Drawings to be included on the USB stick or sent via electronic transfer.
- .2 The Contractor to identify the cost of AS-BUILT DRAWINGS and the Operation and Maintenance Manuals as a separate line item on their progress draw. The values to be broken out can be found in Section 26 05 03 – AS-BUILT DRAWINGS. The project will remain incomplete and no money will be released until the final versions, both hard and electronic, of the drawings and manuals are received and reviewed without comments.
- .3 Binders shall be three-ring, hard-cover, loose-leaf type and identified on the binding edges as "Maintenance Instructions and Data Book", for "SOUTH WINNIPEG RECREATION CAMPUS - PHASE 1."
- .4 Terminology used in all the sections shall be consistent.
- .5 Volume One shall contain the master index of all systems, the name of the Contractor, Electrical Subcontractors and the date of substantial performance for the Contract.
- .6 Volume One shall contain a section with all necessary warranty information.
- .7 Each binder shall have a complete index for all volumes.
- .8 Each binder shall be no more than half filled.
- .9 There shall be a separate section for all materials used on the project which fall under the WHMIS legislation. There shall be Material Safety Data Sheet (MSDS), hazard data sheet, for each of the materials.
- .10 There shall be a separate section for all Insurance Certificates, Test Certificates, Verification Forms and Test Forms.

OPERATING AND MAINTENANCE INSTRUCTIONS

- .11 All relevant information relating to a system or product shall be contained within one binder.
- .12 The manual sections shall follow the specification sections.
- .13 Any diagrams, installation drawings, single line diagrams charts, etc. shall be mechanically reduced while maintaining full legibility to standard page size. If this cannot be achieved, they shall be carefully folded and contained within a clear plastic wallet within the manual.

3.2 Data For Manuals

- .1 Equipment data shall contain:
 - .1 Operating instructions.
 - .2 Operating conditions such as temperature and pressure.
 - .3 Location of equipment.
 - .4 Maintenance instructions and schedules for one-year routine.
 - .5 Recommended list of spare parts.
 - .6 Maintenance schedule.
 - .7 A trouble shooting table showing where to look for problems under various conditions of malfunction.
 - .8 All wiring diagrams.
 - .9 Equipment operating curves.
 - .10 Equipment nameplate data and serial numbers.
- .2 System data shall contain:
 - .1 A listing of all systems.
 - .2 All panel, mcc and fire alarm schedules and locations.
 - .3 Equipment name tags.
 - .4 Cleaning, maintaining and preserving instructions for all material, products and surfaces. Include warnings of harmful cleaning, maintaining and preserving practices.
- .3 Sub-Contractor manuals are required for:
 - .1 Switchboards and power distribution systems.
 - .2 Lighting systems.
 - .3 Emergency power systems.
 - .4 Fire alarm systems.
- .4 As-Built documentation shall contain:
 - .1 Reviewed As-Built Shop Drawings.
 - .2 As-Built Construction Drawings.
 - .3 Originals of test forms.
 - .4 Originals of test certificates.

OPERATING AND MAINTENANCE INSTRUCTIONS

- .5 Cyber Security Report Letter and backup schedule as required by Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

3.3 Operating Instructions

- .1 Instruct The City's representative in all aspects of the operation and maintenance of systems and equipment.
- .2 Where commissioning is a requirement of the project, the Contractor shall comply with all requirements of Section 26 08 00 – COMMISSIONING, for duration of tests.
- .3 Instruct The City for a minimum of five (5) working days.
- .4 All instruction sessions to be video-taped and copy must be provided to the Contract Administrator/The City.
- .5 Arrange for and pay for the services of engineers and other manufacturers' representatives required for instruction on the systems and the equipment as requested by the Contract Administrator and/or The City.
- .6 At the time of final review, provide a sheet for each system and piece of equipment showing the date instructions were given. Each sheet shall show the duration of instruction, name of persons receiving instruction, other persons present (manufacturer's representative, Contract Administrator, etc.), system or equipment involved and signature of The City staff stating that they understood the system installation, operating and maintenance requirements. This information shall be inserted in the manuals after all instructions have been completed.
- .7 Review information with The City representative to ensure that all information required has been provided.
- .8 Electrical equipment and systems included in the instruction requirements, include but not limited to the following:
 - .1 Switchboards and related power distribution equipment.
 - .2 Emergency Inverter System
 - .3 Fire alarm systems.

3.4 Trial Usage

- .1 The City shall be permitted trial usage of systems or parts of systems for the purpose of testing and learning operational procedures. Trial usage shall not affect the warranties nor be construed as acceptance, and no claim for damage shall be made against The City for any damage or breakage to any part or parts due to the tests, where such injuries or breakage are caused by a weakness or inadequacy of parts, or by defective materials or workpersonship of any kind.

END OF SECTION

GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to the requirements of Division 1, The City of Winnipeg Tender Document (for Tender No. 63-2025B) and City of Winnipeg General Conditions for Construction (latest edition), which applies to and forms part of all sections of the work.
 - .1 Where conflict exists between the above noted documents and this specification, the above noted documents shall take precedence.

1.2 Description Of Section

- .1 The specification is divided into sections of work and a section may consist of the work of more than one subcontractor. The responsibility as to which electrical subcontractor provides labour, materials, equipment and services required to complete the work rests solely with the Electrical Subcontractor.

1.3 Sections Affected

- .1 These instructions apply to and form a part of all electrical sections.

1.4 Definitions

- .1 Where used on the Drawings or in the Specifications, the following words are given the meanings below.
 - .1 Provide: means supply, install, connect, and test.
 - .2 Demolish: detach existing items and legally dispose of them off site.
 - .3 Remove and Reinstall: Detach existing items, prepare them for reuse, and reinstall them where indicated.
 - .4 Existing to Remain: existing items that are not removed and that are not otherwise indicated as being removed, removed and salvaged (turned over to City), or removed and reinstalled.
 - .5 Remove and Salvage: detach existing items and turn over to The City.

1.5 Scope

- .1 Provide all labour, materials, equipment and services to complete the work of the electrical division as further specified and as shown on the drawings.
- .2 Should any discrepancy, omissions or errors appear between any parts of the specifications and/or the drawings to cause doubt as to the true meaning and intent of the drawings and specifications, a ruling shall be obtained from the Contract Administrator before submitting the tender. If this is not done the following will be assumed:
 - .1 Where a discrepancy occurs between the specification and the drawings, the more expensive/onerous alternative will be deemed as included in the Contract.
 - .2 Where a discrepancy occurs in the drawings the more expensive/onerous alternative will be deemed as included in the Contract.

GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS

- .3 Where a discrepancy occurs in the specifications the more expensive/onerous alternative will be deemed as included in the Contract.
- .3 For any equipment/device where circuit numbers and/or panel designation labels are missing and not indicated on the drawings or specifications, a clarification shall be obtained from the Contract Administrator before submitting the tender. If this is not done the Contractor shall power the equipment/device from the respective 120 V/208 V or 600 V electrical panel serving the equipment in that area at no additional cost to The City.

1.6 Regulations

- .1 All work shall be performed in accordance with the latest codes, rules, regulations, by-laws and requirements of all authorities having jurisdiction except where the requirements of the drawings and specifications exceed the codes, rules, regulations, by-laws and requirements of the authorities having jurisdiction.
- .2 These specifications are supplementary to the requirements above.
- .3 Comply with all guidelines and standards issued by the authorities having jurisdiction.
- .4 Drawings and specifications should not conflict with the above regulations but where there are apparent discrepancies the Contractor shall notify the Contract Administrator.

1.7 Permits, Fees, and Reviews

- .1 Make submissions to obtain all permits. Include for and pay for all fees and arrange for all reviews required for the work of this division.
- .2 If required by code, plans and specifications have been previously submitted to the Authority Having Jurisdiction.
- .3 Furnish certificates of Acceptance from the Authority Having Jurisdiction and include them in the Operation and Maintenance manual.

1.8 Voltage Ratings

- .1 Operating voltages are as specified in CAN3-C235 (latest edition).
- .2 Motors, electric heating, control and distribution devices and equipment are to operate satisfactorily at 60 Hz within operating limits established by the above standard.

1.9 Coordination With Mechanical Divisions.

- .1 Unless indicated otherwise on the Electrical Drawings, Electrical Subcontractor will be responsible for the supply and installation of the following:
 - .1 Starters.
 - .2 Line and load side wiring for starters.
 - .3 Reduced voltage starters including "Soft Start" starters.
 - .4 Line and load side wiring to variable speed drives, including but not limited to wiring of associated harmonic filters, AC line input reactors, dV/dT filters, and output filters.
 - .1 Where harmonic filter is complete with a capacitor switching system, route a harmonic filter output conductor through the current transformer window within the harmonic filter. Coordinate with Mechanical Subcontractor and follow harmonic filter manufacturer's written instructions.

GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS

- .5 Disconnect switches for all mechanical equipment.
- .6 All power wiring (120 V & above) to all mechanical equipment.
- .7 Electrical ramp heating cables and controls.
- .8 All motorized damper power connections (120 V & above).
- .9 Fire alarm devices.
- .10 All electrical heaters including baseboard heaters, cabinet heaters, force flow heaters, radiant heaters.
- .2 Mechanical Divisions will be responsible for the supply and installation of the following:
 - .1 All variable speed drives and control wiring to starters.
 - .2 Pipe tracing and related controls.
 - .3 Electric hot water heaters.
 - .4 All interposing relays, relays, contactors and 120 V control devices.
 - .5 All 120 V and low voltage control wiring and conduits.
- .3 Determine exact location of starters, motors and line voltage controls based on the Mechanical Drawings to coordinate with the locations of all equipment to ensure the required clearances are maintained. If no wall location is suitable for the motor starters, then mount the starters on a plywood backboard on strut channel supports near the respective equipment to meet the applicable code requirements for motor isolation switches. If a motor or piece of equipment is listed on one of the starter schedules but is not shown on the floor plans, the Subcontractor is to reference the Mechanical Drawings for the location of the respective piece of equipment. No additional costs will be entertained.
- .4 Should the Mechanical Subcontractor change any of the motor or equipment sizes from those identified on the Mechanical Schedules and Drawings at any stage of the project to aid their installation, the Mechanical Subcontractor will incur all extra electrical costs to revise the electrical feeders/wiring, breakers, fuses, starters and equipment to supply power to the revised piece of equipment.
- .5 Should the Mechanical Subcontractor provide alternates to any mechanical equipment selection by deviating from the make and model identified on the Mechanical Schedules and Drawings, the Mechanical Subcontractor will incur all extra costs to revise the electrical provisions including but not limited to feeders/wiring, breakers, fuses, starters and equipment to supply power to the alternate piece of equipment.
- .6 Where power for any flush valves, hands-free faucets, or other powered plumbing fixtures are shown on the Drawings, provide either a hard-wired direct connection or a duplex receptacle, as required for the valve/faucet/fixture in question, based on coordination with the Mechanical Subcontractor.
- .7 Where large smoke dampers or large combination smoke and fire dampers, with multiple actuators per damper, are supplied by the Mechanical Subcontractor, extend the power connections and fire alarm monitoring and control connections shown on the Drawings to each and every actuator.

GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS

1.10 Plywood Backboards, Equipment Mounting, & Housekeeping Pads

- .1 Provide fire rated plywood backboards as shown on the Drawings and mount where all communication equipment is to be wall mounted. Plywood is to be 21 mm, urea-formaldehyde (UF) free and shall be either, Forest Stewardship Council (FSC), Sustainable Forestry Initiative (SFI) or CSA Z809 - (latest edition) certified. Plywood to be either fire rated with the appropriate label displayed once installed or coated with fire retardant paint. Do not paint over plywood fire rating certification stamp. All Certification not to be painted.
- .2 For clause above, submit documentation as a shop drawing for review by the LEED Representative prior to ordering.
- .3 Surface mounted electrical equipment boxes are to be installed on galvanized strut channel stand-offs. Electrical equipment boxes shall include, but not be limited to electrical panels, low voltage lighting control, fire alarm, security, communication, electrical sub-metering, etc. Panels are to be grouped on common base wherever practical.
- .4 Provide steel re-enforced concrete housekeeping pads under all floor mounted electrical equipment.
- .5 Provide firberglass pads under all outdoor ground mounted electrical equipment, unless a different support structure is detailed on the Drawings.
- .6 Additionally, provide steel re-enforced concrete housekeeping pads where shown on the Drawings.
- .7 Provide all housekeeping pads with a minimum height of 100 mm above finished floor and do not extend beyond 50 mm beyond the electrical equipment unless shown otherwise on the Drawings. Ensure concrete pads fully cured for 28 days before installing equipment.

1.11 Finishes

- .1 Metal enclosure surfaces are to be finished by the application of rust resistant primer on both the inside and outside, with at least two coats of enamel.
- .2 Clean and touch up all surfaces of equipment scratched or marred during shipment or installation. Match the original paint.
- .3 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.
- .4 All paints, coatings, sealants and adhesives shall meet the VOC limits in accordance with the LEED Specification sections. Submit documentation as a shop drawing for review by the LEED Representative prior to ordering.

1.12 Safety

- .1 Protect exposed live equipment during construction for personnel safety.
- .2 Shield and mark all live parts "LIVE 120 VOLTS", or with appropriate voltage in English.
- .3 Arrange for the installation of temporary doors for rooms containing electrical distribution equipment. Keep these doors locked except when under direct supervision of an electrician.

GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS

1.13 Fire stops

- .1 Provide fire stops in accordance with front end, and Division 1 documents and as described herein. Contractor to coordinate fire stops with Contractor.
- .2 All paints, coatings, sealants and adhesives shall meet the VOC limits in accordance with the LEED Specification sections. Submit documentation as a shop drawing for review by the LEED Representative prior to ordering.
- .3 Fire stops and smoke seal systems: in accordance with CAN/ULC-S115 (latest edition).
 - .1 Asbestos free materials and systems capable of maintaining an effective barrier against flame, smoke and gases in compliance with requirements of CAN/ULC-S115 (latest edition) and not to exceed opening sizes for which they are intended.
 - .2 Fire stop system rating for service penetrations: to suit the latest edition of the National Building Code of Canada with local amendments or the Local/Provincial Building Code, and meet requirements of local authority having jurisdiction.
 - .3 Fire stop system rating for sealing junction of rated walls to rated floors and ceilings: to suit the National Building Code of Canada with local amendments or the Local/Provincial Building Code, and meet requirements of local authority having jurisdiction.
- .4 Service penetration assemblies: certified by ULC in accordance with CAN/ULC-S115 (latest edition) and listed in ULC Guide No. 40 U19.
- .5 Service penetration fire stop components: certified by ULC in accordance with CAN/ULC-S115 (latest edition) and listed in ULC Guide No. 40 U19.13 and ULC Guide No. 40 U19.15 under the Label Service of ULC.
- .6 Fire resistance rating of installed fire stop assembly not less than the fire resistance rating of surrounding floor and wall assembly, and in accordance with the National Building Code of Canada with local amendments or the Local/Provincial Building Code, and meet requirements of local authority having jurisdiction.
- .7 Fire stops and smoke seals at openings intended for ease of re-entry, such as cables: elastomeric seal; do not use cementitious or rigid seal at such locations.
- .8 Fire stops and smoke seal all electrical penetrations through rated assemblies as per ULC Standards.
- .9 Where sound and vibration control is required, use an elastomeric seal; do not use a cementitious or rigid seal at such locations.
- .10 Primers: to manufacturer's recommendation for specific material, substrate, and end use.
- .11 Water (if applicable): potable, clean and free from injurious amounts of deleterious substances.
- .12 Damming and backup materials, supports and anchoring devices: to manufacturer's recommendations, and in accordance with tested assembly being installed as acceptable to authorities having jurisdiction.
- .13 Sealants for vertical joints: non-sagging.
- .14 Colour: if range available to Contract Administrator's choice of standard colours, generally to match background colour where visible in finished spaces.

GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS

- .15 Through non-fire or non-smoke separations or where waterproof membrane is field applied, where pipes are insulated, sleeves shall be sized to accommodate the insulation and vapour barrier.
- .16 Where-holes are core drilled in existing structures, sleeves shall be provided as specified complete with fire stopping as noted above.
- .17 Submit a complete fire stop system shop drawing package, identifying the products that may be used on the project. Prior to submitting data, review with Authority having Jurisdiction to confirm acceptability of proposed materials and assemblies.
- .18 Installation
 - .1 Install fire stops and smoke seal material and components in accordance with ULC certification and manufacturer's instructions.
 - .2 Seal-holes or voids made by through penetrations, poke through termination devices, and un-penetrated openings or joints to ensure continuity and integrity of fire separation are maintained.
 - .3 Provide temporary forming as required and remove forming only after materials have gained sufficient strength and after initial curing.
 - .4 Tool or trowel exposed surfaces to a neat finish.
 - .5 Remove excess compound promptly as work progresses and upon completion.

1.14 Acoustic Treatment

- .1 Electrical Subcontractor will be responsible for coordinating the electrical installation with the recommendations of the Contract Administrator and the acoustic report where one has been included in the Contract documents.
- .2 Refer to the recommendations of the acoustic report where provided, and provide and install acoustic treatments as necessary. This may include separation of receptacles in stud bays, sealing of junction boxes, application of sound insulating materials etc. Coordinate the installation of these materials with the Contractor and Drywall/Partition Subtrade.
- .3 Do not install back to back receptacles/back boxes within the same stud bay wherever possible. Where it is not possible to stagger receptacles, provide acoustic seal around receptacle/back box to provide acoustic isolation/separation of spaces.

1.15 Hoisting

- .1 Electrical Subcontractor will be responsible for the hoisting of all the equipment in the Contract. Subcontractor to coordinate with Contractor for use of the general hoisting facilities. If hoist facilities are inadequate, then subcontractors must provide their own. Subcontractors must inform Contractors in writing of requirements before tender closing date. Any hoisting required in addition to that provided by the General, will be included in the bid price.
- .2 Electrical Subcontractor to include for the qualified millwrights to move and place all equipment over 1000 lbs. Subcontractor to provide proof of millwright certification.

1.16 Cleaning And Waste Removal

- .1 Clean all electrical equipment that has been exposed to construction dust and dirt.

GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS

- .2 Contractor to clean all electrical equipment, inside and out, prior to turn over to The City. Equipment is subject to review by Contract Administrator and/or The City.
- .3 Contractor is responsible to remove their own waste from the site. All re-usable materials shall be recycled.

1.17 Sprinklers

- .1 All electrical equipment shall be suitable for installation in a sprinklered environment and enclosures are to be CSA Type 1 with drip hood, sprinkler proof enclosure unless otherwise noted.

1.18 Temporary Light And Power

- .1 Temporary light and power for construction shall be provided, metered, and maintained by the electrical trade, as directed by the Contractor – Refer to Section 01 51 00 but each trade shall provide all extension cords, lamps, etc., required to complete their work.
- .2 All temporary light to be fluorescent or LED. Provide adequate lighting to meet all health and safety standards.

1.19 Examination And Protection Of Site

- .1 Before submitting Bid, each trade shall examine the site to determine the conditions which may affect the proposed work. No claims for extra payment will be considered because of failure to fulfil this condition.
- .2 Contractor to document any existing conditions on site and submit a pre-condition survey including pictures. Contractor will be responsible to return the site back to its original form, which includes but is not limited to ground repair including grading and new sod and repair of damaged walls, doors and/or floors.
- .3 Contractor is to protect trees and plants on site and on adjacent properties. Plants to be protect with burlap. Trees and roots within construction area to be protected by the erection of temporary 2 m high plywood hoarding at the drip line of the tree. Contractor to avoid unnecessary traffic, dumping and storage of materials at or near trees or plants.
- .4 When requested by The City and/or Contract Administrator, the Contractor is to provide digital pictures of the site, including but not limited to progress of work and installed equipment, via e-mail to The City and/or Contract Administrator.

1.20 Drawings And Installation

- .1 Refer to 01 31 00 Project Management and Coordination.
- .2 The drawings are intended to show the general character and scope of the work and not the exact details of the installation. The installation shall be complete with all accessories required for a complete and operative installation.
- .3 The location, arrangement and connection of equipment and materials shown on the drawings represent a close approximation to the intent and requirements of the Contract. The right is reserved by the Contract Administrator to make reasonable changes required to accommodate conditions arising during the progress of the work, at no extra cost to The City.

GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS

- .4 Certain details indicated on the drawings are general in nature and specific labelled detail references to each and every occurrence of use are not indicated, however, such details shall be applicable to every occurrence on the drawings.
- .5 The actual location of switches, outlets and luminaires, etc. shall be reviewed by the Contract Administrator before installation.
- .6 The location and size of existing services shown on the drawings are based on the best available information. The actual location of existing services shall be verified in the field before work is commenced. Particular attention shall be paid to buried services.
- .7 Changes and modifications necessary to ensure co-ordination and avoid interference and conflicts with other trades or to accommodate existing conditions, shall be made at no extra cost to The City.
- .8 Leave areas clear where space is indicated as reserved for future equipment, and equipment for other trades.
- .9 Adequate space and provisions shall be left for removal of components and servicing of equipment, with minimum inconvenience to the operation of systems.
- .10 Where equipment is shown to be 'roughed-in only' obtain accurate information from the Contract Administrator before proceeding with the work.
- .11 Electrical Subcontractor is to review architectural specifications, drawings and details to confirm locations of devices and equipment.
- .12 The Electrical Subcontractor is responsible to mark-out his work, fully coordinated with all other trades, in sufficient time for review by Contract Administrator prior to rough-in. Prepare dimensioned layouts of each room prior to rough-in for review by Contract Administrator. Do not proceed with any work until the Contract Administrator has reviewed the layout drawings.
- .13 The Contractor will reimburse the Contract Administrator for their time spent on answering any written questions or requests for information where the answer is clearly identified on the drawings or in the specifications.

1.21 Installation, Interference And Setting Drawings

- .1 Refer to 01 31 00 Project Management and Coordination.
- .2 The Contractor is to complete installation, interference and setting drawings, dimensioned and to scale for all systems. They shall be made available for review by the Contract Administrator, if requested. The drawings are required to make clear the work intended or to show its relation to adjacent work or to the work of other trades. When an alternative piece of equipment is to be substituted for equipment shown, drawings of the area involved shall be prepared by this division.
- .3 Slab layout drawings are to be submitted for review by the Contract Administrator. These slab layout drawings are to be included in the as-built drawings. Refer to Section 01 32 00 Construction Progress Documentation.
- .4 Interference drawings are required for shafts, ceiling spaces, basement areas, typical floors and wherever there is possible conflict in the positioning of electrical equipment, piping, ductwork sub-trades or architectural features.

GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS

- .5 This Division shall prepare sleeving drawings indicating the size and locations of openings required in concrete floor slabs, roof slabs/decks and walls for conduit, bus ducts and equipment for review by the Contract Administrator. In case of failure to provide information in time (i.e. before the concrete is poured) any extras incurred shall be at the expense of this Division.

1.22 Tender Bid Form And Submissions Of Bid

- .1 Submit with tender, Tender Bid Form. Tenders not completed in full may, at the discretion of The City be rejected.

1.23 Approved Manufacturers

- .1 Refer to 01 21 00 Substitutions Procedures.
- .2 Where only one name appears in the specification, the bid shall include for the specified equipment.
- .3 Where two or more names are shown in the specifications as alternates or equal to, this division can select which manufacturer is to be carried.
- .4 The Contractor is to list substitute equipment as a price deduction to the Bid Price on the Tender Bid Form. Acceptance of substitute equipment shall be at the discretion of The City and/or Contract Administrator and has been provided in writing. Any substitutes not approved in writing will not be entertained.
 - .1 The proposed substitution shall show product name and complete description and also what difference, if any, will be made in the amount of the Bid Price for each substitution, should it be accepted.
 - .2 Materials and products specified by the name of the manufacturer, the brand or trade name, or catalogue reference, shall be the basis of the Bid Price.
 - .3 Any alternate and/or substitute equipment listed shall be equal in performance and quality to that specified. If space, power, structural or any other requirements are different from the equipment specified, the cost of any changes shall be included for in the price shown on the Tender Bid Form.
 - .4 The City reserves the right to accept or reject any substitution without question.
 - .5 The "Base and Alternate Equipment" is for North American manufactured products. Where a listed manufacturer can offer either North American or non-North American source for the equipment, the country of origin shall be shown under "Substitute Equipment" and the cost savings shown under "Deduct from Tender Price".

1.24 Products And Materials

- .1 Make and quality of materials used in the construction of this project shall be subject to the approval of the Contract Administrator.
- .2 All equipment and material are to be CSA certified or approved by an accredited organization. Where there is no alternative to supplying equipment which is not CSA certified, obtain special approval from Electrical Inspection Authorities.
- .3 Factory assemble control panels and component assemblies.

GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS

- .4 Materials and equipment supplied by this division shall be new and free from defects and shall be equivalent in physical characteristics and performance to that specified by the manufacturer's name and catalogue reference.
- .5 Where a certain manufacturer's equipment has been specified by name or model number, the Subcontractor shall be responsible for ensuring that the performance and quality meets the specified equipment and that the same access or maintenance space is available for an alternative manufacturer's equipment that is used and that interfacing connections with other trades can be made at no extra cost.
- .6 Within 30 days of the award of Contract, the Contractor is to submit a complete list of the manufacturers for all equipment being supplied on the project.
- .7 Availability
 - .1 In submitting Bid, Contractor warrants that all materials are available in suitable time to meet Contract dates.
 - .2 Subject to sentence .3 below, where the Contractor advises that the Contractor cannot supply materials in suitable time to meet Contract dates, and should it subsequently appear that Work may be delayed for such reason, the Contract Administrator reserves the right to substitute more readily available products of similar character, even if more costly to the Contractor, at no increase in Contract Price.
 - .3 Where the Contractor can show that the Contractor promptly ordered the originally specified materials The City will pay the differential in cost between the originally specified material and the substitute material without any mark-ups applicable by the Contractor, subcontractors, sub-subcontractors or suppliers. For greater certainty, the Contractor's failure to submit shop drawings or other submittals or seek direction in those instances where the Contract Documents so require in sufficient time to permit ordering materials is not cause for The City to pay the cost differential in sentence .2 above.

1.25 Co-Operation With Contract Administrators

- .1 Refer to 01 31 00 Project Management and Coordination.
- .2 To assist in the successful execution of the project, the Contractor shall receive a job report that summarizes the expectations of the Contract Administrator and the Contractor. This document covers topics such as progress billings breakdowns, shop drawing requirements, change order pricing breakdowns, the commissioning process, installation drawings, the specifications, as-built drawings and O+M manuals, along with a number of other items. This job report is intended to reiterate and elaborate on key items of the Contract Documents and is not intended to impose new requirements.
- .3 At the appropriate time during construction the Contractor shall submit the applicable documentation listed in the "Mechanical/Electrical Unfinished Building Occupancy Checklist". The list shall be issued by the Contract Administrator during the course of the project; however, a sample checklist can be provided at any time upon request. The checklist shall be completed by the Contractor when the information required for occupancy is submitted. The Contract Administrator shall review the information and checklist and shall identify when the information is complete. The Contract Administrator's general review letter (required for building occupancy) shall only be issued when all the information requested in the checklist is submitted by the Contractor and deemed to be complete by the Contract Administrator.

GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS

- .4 For electrical systems occupancy, provide a PDF copy of the following documents to the Contract Administrator for review:
 - .1 Electrical inspection authority inspection certificate/report with no deficiencies.
 - .2 Fire alarm verification report with no deficiencies.
 - .1 Ensure that the verification report meets the requirements for verification reports indicated in the Fire Alarm specification section, including the inclusion of audible sound pressure levels and testing with doors closed. Additionally, ensure that the sound pressure levels in the report comply with the minimums, maximums, and minimum levels above ambient stated in Part 3 of the applicable Building Code. Ensure that the report addresses music system mute signal, where applicable to the project.
 - .3 CAN/ULC-S561 "Standard for Installation and Services for Fire Signal Receiving Centres and Systems" certificate.
 - .4 CAN/ULC-S1001 "Standard for Integrated Systems Testing of Fire Protection and Life Safety Systems" reports for electrical systems with no deficiencies.
 - .1 Ensure that the report addresses all systems indicated in the "Life Safety Integration Testing" clause within this specification section.
 - .5 Letter confirming that all emergency lighting and exit signs are installed and illuminated and stating that emergency lighting and exit signs are installed in conformance with the Contract Documents.
 - .6 Letter confirming that all unit equipment for emergency lighting (batteries, heads, exit signs) are installed and powered and have been tested to demonstrate that they last for the run time indicated in the Specifications or on the Drawings. State the applicable run time in the letter. Additionally, ensure that letter states that emergency lighting and exit signs are installed in conformance with the Contract Documents.
 - .7 Letter with written confirmation that all new ceiling luminaires are supported from the building structure, independent from the suspended ceiling, in accordance with the requirements of the Lighting Equipment specification section.
 - .8 Emergency power (inverter) testing report with no deficiencies.
 - .9 Letter confirming that all openings in walls and floors for electrical services have been fire stopped.
 - .10 Cyber Security Report Letter and backup schedule as required by Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
 - .11 Lighting control commissioning documentation.
 - .12 Letter confirming that all breaker trip unit/protective relays settings have been set in accordance with the power system study.
 - .13 Additional items as indicated by the Contract Administrator.
 - .14 Additional items as indicated on the Occupancy of Unfinished Buildings Checklist issued by Contract Administrator.

GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS

1.26 Co-Operation With Other Divisions

- .1 Particular attention must be paid to the proximity of electrical conduit and cable to mechanical piping and equipment.
- .2 Electrical conduits shall not touch or be supported on pipe or duct walls.
- .3 Each section shall confine itself to installing all materials in the spaces shown without encroaching upon space for materials installed under other sections or divisions. Where the space allocated to another section or division is encroached upon, the materials shall be relocated to their proper space allocation in such a manner to complete the work using space allocated to the various sections and divisions. Relocation of materials and work involved shall be paid for by the section responsible for the encroachment at no extra cost to The City.
- .4 The supply of all items is to have built-in to the delivery schedule, ample time for rapid progress of work. Proceed with work determined by the construction schedule.
- .5 The Electrical Subcontractor shall coordinate the exact breaker/fuse sizes with all mechanical equipment shop drawings prior to rough-in and ordering of the electrical distribution equipment. Size of breakers/fuses shown on drawings are based on generic equipment manufacturers and sizes may change depending on successful equipment manufacturer. No additional costs shall be allowed for non-coordinated mechanical shop drawing reviews by the Electrical Subcontractor.

1.27 Temporary Use Of Equipment

- .1 Where the electrical systems are operated during construction, the Electrical Subcontractor shall maintain the system and equipment in proper operating condition.
- .2 Before any area of the building is turned over to The City for acceptance and for beginning of the guarantee/warranty period, the systems and equipment shall be returned to the initial new condition.
- .3 Permanent electrical equipment is only to be used upon permission of The City and Contract Administrator and is only to be used on a limited basis. All equipment must be cleaned prior to turnover.

1.28 Testing

- .1 General
 - .1 Refer to the testing requirements outlined in each individual specification section and provide all required staffing, materials, tools and expertise to perform the required testing.
 - .2 This specification is intended to capture the requirements for factory testing, site start-ups, site testing and training of electrical equipment. This specification represents a minimum requirement and does not absolve the equipment manufacturers from performing any tests required by the standards referenced in the individual specification sections.
 - .3 The testing process for the Electrical Systems shall include:
 - .1 Verification that the installation meets the requirements of the Contract documents.
 - .2 Verification that the system's performance meets the design intent.

GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS

- .3 Building operator training.
- .4 As-Built documentation, operating and maintenance manuals, and systems operating manuals.
- .4 The Electrical Subcontractor, Contract Administrator, and Commissioning Agent (where identified as part of the project) shall provide the services to complete the process. See further explanation below defining the areas of responsibility.
- .5 Provide labour, equipment and material to conduct the testing process as outlined in this Section.
- .2 Factory testing
 - .1 All equipment is to have factory testing performed by the equipment manufacturer. These tests are to include the manufacturers standard factory testing, and any required testing to conform to the standards, and any additional testing referenced in the individual specification sections.
 - .2 The manufacturer is to perform the required testing and submit test reports recording the results of all tests to the Electrical Subcontractor for review and if found acceptable submit to Contract Administrator for Shop Drawing review and the final copy included in the O&M Manuals. Test reports are to be submitted and reviewed by the Electrical Subcontractor and Contract Administrator prior to shipment to site.
 - .3 Any deficiencies noted in the factory testing are to be corrected prior to shipment of electrical equipment unless otherwise agreed to by the Electrical Subcontractor.
- .3 Site Startup
 - .1 Manufacturer to include for the costs of technician(s) to perform initial system start-up on site as required by the Specifications and Electrical Subcontractor. Extent of technician(s) involvement to be coordinated with the needs of the Specifications and the Electrical Subcontractor.
- .4 Site tests
 - .1 Manufacturer to include for the costs of technician(s) to perform site tests as required by the Specifications and Electrical Subcontractor. Refer to tests identified in the individual Specification sections and include all personnel and equipment to perform testing.
- .5 Materials
 - .1 The Contractor and Manufacturer shall provide all instrumentation and equipment necessary to conduct the tests as specified in the specifications. The Contractor shall ensure the instrumentation to be used are properly and adequately calibrated and if required by the Contract Administrator or Commissioning Agent to provide the dates the instrumentation was last calibrated.

1.29 Warranty

- .1 Except where longer warranty periods are required by other specification sections, provide a one (1) year warranty for the Work, starting at Total Performance of the Work.
- .2 Coordinate the extension of manufacturer warranties to comply with the clause above, based on the duration of construction

GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS

1.30 Training

- .1 Where training is outlined within the Electrical Specification, training shall be provided for both components of this project – Recreation Centre and Child Care. Assume that training will be completed with different groups for each project component.
- .2 Refer to 01 79 00 Demonstration and Training.
- .3 The Manufacturer is to include for qualified technician(s) with project specific knowledge to perform in depth training for facility management team members.
- .4 Training may include up to ten (10) attendees and may be video recorded by others.
- .5 Training program to include:
 - .1 One site 'in class' introduction session covering the basics of system operation.
 - .1 Manufacturer to submit a course outline before training commences.
 - .2 Manufacturer to provide course training documentation (if required) for attendees.
 - .2 On site 'hands on' session covering the specific equipment design and operation details, including:
 - .1 All operating procedures including automatic and manual intervention procedures.
 - .2 All regular maintenance procedures.
 - .3 Troubleshooting procedures.
 - .4 Spare parts required.
- .6 Timing of training to be coordinated with Electrical Subcontractor and The City staff and is to be provided in advance of systems supporting critical loads to allow for full ability to operate the systems. The Electrical Subcontractor/Manufacturer to notify The City team a minimum two (2) weeks prior to the date of training.

1.31 Life Safety Integration Testing

- .1 Provide testing of the integration of all life safety and fire protection systems.
- .2 The Integrated Testing Coordinator (ITC) will complete an Integration Testing Plan (ITP). Carry out the testing as described by the ITC in the ITP, and in accordance with CAN/ULC-S1001 as it relates to any electrical systems.
- .3 The ITC and development of the ITP are not the responsibility of this Contractor.
- .4 The testing of the integrated systems shall include, but not be limited to the following systems and all associated components:
 - .1 Fire Alarm System
 - .2 Fire Signal Receiving Centre
 - .3 Mass Notification
 - .4 Elevators
 - .5 Emergency Generators and/or Inverters
 - .6 Audio/Visual Systems

GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS

- .7 Lighting Control Systems
- .8 Notification Systems (Public Address)
- .9 Sprinkler Systems
- .10 Standpipe Systems
- .11 Fire Pumps
- .12 Water Supplies
- .13 Water Supply Control Valves
- .14 Heat Tracing for Life Safety Systems
- .15 Hold-Open Devices
- .16 Smoke Control Systems and Associated Dampers
- .17 Smoke Alarms
- .18 Gas / CO Detection Systems
- .19 Prevention of Smoke Recirculation (AHUs)
- .5 Coordinate with all other trades to carry out the appropriate testing.
- .6 Be responsible for carrying out and coordinating the testing work associated with the ITP. All work shall be coordinated with the ITC and shall include but not be limited to:
 - .1 Perform functional testing of the integration of all life safety and fire protection systems as a whole to ensure the proper operation and interconnection between the systems.
 - .2 Testing of the integrated life safety systems must be done as a complete installed assembly; individual component testing or partially installed assembly testing is not acceptable.
 - .3 Follow the testing methodology for verifying and documentation of operation as outlined in the ITP and in accordance with CAN/ULC-S1001 "Integrated Systems Testing of Fire Protection and Life Safety Systems."
 - .4 Provide fire alarm verification report along with all other documentation requested by the ITC as it relates to the electrical systems in conformance with CAN/ULC-S1001 "Integrated Systems Testing of Fire Protection and Life Safety Systems."

1.32 Schedule of Values

- .1 Refer to City of Winnipeg General Conditions for Construction Contracts and 01 29 00 Payment Procedures. Where conflict exists between the above noted documents and this specification, the above noted documents shall take precedence.
- .2 Refer to Electrical Schedule of Values to be provided prior to Proper Invoice to meet Contract Administrator's approval.

GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS

- .2 The format of the sample schedule of values shall be as shown in the example schedule of values below. The sample schedule of values shall include a breakdown which illustrates all categories shown on the example schedule of values which are relevant to the project. The categories shall be broken down to clearly illustrate the value of the material being supplied as the first subcategory and the value of the labour being supplied as the second subcategory, as shown on the example schedule of values. The Contract Administrator reserves the right to request that additional categories be added to the schedule of values if the Contract Administrator feels that doing so will aid in assessing the Subcontractor's progress on site, thereby expediting Contractor payment. Schedule of values not including the categories shown on the example schedule of values where relevant to the project and / or not providing separate labour value and separate material value subcategories will be rejected.
- .3 The total price of all portions of the work shall equal the total price of the work covered under the electrical division. Cost for as-built drawings and manuals to be carried as a separate line item.
- .4 Contractor to list and track all fixed per unit cost luminaires as part of Light Fixtures - Materials on the progress draw.
- .5 Contractor to list and track each of the approved changes on separate lines on the progress draw.
- .6 Costs of temporary facilities and utilities shall be amortized over the duration of the Work. Claims for 'mobilization', 'bidding costs', or similar lump sums at or before start of work are not acceptable.

EXAMPLE ELECTRICAL SCHEDULE OF VALUES

Electrical Subcontractor Name
Billing Application Electrical Division
Project Name

Application Number – xx				Date – xxxx to xxxx				
<u>Description</u>	<u>Contract Value</u>	<u>%</u>	<u>Billed To Date</u>	<u>%</u>	<u>Prev. Billed</u>	<u>%</u>	<u>This Billing</u>	<u>Balance to Complete</u>
Permits / Mobilization	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Demolition & Removals	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Duct Banks – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Duct Banks – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Feeder Conduit – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Feeder Conduit – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Feeder Wire – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Feeder Wire – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Power & Ltg. Branch Conduit – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Power & Ltg. Branch Conduit – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Power & Lighting Branch Wire – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Power & Lighting Branch Wire – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Fire Alarm Conduit – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Fire Alarm Conduit – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Fire Alarm Cable – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx

GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS

Fire Alarm Cable – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Comms / Security / AV Conduit – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Comms / Security / AV Conduit – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Comms / Security / AV Cable – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Comms / Security / AV Cable – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Distribution Equipment – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Distribution Equipment – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Generator / Inverter – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Generator / Inverter – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Light Fixtures – Material [†]	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Light Fixtures – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Lighting Controls – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Lighting Controls – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Fire Alarm Equipment – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Fire Alarm Equipment – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Wiring Devices – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Wiring Devices – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Hand Dryers – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Hand Dryers – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Commissioning / Training	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Demobilization / Clean-up	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Manuals / As-Built Drawings	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Subtotal	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Additions to Contract								
CO # / PC # / CCN #	xx,xxx.xx	xxx	xx,xxx.xx	xxx	xx,xxx.xx	xxx	xx,xxx.xx	xx,xxx.xx
Cash Allowance #	xx,xxx.xx	xxx	xx,xxx.xx	xxx	xx,xxx.xx	xxx	xx,xxx.xx	xx,xxx.xx
Subtotal	xx,xxx.xx	xxx	xx,xxx.xx	xxx	xx,xxx.xx	xxx	xx,xxx.xx	xx,xxx.xx
Total Contract	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Less Holdback			xxx,xxx.xx		xxx,xxx.xx		xxx,xxx.xx	
Total			xxx,xxx.xx		xxx,xxx.xx		xxx,xxx.xx	

[†] Inclusive of fixed per unit cost luminaires. Refer to luminaire schedule and/or electrical supplementary bid form for luminaire fixed unit costs.

GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS

1.33 Metric Conversions

- .1 Particular care shall be taken with imperial versus S.I. metric conversions. This applies to all services including, but not limited to, equipment, conduit and site services in both new and existing installations.

1.34 Contract Administration or Valuation Of Changes

- .1 Further to Contract requirements, the method to be used in determining the value of a change to the Work, by Change Order, shall be:
 - .1 Estimate and acceptance in a lump sum, unless the Contract Administrator otherwise determines that the method shall be unit prices set out in the Contract.
- .2 Contractor shall provide the Contract Administrator with a detailed cost analysis of the contemplated change indicating:
 - .1 Quantity of each material.
 - .2 Unit cost of each material.
 - .3 Time involved.
 - .4 Sub-trade quotations including a complete analysis of costs.
 - .5 Mark-ups, if applicable.
 - .6 Value of GST or HST, as applicable.
 - .7 Proposed change in Contract Time.
- .3 The detailed cost breakdown is to list material and labour separately for each item on the proposed change. The breakdown for contemplated change is to follow the format of the attached document.
- .4 The following shall not be included in the cost of the work but are covered by the hourly labour rate:
 - .1 The Contractor's payroll, administrative, head office and site office expenses, including stationary, postage and other office supplies.
 - .2 The costs of the Contractor's Project Manager, clerical and administrative personnel, and executive personnel.
 - .3 Use of temporary offices, sheds, small/hand tools, storage, and site office consumables, etc., including but not limited to the cost of telephone, light, power, water and heat used therein.
 - .4 Transportation and overnight room expenses for out of town labour, if local labour is unavailable.
 - .5 Insurance premiums, all government payroll burdens, variable labour factors and union or association funds.
 - .6 Licenses and permits, except when these are special for a particular item of work.
 - .7 Printing charges for Proposed Changes, Change Orders and Drawings for Contractor's and Subcontractors' use in the work. Contract Administrator will provide a PDF electronic copy of change notice documentation.

GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS

- .8 The cost of preparing As-Built, layout and working drawings and shop drawings. This includes any and all AutoCAD/BIM costs related to interference drawings or other associated drawings that may be required as part of the changes.
- .9 The cost of clean-up and disposal of waste material.
- .10 Parking, travel, coffee break/rest periods, warranties, safety training, WHMIS and health and safety committee, and non-productive time.
- .11 Rentals, additional bonding, project financing.
- .5 The Contractor shall inform the Surety Company or Companies who have issued any bonds for this Contract, and any Insurers who have insured any part of the work or operations or who have an interest in this Contract, of all changes in the Contract. Pay all costs of any changes in bonds or insurances required to maintain bonds or insurances in conformance with the requirements of the Contract Documents. Provide The City immediately with any revised bonds or insurances.
- .6 Special equipment rental rates will be charged at cost. The Contractor shall provide an official quotation of the equipment rental with the Proposed Change quotation as backup, otherwise special equipment rentals will not be accepted by The City/ Contract Administrator.
- .7 The maximum percentage fee for mark-ups is as stated in the City of Winnipeg General Conditions for Construction Contracts.
- .8 All changes, change notices, revisions to Contract, Field Instructions or any additional costs or deletes to the Contract price are subject to review and scrutiny by a qualified third party or individual.
- .9 The material costs used shall be a discount to nationally available pricing guides (i.e. Trade Service, Allpricer, etc.) to reflect a value with a fair and reasonable markup to the actual cost of the materials purchased from distributors. The City and/or Contract Administrator reserve the right to negotiate material pricing to a value that is fair and reasonable to The City.
- .10 Labour Rate
 - .1 During the duration of the electrical Contract, extra work hourly labour units are to be based on the latest edition of the National Electrical Subcontractors Association (NECA) labour units column 1(one). No additional factors will be accepted.
 - .2 The hourly labour rate for all changes will be based on a Journeyman Electrician rate.
 - .3 The following labour burdens are not part of the hourly labour cost, but are covered under the NECA labour unit rates: safety measures and regulations; drawing and specification study; layout, measuring and marking the installation location; material unloading, jobsite storage and delivery to the installation area; inspection, uncrating and shipping support removal; tool acquisition and return to storage; clean-up of excess material; and testing circuits for continuity.
- .11 When pricing additional work for Proposed Changes, the Electrical Subcontractor shall only price new materials that are required for the Proposed Change. Where existing materials and/or infrastructure (i.e. homerun conduits back to electrical panels) can be re-used for the Proposed Change, the Electrical Subcontractor shall utilize these items in the valuation of the Change at no extra cost.

GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS

PROPOSED CHANGE ORDER

Company Name:	CCN #
Address:	Date:
City, Prov.:	Project Name:
Postal Code:	Project Number:
	Page Number:
Telephone:	Change Order #:
Fax:	
E-Mail address:	

Client Address:

Work Description

We reserve the right to correct this quote for errors and omissions.
This quote covers direct costs only.
This price is good for acceptance within 30 days from the date of receipt.

Itemized Breakdown

<u>Description</u>	<u>Qty</u>	<u>Net Price U</u>	<u>Total Mat(\$)</u>	<u>Labor U</u>	<u>Total Hours</u>
¾' EMT		xxx.xx C		5.00 C	
¾' EMT STL SS CONN		xx.xx C		10.00C	
¾' EMT STL SS CPLG		xx.xx C		5.00 C	
¾' EMT STRAO 1-H		xx.xx C		4.00 C	
#10 x 1" SELF TAPPING SCREW		x.xx C		5.50 C	

TOTALS

Description

Material

General Materials

Permitted Mark-up (@ xx.xx %)

Material Total

Labour

Journeyman (xx Hrs. @ \$xx.00)

Foreman @ 10% (xx Hrs. @ \$xx.00)

Labour Total

Material and Labour Total

Final Amount

GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS

1.35 Cyber Security

- .1 Coordinate with The City's Information Technology representatives, obtain a copy of The City's cyber security policy and provide all applicable cyber security configurations.
- .2 Definitions
 - .1 Cyber Assets: Systems (including hardware, software, and data) and communication networks (including hardware, software, and data).
 - .2 Critical Cyber Assets: Cyber assets that perform critical system functions. The loss or compromise of these cyber assets would adversely affect the operational reliability of the system.
 - .3 Cyber Attack: The use of electronic means to interrupt, manipulate, destroy, or gain unauthorized access to a computer system, network, or device.
 - .4 Cybercrime: Any crime where cyber – the internet and information technologies, such as software, firmware, computers, tablets, personal digital assistants or mobile devices – has a substantial role in the commission of a criminal offence.
 - .5 Cyber Hygiene: Practices and steps that users of computers and other devices take to maintain system health and improve online security. These practices are often part of a routine to ensure the safety of identity and other details that could be stolen or corrupted.
 - .6 Cyber Incident: Any unauthorized attempt, whether successful or not, to gain access to, modify, destroy, delete, or render unavailable any computer network or system resource.
 - .7 Cyber Security: Technologies, processes, and practices designed to protect networks, devices, programs, and data from attack, damage, or unauthorized access.
 - .8 Cyber Threat or Cyber Security Threat: Malicious act that seeks to damage data, steal data, or disrupt digital life in general. Cyber threats include computer viruses, data breaches, Denial of Service (DDoS / DoS) attacks and other attack vectors.
 - .9 Cyber Threat Actors: Broad term for any states, groups, or individuals who, with malicious intent, aim to take advantage of vulnerabilities, low cyber Security awareness, and technological developments to gain unauthorized access to information systems in order to access or otherwise affect victims' data, devices, systems and networks.
 - .10 IP Multicast: Technique for one-to-many and many-to-many real-time communication over an IP Infrastructure network.
 - .11 Endpoint: Remote computing device that communicates back and forth with a network to which it is connected. Such as a server, desktop, or laptop.

GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS

- .12 Network Certificates: Also known as a Digital Certificates, which are an electronic “password” that allows a person or organization to exchange data securely over the internet using the public key infrastructure (PKI). Digital Certificates are also known as a public key certificate or identity certificate. There are 3 Main types of certificates:
 - .1 Secure Socket Layer Certificate (SSL) Digi-SSL
 - .2 Software Signing (Code Signing Certificate) Digi-Code
 - .3 Client Certificate (Digital ID) Digi-ID
- .13 Social Engineering: Exploitation methods that target human vulnerabilities, such as carelessness and trust.
- .14 Technical Vulnerabilities: Weaknesses or flaws in the design, implementation, operation, or management of an information technology system, device, or service.
- .3 Cyber Security Measures
 - .1 Implement at minimum the following multi-layered Cyber Security measures to limit and / or reduce The City’s potential risk from a cyber threat event; such as a Cyber Security data breach or Cyber Security attack.
 - .2 Password Management
 - .1 Employ password management best practices such as:
 - .1 Do not use default passwords.
 - .2 Use strong and unique passwords for all applications. Use a minimum of 8 characters where there is no password policy inherent in the software; use a mixture of uppercase and lowercase letters, numbers, and include at least one special character (! @ # ?]).
 - .3 Reset passwords at regular intervals.
 - .4 Configure two-factor authentication for all accounts where possible in the system software.
 - .5 Do not use System Admin logins for simple tasks; create separate User accounts with rights levels appropriate for the job function. Create and define user accounts as appropriate such as Role based, Individual logins or assigned roles.
 - .6 Use different passwords for every account.
 - .7 Enforce secure password policies within the business environment.
 - .8 Have interface lock after a predefined # of failed login attempts for a pre determined time interval.

GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS

- .3 Port and Interface Management
 - .1 Employ Port Management techniques such as:
 - .1 Restrict access on network switch ports to assigned devices addresses.
 - .2 Lock down all open, unused and unsecure ports on the networking devices such as switches, routers, and firewalls.
 - .3 Shut off all unused communication services and hardware interfaces.
 - .4 Advise The City on use of 3rd party port security monitoring.
- .4 Physical and Virtual Networks
 - .1 Provide a dedicated VLAN for network connected systems where a dedicated LAN has not been provided.
- .5 Encryption
 - .1 Use minimum TLS 1.2 for all network attached equipment and use TLS 1.3 where available.
- .6 Network Certificates
 - .1 Ensure Network Certificates are up to date and not expired for all equipment and systems.
- .7 Firmware & Software Update Management
 - .1 Use the latest stable Firmware / Software version on all devices / equipment as well as implement a Firmware / Software Update management process and procedure.
- .8 Manufacturer's System Hardening Guides
 - .1 Provide the Manufacturer's System hardening guides for the equipment being installed and implement as many recommendations / features as possible.
- .9 External Memory
 - .1 Restrict the use of external memory. Restrict or eliminate the use of devices such as external USB Thumb drives unless expressly allowed by The City's Information Technology representatives.
- .10 Log Off
 - .1 Enable auto-log off timer for all software, websites and logins. Set auto-log off timer on local Workstation(s) being used to access the equipment with a reasonable timer in the case that an employee leaves the workstation unattended.
- .11 Anti-Virus Software
 - .1 Enable and configure anti-virus software on PC endpoints in accordance with The City's Information Technology requirements, unless it is to be installed and configured by The City.
- .12 Filtering Techniques
 - .1 Apply filtering techniques including the types listed below where possible:
 - .1 Web Filtering: A Web filter adds another layer to anti-phishing defences by blocking the web based component of phishing and malware attacks.

GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS

- .2 Multicast Message Filtering: Filters the packets sent to multicast groups users are not subscribed to.
 - .3 Content Filtering: Is the use of a program to screen and / or exclude access to web pages or email deemed objectionable. A content filter will then block access to this content.
 - .13 Back up Regularly
 - 1. Provide backup schedule in the closeout submittals and configure system for automatic backups wherever possible.
 - 2. Identify files that require manual backup and the backup procedure. This helps to protect against many types of data loss, especially if a Cyber Threat Actor gains access.
- .4 IT Devices and Systems
 - .1 Apply the Cyber security measures listed in the clauses above in part or in full, as possible, to a wide range of Information Technology (IT) Devices including:
 - .1 Firewalls
 - .2 Routers
 - .3 Network switches (Core and Edge Devices)
 - .4 Servers and databases
 - .5 Workstation computers
 - .6 Network connected system devices and controllers
 - .7 Wireless Access Points and wireless controllers
 - .8 Mobile phones and tablets
 - .9 Any IT System or endpoint connected to the network
- .5 Operational Technology (OT) Devices and Systems
 - .1 Apply the Cyber security measures listed in the clauses above, in part or in full, as possible, to a wide range of OT Network devices including:
 - .1 Industrial Control Systems such as:
 - .1 (PLC's) Programmable Logic Controllers are an industrial digital computer which has been ruggedized and adapted for the control of manufacturing processes, such as assembly lines, or robotic devices.
 - .2 (SCADA) Supervisory Control and Data Acquisition is a control system architecture comprising of computers, networked data communications and graphical user interfaces (GUI) for high level process supervisory management.
 - .3 (DCS) Distributed Control System is a computerized control system for a process or plant usually with many control loops, in which autonomous controllers are distributed throughout the system.
 - .4 (CNC) Computer numerical Control is the automated control of machining tools (Drills, boring tools, lathes) and 3D printers by means of a computer.

GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS

- .2 Building Management Systems (BMS) and Building Automation Systems (BAS)
 - .3 HVAC equipment
 - .4 Lighting controls for both internal and external applications
 - .5 Energy monitoring and metering equipment
 - .6 Transportation and parking systems
 - .7 Scientific equipment
 - .8 Any other OT System or endpoint that can be connected to the network
- .6 Report Cybercrime
- .1 Advise The City and / or their representatives of any indication of a Cyber Incident of a criminal nature when performing any work on a network connected system.
- .7 Cyber Security Report Letter
- .1 Provide a Cyber Security Report Letter in the closeout documents to the client stating which Cyber Security measures have been implemented, when implementing any and / or all of the Cyber Security Measures mentioned in this Specification.

PART 2 - PRODUCTS

2.1 Not Used

PART 3 - EXECUTION

3.1 Not Used

END OF SECTION

AS-BUILT DRAWINGS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.2 Related Work Specified Elsewhere

- .1 Refer to Section 01 33 00 – SUBMITTAL PROCEDURES.
- .2 Refer to Section 01 78 00 – CLOSEOUT SUBMITTALS.
- .3 Refer to Section 01 32 00 – CONSTRUCTION PROGRESS DOCUMENTATION

1.3 Record Of Revisions On Site

- .1 Maintain an updated copy of plans and schematics in the digital format for which the project is provided (i.e. AutoCAD or Autodesk Revit MEP) and be capable to produce documents in Adobe PDF upon request.

PART 2 - PRODUCTS

2.1 As-Built Drawings

- .1 Request in writing from the Contract Administrator all electrical AutoCAD drawings. Complete release form provided by Contract Administrator and pay the Contract Administrator directly the costs identified in this section below prior to receiving the drawings. After the final as-built drawings have been reviewed, send the Contract Administrator a copy for their records and with each set of maintenance manuals. Provide as per 01 33 00 Submittal Procedures. Use the same version of AutoCAD software that the drawings were created in and provide electronic files saved in a version acceptable to the end The City and Contract Administrator.
- .2 The Contractor is to identify the cost of As-Built Drawings and the Operation and Maintenance Manuals as a separate line item on their progress draw. The following values are to be broken out:

\$5,000	For Electrical Contracts up to \$250,000
2% of Electrical Contract	For Electrical Contracts from \$250,000 to \$1,500,000
\$30,000	For Electrical Contracts over \$1,500,000

- .3 The project will remain incomplete and no money will be released until the final versions, both hard and electronic, of the drawings and manuals are received.
- .4 Final as-built prints/plots shall not contain markings or corrections by hand (i.e. marker, pen, pencil, etc.). References to the Architect and Engineer must be deleted from the drawings.
- .5 Final as-built drawings to include all revisions made to the drawings during construction, including all approved changes. The as-built drawings are to also include the routing of all feeders except for branch circuits, all junction boxes to be shown, drawing legend to be updated to include all symbols and lines used to show as-built conditions, quantity of wires in each conduit, and circuit numbers of wires in each conduit. Include slab layout drawings in as-built drawing package.

AS-BUILT DRAWINGS

- .6 CADD Requirements.
 - .1 A complete list of layer names and brief description of each layer's use shall accompany all files.
 - .2 Fonts for text shall be Autodesk standard. Custom fonts, shape files, etc., are not to be used.
 - .3 Final as-built drawings shall be returned on USB stick.
 - .4 Each USB stick shall include a file containing Contract Administrator and The City, Contract number, file names and Drawing number. Provide a "readme.txt" file in ASCII format. A printed copy of the readme file shall accompany each USB stick.
 - .5 All drawings shall be in the same units as issued on Bid Documents.
 - .6 Provide a complete list of symbol (block) names with a description of each symbol.
 - .7 Special effort shall be made to ensure that drafting is accurate: i.e. appropriate lines are indeed horizontal and vertical; lines that should intersect do but not over-intersect and ensure that entities are placed on correct layers.
- .7 Maintain records on site, as the job progresses, and record all changes and deviations from that shown on Contract Drawings. After review and approval of service lines in trenches, take "as-built" measurements, including all depths, prior to commencement of backfilling operations. Show the location of buried electrical ducts and conductors on the drawings and dimensioned from fixed points. Keep drawings up-to-date during construction and in addition to field measurements include Change Orders, Field Instructions and all other changes.
- .8 On completion of the building, forward to the Contract Administrator the digital drawings indicating all such changes and deviations for review by the Contract Administrator.
- .9 If required, the Contract Administrator will provide a quotation to this Contractor to transfer "As-Built" information from the mark-up documentation to the acceptable software.
- .10 The Electrical Subcontractor may request from the Contract Administrator the most current electronic documentation (Electrical Drawings) in AutoCAD sent via electronic transfer. The Contract Administrator will provide the Drawings one time at no charge. Where the Drawings are requested more than one time throughout the course of the project, a nominal charge of \$500.00 will apply to the second and subsequent requests.
- .11 The AutoCAD as-built documents shall meet all The City's and Contract Administrator's requirements.

PART 3 - EXECUTION

3.1 Not Used

END OF SECTION

SUBMITTALS/SHOP DRAWINGS

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.2 Related work specified elsewhere

- .1 Comply with Section 01 33 00 – Submittal Procedures for Submittals except as amended below.

PART 2 - PRODUCTS

2.1 Shop Drawings

- .1 Shop Drawings shall be organized by Specification Section. Ensure shop drawing package for a given Specification Section is complete, including all equipment, products, materials, and systems to be used as part of that Specification Section, and submit as a single shop drawing package. Do not submit numerous separate shop drawings for the same Specification Section. Do not combine more than one section into one submission. Incorrect submissions will be returned without review.
- .2 Submittals/Shop Drawings shall indicate clearly the materials and/or equipment actually being supplied, all details of construction, accurate dimensions, capacity, operating characteristics and performance. Each Shop Drawing shall give the identifying number of the specific assembly for which it was prepared (e.g. SWBD-1A).
- .3 Submit shop drawings electronically, by email, in PDF format. Submissions that are not electronic without prior approval from the Contract Administrator shall be returned as not reviewed. Provide the following information in the email submission:
 - .1 S+A project number and Contractor Shop Drawing Identifier in Subject Line
 - .2 Attachments shall be limited to 10 MB
 - .3 Provide FTP hyperlink for all attachments in excess of 10 MB with appropriate information for downloading the file (as required)
 - .4 Shop Drawing Submission to the following email address:
 - .1 ContractAdmin.Winnipeg@smithandandersen.com
- .4 Shop drawings submitted directly to Smith + Andersen personnel (and not copied to the email address provided above) without advanced permission will not be processed nor considered as received.
- .5 Each Shop Drawing for non-catalogue items shall be prepared specifically for this project. Shop Drawings and brochures for catalogue items shall be marked clearly to show the items being supplied.
- .6 When requested, Shop Drawings shall be supplemented by data explaining the theory of operation – for example: lighting control sequence of operation – the Contract Administrator may also request that this information be added to the maintenance and operating manual.

SUBMITTALS/SHOP DRAWINGS

- .7 Provide a cover sheet with the project name, issue date, issue number, specification section number, and title of section with space for Shop Drawing review stamps for the Contractor and Contract Administrator.

PART 3 - EXECUTION

3.1 Submission

- .1 Each Shop Drawing or catalogue sheet shall be in original PDF format stamped and signed by the Contractor to indicate that they have checked the drawing for conformance with all requirements of the Drawings and Specifications, that they have co-ordinated this equipment with other equipment to which it is attached and/or connected and that they have verified all dimensions to ensure the proper installation of equipment within the available space and without interference with the Work of other trades. Ensure that electrical and mechanical co-ordination is complete before submitting drawings for review.
- .2 Scanned PDF versions are not acceptable.
- .3 Equipment shall not be released for manufacture until the shop drawing has been reviewed by Contract Administrator. Contractor shall assume responsibility and cost for field changes. Installation of any equipment shall not start until after final review of Shop Drawings by the Contract Administrator has been obtained.
- .4 Should equipment or materials that arrive on site differ from those shown on the Shop Drawings, bear all costs for:
 - .1 Revising the equipment and materials.
 - .2 Revising the Work of other contractors impacted.
- .5 As part of the electrical Contract Administrator's scope of the work, shop drawings shall be reviewed no more than twice. Should three or more reviews be required due to reasons of Contractor omissions causing resubmission requests, the Contractor shall reimburse the electrical Contract Administrator for time expended in these extra reviews.

END OF SECTION

MOUNTING HEIGHTS

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Not Used

PART 3 - EXECUTION

3.1 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 with the Contract Administrator before proceeding with installation.
- .3 Unless indicated otherwise on the drawings or within the specifications, install electrical equipment at following heights.
 - .1 Local switches: 900 mm.
 - .2 Wall receptacles:
 - .1 General: 450 mm.
 - .2 Above top of counters or counter splash backs: 175 mm.
 - .1 Where these receptacles are located adjacent to and in close proximity to local switches, mount receptacles at the same elevation as the local switches to provide a neat, aligned, installation.
 - .3 In mechanical rooms: 1200 mm.
 - .4 In equipment storage rooms: 900 mm.
 - .3 Receptacles for maintenance of equipment located on rooftops:
 - .1 Not less than 750 mm above the finished roof, per Electrical Code.
 - .4 Panelboards: 2000 mm to top of panel.
 - .5 Telephone and interphone outlets: 450 mm.
 - .6 Wall mounted telephone and interphone outlets: 1050 mm.
 - .7 Fire alarm stations: 1050 mm, 1200mm max.
 - .8 Wall Mounted Fire alarm audible devices: 2300 mm and not less than 150 mm from the ceiling, measured to the top of the device.
 - .9 Television outlets not mounted behind a wall mounted television: 450 mm.
 - .10 Wall mounted speakers: 2100 mm.
 - .11 Clocks: 2100 mm.
 - .12 Power Door Operator push buttons: 850-950 mm.

MOUNTING HEIGHTS

- .13 Wall mounted Exit Signs
 - .1 For 2400 mm to 2500 mm ceiling heights: 2100 mm.
 - .2 For all ceilings heights greater than 2500 mm: 2400 mm.
- .14 Wall mounted Battery Packs and Emergency Heads
 - .1 For 2400 mm to 2500 mm ceiling heights: 2100 mm.
 - .2 For all ceilings heights greater than 2500 mm: 2400 mm.
- .15 Wall mounted occupancy sensors: 1050 mm.
- .16 Wall mounted visible signal devices: 2100 mm to centre of lens; or as allowed by CAN/ULC-S524 "Standard for Installation of Fire Alarm Systems" except where facility accessibility standards require otherwise.
- .17 Top of remote annunciator and passive graphic panels shall be no more than 1800 mm above finished floor.
- .18 Wall mounted emergency telephone (Fireman's Handset): 1350 to 1500 mm.

END OF SECTION

WIRES AND CABLES UNDER 2000 V

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.

1.2 References

- .1 CSA C22.2 No. 0.3, Test Methods for Electrical Wires and Cables, latest edition.
- .2 CSA C22.2 No. 38, Thermoset-Insulated Wires and Cables, latest edition.
- .3 CSA C22.2 No. 51, Armoured Cables, latest edition.
- .4 CSA C22.2 No. 75, Thermoplastic-Insulated Wires and Cables, latest edition.
- .5 CSA C22.2 No. 96, Portable Power Cables, latest edition.
- .6 CSA C22.2 No. 123, Metal Sheathed Cables, latest edition.
- .7 CSA C22.2 No. 124, Mineral-Insulated Cable, latest edition.
- .8 CSA C22.2 No. 131, Type TECK 90 Cable, latest edition.
- .9 CSA C22.2 No. 174, Cables and Cable Glands for Use in Hazardous Locations, latest edition.
- .10 CAN/ULC S139 / UL 2196 (Binational Standard), Standard for Fire Test for Circuit Integrity of Fire-Resistive Power, Instrumentation, Control, and Data Cables, latest edition.
- .11 ASTM B800 - Standard Specification for 8000 Series Aluminium Alloy Wire for Electrical Purposes-Annealed and Intermediate Tempers, latest edition.

1.3 Shop Drawings And Product Data

- .1 Submit Shop Drawings and product data in accordance with Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.

1.4 Warranty

- .1 Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

PART 2 - PRODUCTS

2.1 General

- .1 All Conductors are to have a lead content of less than 300 parts per million. Submit documentation as part of shop drawing submittal.

2.2 Building Wires

- .1 Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.
- .2 Contractor to provide copper conductors on conductors sizes up to and including #8 AWG. Contractor to provide copper conductors for sizes larger than #8 AWG unless identified as aluminium or NUAL on the drawings.

WIRES AND CABLES UNDER 2000 V

- .3 All conductors to have size as indicated, with insulation of chemically cross-linked thermosetting polyethylene material rated RW90 or RWU90 to CSA C22.2 No. 38 rated as follows:
 - .1 Insulation rated at 1000 V for 600 V systems that are ungrounded or have a neutral grounding resistor to limit ground fault current.
 - .2 Insulation rated at 600 V for the other 600 V and 347/600 V distribution systems not covered under item #1 above.
 - .3 Insulation rated at 600 V for all systems rated at 480 V and less.
- .4 All aluminium or NUAL conductors to be an aluminium alloy with CSA certified as an Aluminium conductor material (ACM) and meet the requirements of the Aluminium Association Inc. AA8030 and ASTM B800 standards. Provide an anti-oxidant compound, Ideal NOALOX, on all aluminum conductor terminations.
- .5 RWU90 wiring is to be used for underground installations.

2.3 Teck Cable

- .1 Cables to CSA C22.2 No.131.
- .2 Conductors:
 - .1 Bonding conductor: copper.
 - .2 Circuit conductors: copper, size as indicated unless aluminium or NUAL is identified on the drawings. Aluminium or NUAL conductor to be provided as per item 2.1.4.
- .3 Insulation:
 - .1 Chemically cross-linked thermosetting polyethylene type RW90, rated 1000 V.
- .4 Inner jacket: polyvinyl chloride material.
- .5 Armour: interlocking aluminum.
- .6 Overall covering: thermoplastic polyvinyl chloride material rated at a minimum of FT-4.

2.4 Variable Frequency Drive Cables

- .1 Variable frequency drives are also known as variable speed drives.
- .2 Cables to CSA C22.2 No. 123 or No. 131, and to CSA C22.2 No. 174.
- .3 Conductors:
 - .1 Three (3) bare copper bonding conductor sized to Table 16 of the electrical code.
 - .2 Circuit conductors: copper, size as indicated on Drawings.
 - .3 Profile of VFD Cable cross section shall be entirely symmetrical.
- .4 Shield: Flat copper tape shield, or continuously corrugated and welded aluminum sheath, depending on cable construction.
- .5 Insulation:
 - .1 Chemically cross-linked thermosetting polyethylene (XLPE) with high dielectric strength to withstand repetitive high voltage spikes of 3.1 times the nominal system voltage rating due to VFD IGBT output.

WIRES AND CABLES UNDER 2000 V

- .2 Type RW90 or RWU90 CSA rated for 1000 V, and suitable for voltage spikes mentioned in .1 above.
- .6 Where compliant with CSA C22.2 No. 123, Armour: continuously corrugated and welded aluminum.
- .7 Where compliant with CSA C22.2 No. 131, Inner jacket: polyvinyl chloride material.
- .8 Where complaint with CSA C22.2 No. 131, Armour: interlocking aluminum.
- .9 Overall covering: thermoplastic polyvinyl chloride (PVC) material rated at a minimum of FT-4.
- .10 Cable to be complete with manufacturer's cable termination kits including terminating connectors for proper termination of shield to ground. Termination kits to ensure common mode stray currents are drawn away from the motor to extend motor life-span. Termination kits to include self-terminating connectors that provide 360 degree contact to the shield / sheath.

2.5 Mineral-Insulated Cables

- .1 Conductors: solid bare soft-annealed copper, size as indicated.
- .2 Insulation: compressed powdered magnesium oxide to form compact homogeneous mass throughout entire length of cable.
- .3 Overall covering: annealed seamless copper sheath, Type M1 rated 600 V, 250 C.
- .4 Outer jacket: PVC applied over sheath, where installed in damp and wet locations.
- .5 Two (2) hour fire rating.
- .6 Conform to requirements of CSA C22.2 No. 124; and CAN/ULC S139.
- .7 All mineral-insulated cable larger than #6 AWG shall be single conductor. For conductors #6 AWG and smaller, multi-conductor mineral-insulated cable is acceptable.
- .8 Manufacturer / Product: nVent Pyrotenax System 1850.

2.6 Fire Rated Type RC Cable

- .1 Conductors: stranded annealed copper, size as indicated.
- .2 Insulation: low smoke silicon rubber.
- .3 Armour: continuously welded and corrugated copper sheath.
- .4 Outer Jacket: Provide black low smoke, zero halogen polyolefin, FT4 rated where installed in damp and wet locations.
- .5 Two (2) hour fire rating.
- .6 Conform to requirements of CSA C22.2 No. 123; and CAN/ULC S139 with hose stream.
- .7 Manufacturer / Product:
 - .1 Prysmian Draka Lifeline Type RC90.
 - .2 Berkshire Hathaway Marmon RSCC VITALink Type RC90.

WIRES AND CABLES UNDER 2000 V

2.7 Armoured Cables

- .1 Cables to: CSA C22.2 No. 51.
- .2 Circuit conductors: copper, size as indicated unless aluminium or NUAL is identified on the drawings. Aluminium or NUAL conductor to be provided as per item 2.1.4.
- .3 Type: AC90 (BX).
- .4 Armour: interlocking type fabricated from aluminium strip.
- .5 Type: ACWU90 - PVC flame retardant jacket over armour meeting requirements of Vertical Tray Fire Test of CSA C22.2 No. 0.3 with maximum flame travel of 1.2 m.

2.8 Aluminum Sheathed Cable

- .1 Circuit conductors: copper, size as indicated unless aluminium or NUAL is identified on the drawings. Aluminium or NUAL conductor to be provided as per item 2.1.4.
- .2 Insulation: type RA90 rated 1000 V.
- .3 Sheath: aluminium applied to form continuous corrugated seamless sheath.
- .4 Outer jacket of PVC applied over sheath for direct burial or wet locations.

2.9 Wiring Termination

- .1 Lugs, terminals, screws used for termination of wiring to be to be dual rated for Copper/Aluminum (Cu/Al).
- .2 Lugs, terminals, and screws used for termination of multiple wires must be rated for their intended use.

PART 3 - EXECUTION

3.1 General

- .1 Provide a minimum of one bonding conductor for each three ungrounded conductors on all cable runs that do not include conduit. Provide a minimum of one bonding conductor within each power conduit.
- .2 For all bonding conductors, provide copper conductors insulated with a green coloured insulation.
- .3 Provide a separate dedicated insulated bonding conductor for isolated ground receptacles. See detail on Drawings for more information.
- .4 Provide a dedicated neutral for GFCI and AFCI breaker circuits. Install in accordance with breaker manufacturer's written instructions.
- .5 Size bonding conductor to applicable tables of the:
 - .1 Manitoba Electrical Code
 - .2 Winnipeg Electrical Bylaw
- .6 All equipment, junction boxes, pull boxes, liquid tight flex, etc. to be bonded to ground through bonding conductors.
- .7 Provide separate neutral conductor for each 120 volt circuit for all circuits feeding receptacles and power outlets.

WIRES AND CABLES UNDER 2000 V

- .8 Do not install cables or devices on the surface of, or within 100 mm of the underside of roof decks.
- .9 Ensure slack is provided in wiring connections to equipment which contains moving parts.
- .10 Provide a variable frequency drive (VFD) cable from each VFD unit to each motor. Wiring to be installed in accordance with the VFD and motor manufacturer instructions.
- .11 Utilize compression type fittings for the following terminations: incoming conductors into main lug only panelboards rated over 600 A; and terminations onto bus work in switchboards, transformers, transfer switches, UPSs, and other electrical equipment.
 - .1 For all compression type fittings, provide two-hole long barrel type lugs complete with lug inspection / viewing windows that allow installer to see how far the conductor has been inserted into the lug. Where mechanical screw type lugs are allowed, ensure that they are suitable for the quantity of parallel runs of wire that are to be terminated under. Provide lugs that are dual rated for copper (Cu) and aluminum (Al).
- .12 Armoured Cable Type AC90 (BX) may only be used for individual drops from slab mounted junction box to recessed mounted light fixtures or where noted on the drawings where wiring is required to be installed within an existing wall. The maximum allowable distance of armoured cable is 3 m. Contractor to receive written approval from the Contract Administrator to run armoured cable further than 3 m from junction box. Daisy chaining of fixtures is only acceptable in dry wall ceilings. Wiring in conduit is to be brought to a junction box to allow for the transition to armoured cable. Armoured cable is not to be installed directly into electrical panels or run in walls for receptacles.
- .13 Branch circuit wiring to be upsized as follows to address voltage drop when:
 - .1 The entire length of the circuit wiring exceeds 25 m – branch wiring to be a minimum of No. 10 AWG.
 - .2 The entire length of the circuit wiring exceeds 40 m – branch wiring to be a minimum of No. 8 AWG.
 - .3 The entire length of the circuit wiring exceeds 60 m – branch wiring to be a minimum of No. 6 AWG.
- .14 Where feeders or branch circuits are run underground, upsize conductors to comply with the requirements of electrical code Rule 4-004, Ampacity of wires and cables, using Diagrams D8 to D11 and Tables D8A to D11B of the electrical code. Where conductors are upsized due to Tables D8A to D11B, upsize conduits to comply with the requirements of electrical code Rule 12-910, Conductors and cables in conduit and tubing. If configuration of underground service is not aligned to one of the configurations within Tables D8A to D11B, then conductors shall be upsized to comply with electrical code Rule 4-004 as calculated by the IEEE 835 calculation method.
- .15 Where one (1) hour or two (2) hour conductor fire rating is indicated on the Drawings, provide fire rated Mineral-Insulated cables or fire rated MC cables. Fire rated Mineral-Insulated and MC cables shall be installed in accordance with the manufacturer's installation instructions and the fire rated cable product listing in order to maintain their fire rating. Special attention shall be paid to cable supporting method and fire rating of the structure from which the cables are supported.

WIRES AND CABLES UNDER 2000 V

- .16 Where conductors supply power to emergency lighting and the emergency lights are located on a different floor level than the power source (i.e. panel), then the conductors shall be fire rated for at minimum one (1) hour using fire rated Mineral-Insulated cables. Conductors with two (2) hour fire rating shall be used where indicated on Drawings. Provide fire rated Mineral-Insulated cables or fire rated MC cables where conductors require fire ratings.
- .17 Where alternatives to fire rated cables are indicated on the Drawings, such as running conduits within concrete cast in place slabs, under concrete slabs on grade, or within fire rated shaft/riser, care must be taken to ensure that the required fire rating is maintained. Where drawings call for conduits to be run within concrete cast in place slabs, the slabs must be of sufficient thickness to achieve the required fire rating and be no less than 51 mm (2 in.) of concrete cover both above and below conduits where one (1) hour fire rating is required and 102 mm (4 in.) concrete cover both above and below conduits where two (2) hour fire rating is required. The Contractor shall submit a letter confirming the concrete coverage or construction of fire rated assembly provides the sufficient fire rating of the enclosed conduits.
- .18 Wire Splicing
 - .1 Splice up to and including No. 6 AWG with nylon insulated expandable spring type connectors.
 - .2 Splice larger conductors using compression type connectors wrapped in PVC insulation or heat shrink or cold shrink, rated at the respective voltage. Type of wrap insulation shall be suitable for the installation environment. For exterior applications, cold shrink must be used.

3.2 Installation of building wires

- .1 Install all building wiring in conduit unless otherwise noted. Conduit to be sized to the electrical code unless noted on the drawings or in the specifications.
- .2 All conductors are to be colour coded. Provide colour tape at all terminations to identify all conductors in each run.

3.3 Installation Of Teck 90 Cable, Variable Frequency Drive Cable, Armoured Cable or Aluminum Sheathed Cable

- .1 Group cables wherever possible on channels.
- .2 Terminate cables in accordance with manufacturer's installation instructions.
- .3 Fastenings:
 - .1 One-hole steel straps to secure surface cables 53 mm and smaller. Two-hole steel straps for cables larger than 53 mm.
 - .2 Channel type supports for two or more cables.
 - .3 Galvanized threaded rods: 6 mm diameter minimum to support suspended channels.
 - .4 Pre-engineered support systems complying with CSA C22.2 No. 18.4 "Hardware for the support of conduit, tubing, and cable (Bi-national standard with UL 2239)."
- .4 Connectors:
 - .1 Watertight, approved for respective cables.

WIRES AND CABLES UNDER 2000 V

- .5 For single conductor cables, ground the sheath at the upstream (source) panel and provide insulated fibre plate at the load end, so as to prevent circulating sheath currents.
- .6 Where TECK 90 cable is run through or passes through a plenum space, install TECK 90 cable in conduit and comply with electrical code conduit fill percentage rules.

3.4 Installation Of Mineral-Insulated Cable System And Fire Rated Type RC Cable System

- .1 General:
 - .1 Comply with: the requirements of the manufacturer's UL listing for the fire rated cable system and the manufacturer's written installation instructions.
 - .2 Provide all Products required by the manufacturer's UL listing to provide a fully certified system.
- .2 Handling:
 - .1 Cable shall be uncoiled by rolling or rotating supply reel. Do not pull from coil periphery or centre.
- .3 Splicing:
 - .1 Make all fire rated splices in the factory. In the event that a field splice is necessary, have the manufacturer's field technician make it in the field.
- .4 Terminations:
 - .1 Make field made terminations using the cable manufacturer's termination kits. Use stripping tools, crimping tools and compression tools, available from the manufacturer for proper cable termination.
 - .2 Connections to ferrous cabinets for single conductor cables shall incorporate brass plates. Install per manufacturer's drawing.
 - .3 At cable terminations, use thermoplastic sleeving over bare conductors.
- .5 Sheath induction reduction:
 - .1 When multi-phase circuits have paralleled single conductors, run cables in groups having one of each phase in each group.
 - .2 Separate each set of paralleled conductors by at least two single cable diameters.
- .6 Exposed or Surface Installations:
 - .1 Secure cable(s) to the fire rated building structure using:
 - .1 Supporting methods outlined in the manufacturer's UL listing for the fire rated system utilized.
 - .2 Support fire rated cables at the intervals required by the manufacturer's UL listing.
- .7 Wall or floor penetrations:
 - .1 Provide approved fire stopping of all penetrations.
 - .2 Neatly train and lace cable inside boxes, equipment, and panelboards.
 - .3 Where cables are buried in cast concrete or masonry, sleeve for entry of cables.

WIRES AND CABLES UNDER 2000 V

- .4 When penetrating a fire rated wall or fire rated floor, the cable must extend a minimum of 305 mm beyond the fire rated wall or fire rated floor. The 305 mm dimension can be in any direction as 305 mm of cable length is required to allow for proper heat dissipation such that cable terminations do not overheat.

3.5 Field Quality Control

- .1 Prior to energizing wires/cables, measure insulation resistance of each wire/cable. Ensure readings are acceptable per installation recommendations. Tabulate and submit for approval as a submittal.
- .2 Contractor to oversee all testing and correct any deficiencies noted.

3.6 Installation Of Control Cables

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

END OF SECTION

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.

1.2 References

- .1 CSA C22.2 No. 41– Grounding and Bonding of Equipment, latest edition.
- .2 Manitoba Electrical Code, latest edition.
- .3 Manitoba Building Code, latest edition.
- .4 Winnipeg Electrical By-law, latest edition.
- .5 Manitoba Building Code, latest edition.
- .6 CAN/ULC-S115, Fire Tests of Fire Stop Systems, latest edition.
- .7 IEEE Standard 81 – IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System, latest edition.

1.3 Description

- .1 Provide system grounding to meet requirements of current applicable codes.

1.4 Shop drawings and product data

- .1 Submit shop drawings and product data in accordance with Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
- .2 Submit shop drawings for ground bars and ground rod inspection wells for Contract Administrator's review prior to manufacture.
- .3 Submit main system ground test report as a shop drawing for Contract Administrator's review. Include final reviewed report in the project O&M manuals.

1.5 Warranty

- .1 Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Grounding & Bonding Equipment

- .1 Meet standard of CSA C22.2 No. 41 – Grounding and Bonding of Equipment, latest edition.

2.2 Conductors

- .1 Bare or insulated, stranded, soft drawn annealed copper wire, for: ground bus, electrode interconnections, metal structures, ground connections, telephone ground.

GROUNDING + BONDING

2.3 Lugs

- .1 For all grounding and bonding connections onto bus work, utilize compression type fittings meeting the requirements of Section 26 05 21 – WIRES AND CABLES UNDER 2000 V.

PART 3 - EXECUTION

3.1 Installation

- .1 Install complete permanent, continuous, system and circuit, equipment, grounding and bonding systems including, conductors, connectors, and accessories, as indicated, to conform to requirements of local authority having jurisdiction over installation.
- .2 Provide main station ground grid as shown on drawing but the ground grid shall consist of a minimum of four (4) driven ground rods. Copper ground rods shall be not less than 3 m long and 19 mm in diameter and where practicable located adjacent to the equipment to be grounded (i.e. main electrical room). Interconnect all ground rods underground with a #2/0 AWG bare ground conductor.
 - .1 If main ground grid cannot be installed directly below the main electrical room, then provide a remote ground grid by installing the ground rods at the lowest floor level of the building and provide two grounding conductors of a minimum of #4/0 AWG copper to connect the ground grid to the main electrical room equipment. Run the two conductors through separate routes separated by a minimum of 5 m.
- .3 Supply and install a new ground bus system consisting of a length of copper bus, 25 mm thick ebony pad with chamfered edges as shown on the drawings. A minimum of two 1200 mm ground bars are to be provided in main electrical room(s) Where a perimeter ground bus is shown on the drawings, supply and install a 50 mm x 6 mm copper bus on all walls attached at 1.5 m intervals on 13 mm standoffs. The perimeter ground bus shall be continuous around the room and shall be continued above or below all openings such as doors and vents.
- .4 Interconnect the ground bars to the ground grid with a minimum #6 AWG bare copper ground conductor if the ground grid is adjacent to the main electrical room(s). Where the ground grid is remote, connect the ground bars to the remote ground grid as described in 3.1.2.(1) above.
- .5
- .6 Connect to the ground bus all metal equipment enclosures, as well as all other metal parts such as mechanical pipes, ducts, waste lines with minimum #6/0 AWG bare copper conductors.
- .7 For solidly grounded systems, transformer neutrals, main service entrance switchboard neutrals and all similar bonding connections, the bonding conductors shall be sized in accordance with Table 16 of the Electrical Code.
- .8 Provide cable grips to receive all grounding conductors. Identify all grounding conductors at the ground pad using lamacoid nameplates. Ground bus system to be provided in rooms as shown.

GROUNDING + BONDING

.9 Terminate the following conductors at the ground bus system:

- Service neutral -as indicated on drawings
- Telecommunications ground -as per TIA Standard 607, latest edition

TBB/GE linear length m (ft)	TBB/GE size (AWG)
less than 4 (13)	6
4 – 6 (14 – 20)	4
6 – 8 (21 – 26)	3
8 – 10 (27 – 33)	2
10 – 13 (34 – 41)	1
13 – 16 (42 – 52)	1/0
16 – 20 (53 – 66)	2/0
20 – 26 (67 – 84)	3/0
26 – 32 (85 – 105)	4/0
32 – 38 (106 – 125)	250 kcmil
38 – 46 (126 – 150)	300 kcmil
46 – 53 (151 – 175)	350 kcmil
53 – 76 (176 – 250)	500 kcmil
76 – 91 (251 – 300)	600 kcmil
Greater than 91 (301)	750 kcmil

where,

TBB = Telecommunications Bonding Backbone

- Main system ground -#2/0 AWG or 2 x # 4/0 AWG for remote ground grids
 - Bonding conductor -as per Table 16 of CSA C22.1
- .10 Ground all metallic water, gas, and waste systems with a minimum #6 AWG copper in accordance with code requirements.
- .11 Install bonding connections to typical equipment included in, but not necessarily limited to, following list: frames of motors, starters, control panels, building steel work, elevators, distribution panels and outdoor lighting.
- .12 Commission an approved certified testing Agency to perform a main system ground test. Submit the main system ground test report as a shop drawing for Contract Administrator's review. Provide a copy of the report in the maintenance manual. (Refer to Part 3.2).
- .13 Install connectors in accordance with manufacturer's instructions.
- .14 Ground rods to be interconnected by grounding grid conductors (sized as per sections above) and buried to a maximum depth of 600 mm below the rough station grade and a minimum depth of 150 mm below the finished station grade.
- .15 Protect exposed grounding conductors from mechanical damage.
- .16 Install bonding conductor for flexible conduit and connect at both ends to grounding bushing with solderless lug, clamp or cup washer and screw. Neatly cleat bonding conductor to exterior of flexible conduit.
- .17 Provide separate, insulated bonding conductor within each feeder and branch circuit raceway.

GROUNDING + BONDING

3.2 Testing

- .1 The Subcontractor shall pay for the testing and verification of the entire building ground system using a certified testing Agency. Tests shall include main ground grid and ground rods, and grounding connections between all electrical and communication rooms. The agency shall provide complete test reports indicating test methodology and results. All costs shall be included in Contract bid.
- .2 Following are acceptable methods of testing the ground grid. Testing shall be in accordance with IEEE Standard 81 (latest edition).
 - .1 Two-Point Method
 - .2 Three-Point Method
 - .3 Ratio Method
 - .4 Staged Fault Tests
 - .5 Fall-of-Potential Method

END OF SECTION

HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.

1.2 Shop Drawings And Product Data

- .1 Submit Shop Drawings and product data in accordance with Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
- .2 Conduit and equipment provided under the Electrical division shall be complete with all necessary supports and hangers required for a safe and workpersonlike installation.

1.3 Warranty

- .1 Provide a warranty in accordance with the requirements of Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Materials

- .1 Provide “U” type support Strut as manufactured by Unistrut or Hilti.

PART 3 - EXECUTION

3.1 Installation

- .1 All drilling for hangers, rod inserts and work of similar nature shall be done by this Division.
- .2 Auxiliary structural members shall be provided under the electrical section concerned where conduits or equipment must be suspended between the joists or beams of the structure, or where required to replace individual hanger to allow for installation on new services. Submit details for review as requested.
- .3 Depending on type of structure, hangers shall be either clamped to steel beams or joists, or attached to approved concrete inserts.
- .4 Approved type expansion shields and bolts may be used for conduit up to 103 mm diameter where the pre-setting of concrete inserts is not practical. Submit Shop Drawings.
- .5 Suspension from metal deck shall not be allowed unless specifically accepted by the Contract Administrator. Drawings of the proposed method of suspension must be submitted for review.
- .6 Hangers, hanger rods and inserts in all parking and ramp areas shall meet the requirements of CAN/CSA-S413 – Parking Structures (latest edition) and shall be of corrosion-resistant material or have an effective, durable corrosion resistant coating. Submit samples for approval.
- .7 Suspending one hanger from another shall not be permitted.

HANGERS AND SUPPORTS

- .8 All hangers, supports, brackets and other devices used outside the building wall shall be galvanized. If galvanized components cannot be used submit samples of proposed substituted for review before installation.

3.2 Horizontal Runs On The Roof

- .1 Where conduit or cables are run horizontally across a roof, conduit or cable shall be supported from pre-manufactured UV resistant sleepers with closed cell foam base.
- .2 Sleepers shall be "E-Z Sleeper" product from Pipe-Ease Inc. or approved equivalent.
- .3 Wood Blocks are not acceptable.

END OF SECTION

SPLITTERS, JUNCTION, PULL BOXES AND CABINETS

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
- .3 Section 26 05 53 – IDENTIFICATION.
- .4 Section 26 05 63 – ACCESS DOORS AND ACCESSIBILITY.

1.2 Reference

- .1 Manitoba Electrical Code, latest edition.
- .2 Manitoba Building Code, latest edition.
- .3 Winnipeg Electrical By-law, latest edition.
- .4 Manitoba Building Code, latest edition.
- .5 CAN/ULC-S115, Fire Tests of Fire Stop Systems, latest edition.

1.3 Shop Drawings And Product Data

- .1 Submit shop drawings and product data for cabinets in accordance with specification Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.

1.4 Warranty

- .1 Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Splitters

- .1 Sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position. Provide CSA Type 1 enclosures in non-sprinklered environments and CSA Type 4/12 in sprinklered environments.
- .2 Main and branch lugs to match required size and number of incoming and outgoing conductors as indicated. Lugs to be dual rated for Copper/Aluminum (Cu/Al).
- .3 At least three spare terminals on each set of lugs in splitters less than 400 A.

2.2 Junction And Pull Boxes

- .1 Welded steel construction with screw-on flat covers for surface mounting.
- .2 Covers with 25 mm minimum extension all around, for flush-mounted pull and junction boxes.

2.3 Cabinets

- .1 Type E: sheet steel, hinged door and return flange overlapping sides, handle, lock and catch, for surface mounting.

SPLITTERS, JUNCTION, PULL BOXES AND CABINETS

- .2 Type T: sheet steel cabinet, with hinged door, latch, lock, 2 keys, containing 19 mm plywood backboard for surface or flush mounting. The plywood backboard is to have a fire-resistant coating on the front. Do not paint over plywood fire rating certification stamp.

PART 3 - EXECUTION

3.1 Splitter Installation

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

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 2000 mm above finished floor.
- .3 Install terminal block as indicated in Type T cabinets.
- .4 Only main junction and pull boxes are indicated. Install pull boxes as follows:
 - .1 A conduit run exceeds 30 m and;
 - .2 360 degrees of combined bends between pull boxes for power conduits or 180 degree of combined bends between pull boxes for communication and low voltage conduits.

3.3 Identification

- .1 Provide equipment identification in accordance with Section 26 05 53 – IDENTIFICATION.
- .2 Install identification labels indicating system name, voltage, and phase.

END OF SECTION

OUTLET BOXES, CONDUIT BOXES AND FITTINGS

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.2 References

- .1 Manitoba Electrical Code, latest edition.
- .2 Manitoba Building Code, latest edition.
- .3 Winnipeg Electrical By-law, latest edition.
- .4 Manitoba Building Code, latest edition.
- .5 CAN/ULC-S115, Fire Tests of Fire Stop Systems, latest edition.

1.3 Warranty

- .1 Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Outlet And Conduit Boxes General

- .1 Size boxes in accordance with the electrical code.
- .2 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 75 mm x 50 mm x 38 mm or as indicated. 100 mm square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.
- .2 Provide cast FS aluminum boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacles connected to rigid conduit.
- .3 Provide electro-galvanized steel utility boxes for surface mounted boxes connected to surface-mounted EMT conduit, minimum size 100 mm x 54 mm x 48 mm.
- .4 Square or octagonal outlet boxes for lighting fixture outlets.
- .5 Square outlet boxes with extension and plaster rings for flush mounting devices in finished plaster or tile walls.

OUTLET BOXES, CONDUIT BOXES AND FITTINGS

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

2.5 Floor Boxes

- .1 Concrete tight electro-galvanized sheet steel floor boxes with adjustable finishing rings to suit floor finish with brushed aluminum faceplate. Device mounting plate to accommodate short or long ear duplex receptacles. Minimum depth: 28 mm for receptacles; 73 mm for communication equipment.
- .2 Adjustable, watertight, concrete tight, cast floor boxes with openings drilled and tapped for 16 mm and 21 mm conduit. Minimum size: 73 mm deep.
- .3 Refer to details within drawings for additional information.

2.6 Outlet Boxes For Non-Metallic Sheathed Cable

- .1 Electro-galvanized, sectional, screw ganging steel boxes, minimum size 75 mm x 50 mm x 63.5 mm with two double clamps to take non-metallic sheathed cables.

2.7 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 35 mm and pull boxes for larger conduits.
- .4 Double locknuts and insulated bushings on sheet metal boxes.

2.8 Service Fittings

- .1 'High tension' receptacle fitting made of 2 piece die-cast aluminum with brushed aluminum housing finish for duplex receptacles. Bottom plate with two knockouts for centered or offset installation.
- .2 Pedestal type 'low tension' fitting made of 2 piece die cast aluminum with brushed aluminum housing finish to accommodate Amphenol jack connectors.

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.

OUTLET BOXES, CONDUIT BOXES AND FITTINGS

- .5 Non-combustible electrical outlet boxes that penetrate a vertical fire separation or a membrane forming part of an assembly required to have a fire-resistance rating, do not require fire stops provided,
 - .1 They do not exceed:
 - .1 160 cm² (0.016 m²) each in area, and
 - .2 An aggregate area of 650 cm² (0.065 m²) in any 9.3 m² of surface area, AND
 - .2 The annular space between the membrane and the box does not exceed 3 mm.
- .6 Where the conditions of clause 3.1.5 are not met, provide fire stops for the outlet boxes.
- .7 Opposing outlets on non-fire rated partition walls shall have a minimum 150 mm horizontal separation. Outlets shall not be mounted back to back.
- .8 Conform to the fire stopping requirements of the building code: unless provided with a fire stop in accordance with CAN/ULC-S115, "Fire Tests of Fire Stop Systems", electrical outlet boxes on opposite sides of a vertical fire separation required to have a fire-resistance rating shall be separated by a horizontal distance of not less than 600 mm, or be installed in adjacent stud cavities.

END OF SECTION

CONDUITS, CONDUIT FASTENERS AND FITTINGS

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 31 – SPLITTERS, JUNCTION, PULL BOXES AND CABINETS
- .3 Section 26 05 32 – OUTLET BOXES, CONDUIT BOXES AND FITTINGS

1.2 References

- .1 CAN/CSA C22.2 No.18- Outlet Boxes, Conduit Boxes, and Fittings, latest edition.
- .2 CSA C22.2 No.45.1- Electrical Rigid Metal Conduit - Steel, latest edition.
- .3 CSA C22.2 No.56- Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit, latest edition.
- .4 CSA C22.2 No.83- Electrical Metallic Tubing, latest edition.
- .5 CSA C22.2 No.211.2- Rigid PVC (Unplasticized) Conduit, latest edition.
- .6 CAN/CSA C22.2 No.227.3- Flexible Non-metallic Tubing, latest edition.
- .7 CSA C22.2 No.227.1 - Electrical Non-Metallic Tubing, latest edition.

1.3 Warranty

- .1 Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Conduits

- .1 Electrical rigid metal conduit: to CSA C22.2 No.45.1, galvanized steel or aluminum threaded.
- .2 Epoxy coated conduit: to CSA C22.2 No.45, with zinc coating and corrosion resistant epoxy finish inside and outside.
- .3 Electrical metallic tubing (EMT): to CSA C22.2 No.83, with couplings.
- .4 Rigid PVC conduit: to CSA C22.2 No.211.2.
- .5 Flexible metal conduit: to CSA C22.2 No.56, steel or liquid-tight flexible metal.
- .6 Electrical non-metallic tubing (ENT): to CSA C22.2 No. 227, with couplings.

2.2 Conduit Fastenings

- .1 One-hole steel straps to secure surface conduits NPS 2 and smaller. Two-hole steel straps for conduits larger than NPS 2.
- .2 Beam clamps to secure conduits to exposed steel work.
- .3 Channel type supports for two or more conduits at 1 m on centre.
- .4 Hot dipped galvanized threaded rods, 6 mm dia. minimum, to support suspended channels.

CONDUITS, CONDUIT FASTENERS AND FITTINGS

- .5 For non-fire rated applications, pre-engineered support systems complying with CSA C22.2 No. 18.4 "Hardware for the support of conduit, tubing, and cable (Bi-national standard with UL 2239)."

2.3 Conduit Fittings

- .1 Fittings: manufactured for use with conduit specified. Coating: same as conduit.
- .2 Factory 90 degree elbow where 90 bends are required for 1" and larger conduits when a hydraulic bender is not used.
- .3 Connectors, and couplings for EMT conduit are to be set-screw steel type. Below the level of suspended ceilings, in a sprinklered environment, provide watertight fittings and "O" rings on all conduit runs and when conduit is terminated at any piece of electrical equipment.
- .4 Provide plastic bushings for all connectors, rigid nipples and rigid conduit 35 mm or larger.

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.

2.5 Fish Cord

- .1 Fish cord to be made of polypropylene.

PART 3 - EXECUTION

3.1 Installation

- .1 All conduits on project to be surface mounted. Conduits are not allowed in cast in-place concrete or concrete slabs unless written consent is received from the Contract Administrator and The City. Only once approved by the Contract Administrator and The City do the clauses contained within this section and the respective sections relating to conduits in cast in-place concrete or concrete slabs apply.
- .2 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .3 Do not install conduits, associated raceway system, or devices on the surface of, or within 100 mm of the underside of roof decks.
- .4 Conceal conduits except in mechanical and electrical service rooms or in unfinished areas. Conduits to have their own support system and are to be supported independently of the ceiling grid or ceiling support system.
- .5 Where vertically run conduit passes through a slab, Contractor to provide a 100 mm high concrete pad with the pad extending 100 mm on all sides of the conduit.
- .6 Use electrical metallic tubing (EMT) conduit except where specified otherwise.
- .7 Use epoxy coated conduit in corrosive areas.
- .8 Use rigid galvanized steel threaded conduit where conduit is subject to mechanical damage.
- .9 Use rigid PVC conduit underground or in corrosive areas and where indicated.

CONDUITS, CONDUIT FASTENERS AND FITTINGS

- .10 Use flexible metal conduit for connection to motors or vibrating equipment in dry areas, connection to recessed luminaires without a prewired outlet box, connection to surface or recessed luminaires and work in movable metal partitions. Ensure slack is provided in wiring connections to equipment which contains moving parts.
- .11 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations. Use only liquid tight fittings when using liquid tight flexible metal conduit. Liquid tight flexible metal conduit to have a jacket with an FT6 rating when used in plenums otherwise provide a minimum FT4 rating. Ensure slack is provided in wiring connections to equipment which contains moving parts.
- .12 Use explosion proof flexible connection for connection to explosion proof motors.
- .13 Install conduit sealing fittings in hazardous areas. Fill with compound.
- .14 Minimum conduit size for lighting and power circuits: NPS 21 mm, unless otherwise noted on the Drawings.
- .15 Minimum conduit size for data / voice cabling: as indicated on drawings, otherwise 27 mm.
- .16 Install EMT conduit from a raised floor branch circuit panel to outlet boxes located in sub floor.
- .17 Install EMT conduit from a raised floor branch circuit panel to junction box in sub-floor. Run flexible metal conduit from junction box to outlet boxes for equipment connections in sub-floor.
- .18 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .19 Mechanically bend steel conduit over 21 mm diameter.
- .20 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .21 Install fish cord in empty conduits.
- .22 Run two 27 mm spare conduits up to ceiling space and two 27 mm spare conduits down to sub-floor space from each flush panel. Terminate these conduits in 152 x 152 x 102 mm junction boxes or in case of an exposed concrete slab, terminate each conduit in flush concrete or surface type box.
- .23 Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.
- .24 Dry conduits out before installing wire.
- .25 All cutting and patching of masonry/concrete floors, walls, and roof for electrical services shall be by this Division. Obtain approval from The City and/or structural Contract Administrator before cutting any structural walls or floors. Cutting and drilling shall only be at times allowed by The City. Check and verify the location of existing mechanical and electrical services in walls and below the floor slab in all areas requiring core drilling and cutting. Protect all tenant areas where core drilling occurs. Carefully chip top and bottom of slab to expose rebar to minimize cutting of rebar when core drilling. Provide x-ray study before drilling or cutting where required by The City and/or structural Contract Administrator.
- .26 Provide sleeves for all new conduit passing through floor and roof slabs, beams, concrete walls and slab to slab partitions, etc.

CONDUITS, CONDUIT FASTENERS AND FITTINGS

- .27 Where cables and conduits pass through partitions and through floors that are not fire rated, provide an air-tight seal around the cables and conduits.
- .28 Where cables and conduits pass through floors and fire rated walls, pack space between conduit (or cable) and sleeve with an approved fire stop as specified in Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .29 Prior to installation of any wire or cable in the ducts, pull through each duct a flexible mandrel not less than 300 mm long and size for the internal diameter of duct, followed by stiff bristle brush to remove sand, earth and other foreign matter. Avoid disturbing or damaging ducts where concrete has not set completely. Provide photo and video evidence of compliance with this clause and send to Contract Administrator for review within 24 hours of Work occurring.

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 mounted 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.
- .7 Conduits must not be used to support other conduits.

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.

CONDUITS, CONDUIT FASTENERS AND FITTINGS

3.6 Conduits Underground

- .1 Slope conduits to provide drainage.
- .2 For all non-PVC conduits run underground, provide waterproof joints with heavy coat of bituminous paint.

END OF SECTION

CABLE TRAYS

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.

1.2 Section Includes

- .1 Cable trays and accessories.

1.3 References

- .1 Manitoba Electrical Code.
- .2 Manitoba Building Code.
- .3 Winnipeg Electrical By-law.
- .4 Manitoba Building Code.
- .5 CAN/ULC-S115, Fire Tests of Fire Stop Systems, latest edition.
- .6 CSA-C22.2 No. 126.1 – Metal Cable Tray Systems, latest edition.
- .7 CSA-C22.2 No. 126.2 – Non-metallic Cable Tray Systems, latest edition.
- .8 ASTM B 633 – Specification for Electrodeposited Coatings of Zinc on Iron and Steel, latest edition.
- .9 ASTM A 653 – Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot Dip Process, latest edition.
- .10 ASTM A 123 – Specification for Zinc (Hot Galvanized) Coatings on Iron and Steel, latest edition.
- .11 ASTM A 510 – Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel, latest edition.
- .12 NEMA VE 1 – Metal Cable Tray Systems, latest edition.
- .13 NEMA VE 2 – Cable Tray Installation Guidelines, latest edition.
- .14 ASTM A 641 – Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire, latest edition.
- .15 ASTM A 580 – Standard Specification for Stainless Steel Wire, latest edition.
- .16 ASTM D 769 – Standard Specification for Black Oxide Coatings, latest edition.

1.4 Shop Drawings And Product Data

- .1 Submit Shop Drawings and product data in accordance with Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
- .2 Shop Drawings: Indicate tray type, dimensions, support points, and finishes.
- .3 Product Data: Provide data for fittings and accessories.

CABLE TRAYS

- .4 Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agencies specified under article 1.3 –References. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

1.5 Project Record Documents

- .1 As-Built Drawings to indicate actual routing of cable tray and locations of supports.

1.6 Qualifications

- .1 Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years of experience.
- .2 Furnish products listed and classified by UL Inc., CSA, CUL, as suitable for purpose specified and shown.

1.7 Warranty

- .1 Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Ladder-Type Cable Tray

- .1 Description: CSA-C22.2 No. 126, NEMA VE 1.
- .2 Load Class: Unless otherwise noted on the drawings, cable tray shall be Class B - 65 LB/FT..
- .3 Material: Hot dipped galvanized steel.
- .4 Inside Width: as indicated.
- .5 Inside Depth: 100 mm or as indicated.
- .6 Straight Section Rung Spacing: 300 mm on centre for electrical wiring or 150 mm on centre on communication cable trays.
- .7 At junctions of cable trays provide manufactured transition pieces with a bending radius equal to or larger than the width of the cable tray.
- .8 Provide manufacturer's standard clamps, hangers, brackets, splice plates, reducer plates, blind ends, barrier strips, connectors, and grounding straps.
- .9 Covers: not required unless indicated on Drawings.

2.2 Wire Basket Sections And Components

- .1 Provide wire basket of types and sizes indicated; with connector assemblies, clamp assemblies, connector plates, splice plates and splice bars. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the following additional construction features.
- .2 Materials and Finishes: Material and finish specifications for wire basket sections and components to be electrodeposited zinc plating in accordance with ASTM B 633, Type III, SC-1, with straight sections made from carbon steel wire, ASTM A 510, Grade 1008, unless one of the following finishes is noted on the drawings:

CABLE TRAYS

- .1 Stainless Steel: Straight sections and accessories shall be made from AISI Type 316L Stainless Steel meeting the minimum mechanical properties of ASTM A 580.
- .2 Powder Coat: Straight sections shall be powder coated black with an average paint thickness of 1.2 mils (30 microns) to 3.0 mils (75 microns). Colour to be custom and selected during shop drawing stage.
- .3 Hot Dipped Galvanizing: Straight sections shall be made from steel meeting the minimum mechanical properties of ASTM A 510, Grade 1008 and shall be hot dipped galvanized after fabrication in accordance with ASTM A 123.
- .3 Type of Wire Basket Support System
 - .1 All straight section longitudinal wires shall be constructed with a continuous top wire safety edge. Safety edge must be kinked and T-welded on all tray sizes.
 - .2 Wire basket shall be made of high strength steel wires and formed into a standard 50 mm by 100 mm wire mesh pattern with intersecting wires welded together. All mesh sections must have at least one bottom longitudinal wire along entire length of straight section.
 - .3 Wire basket sizes shall conform to the following nominal criteria:
 - .1 Straight sections shall be furnished in standard lengths.
 - .2 Wire diameter shall be 5 mm minimum on all mesh sections.
 - .3 Wire basket shall have a minimum usable loading depth of 100 mm unless 50 mm or 150 mm is noted on the drawings by a width noted on the drawings. If no width is detailed then 300 mm will be the minimum.
 - .4 All fittings shall be field formed, from straight sections, in accordance with manufacturer's instructions.
 - .5 All splicing assemblies shall be UL/CSA approved as a bonding conductor. When using powder coated wire basket as bonding conductor, the paint must be completely removed at all contact points of splice/ground bolt attachment.
 - .6 Wire basket supports shall be trapeze hangers unless center support hangers or wall brackets are noted on the drawings. Trapeze hangers or center support hangers shall be supported by 1/4 inch or 3/8 inch diameter threaded rods or pre-engineered support systems complying with CSA C22.2 No. 18.4 "Hardware for the support of conduit, tubing, and cable (Bi-national standard with UL 2239)."
 - .7 Special accessories shall be furnished as required to protect, support and install a wire basket support system.
- .4 Provide manufacturer's standard clamps, hangers, brackets, splice plates, reducer plates, blind ends, barrier strips, connectors, and grounding straps.
- .5 Covers: not required unless indicated on drawings.

2.3 Warning Signs

- .1 Nameplates: 12.7 mm high black letters on yellow plastic nameplates, with the following wording:
 - .1 WARNING! DO NOT USE CABLE TRAY AS WALKWAY, LADDER OR SUPPORT. USE ONLY AS MECHANICAL SUPPORT FOR CABLES AND TUBING!

CABLE TRAYS

2.4 Manufacturers

- .1 The following are approved manufacturers:
 - .1 CER- Canadian Electric Raceways.
 - .2 Pursley.
 - .3 B-Line.
 - .4 Pilgrim.
 - .5 Columbia-MBF-Cope.
 - .6 Legrand.
 - .7 ABB / Thomas & Betts.

PART 3 - EXECUTION

3.1 Installation

- .1 Install in accordance with manufacturer's instructions.
- .2 Install metallic cable tray in accordance with NEMA VE 1. Install wire basket in accordance with NEMA VE-2, to ensure that the cable tray equipment complies with requirements of all applicable codes including the local electrical code.
- .3 Provide supports at each connection point, at the end of each run, and at other points to maintain spacing between supports of 3 m.
- .4 Use expansion connectors where required.
- .5 Grounding and bonding:
 - .1 Provide continuity between tray components.
 - .2 Use anti-oxidant compound to prepare aluminum contact surfaces before assembly.
 - .3 Provide #6 AWG bare copper bonding conductor through entire length of tray; bond to each component.
 - .4 Connections to tray may be made using mechanical or exothermic connectors.
- .6 Install warning signs at 15.25 m centers along cable tray, located to be visible.

END OF SECTION

POKE-THRU DEVICES

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.

1.2 Scope

- .1 These poke-thru devices provide the interface between power and communication cabling in an above grade concrete floor and the activation location where power and/or communication device outlets are required. These poke-thru devices provide flush device outlets that will not obstruct the floor area.

1.3 Classification And Use

- .1 This poke-thru shall have been examined and tested by Underwriters Laboratories Inc. to Standard UL514A and/or UL514C and tested to Canadian Standard C22.2 and bear the cULus mark. This poke-thru device shall also have been tested by Underwriters Laboratories Inc. as to fire resistance and bear the fire classification mark. Devices shall be classified for use 2-hour rated, unprotected reinforced concrete floors and 2-hour rated floors employing unprotected steel floor units and concrete toppings (D900 Series Designs) or concrete floors with suspended ceilings (fire resistive designs with suspended ceilings should have provisions for accessibility in the ceiling below the poke-thru fittings).

1.4 Shop Drawings And Product Data

- .1 Submit Shop Drawings and product data in accordance with Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.

1.5 Warranty

- .1 Provide a warranty in accordance with the requirements of Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Materials

- .1 Poke-Thru Assembly. This assembly consists of an insert and an activation cover.
- .2 Refer to Electrical drawings for additions
 - .1 Insert:
 - .1 The insert body shall have the necessary channels to provide complete separation of power and communication services. There shall be one 21 mm channel for power and two 16 mm channels for communication cabling. The channels shall be arranged such that communication cables can be conduit protected and connected to the insert body using a die-cast zinc conduit connector with two 16 mm threaded openings to accept both rigid and flexible conduit connections.

POKE-THRU DEVICES

- .2 The body will consist of an intumescent fire stop material to maintain the fire-rating of the floor slab. The intumescent material will be held securely in place in the insert body and shall not have to be adjusted to maintain fire-rating of the unit and the floor slab. The insert shall have a spring steel retaining ring that will hold the poke-thru device in the floor slab without additional fasteners. The poke-thru insert shall also consist of a 21 mm conduit stub that is connected to the insert body and a 402 ml stamped steel junction box for wire splices and connections. The stamped steel junction box shall also contain the necessary means to electrically ground the poke-thru assembly.
- .2 Activation Cover:
 - .1 The activation cover shall be manufactured of die-cast aluminum alloy and be capable of being powder coated or plated. Coated finish to be textured, two-stage epoxy paint in gray, black, or ivory. Activation cover shall also be available in a solid brass forging. Brass finish shall be a brushed finish with a lacquer sealant. Finish to be confirmed by Contract Administrator during shop drawing review. The activation cover shall have a slide function to allow for cables to be utilized while the cover is closed...
 - .2 The activation shall have two locations to mount communication connectors. Connectors shall be mounted using a mounting bracket. Mounting brackets shall be provided to mount communication connectors.
 - .3 Cover to be mop proof.

2.2 Manufacturers

- .1 The following are approved manufacturers:
 - .1 Legrand - Wiremold - Evolution Series
 - .2 Hubbell – System One

PART 3 - EXECUTION**3.1 Installation**

- .1 Unit shall permit all wiring to be completed at floor level. Unit shall mount in a cored-hole with a minimum diameter per manufacturer requirements.
- .2 Use is defined by the UL Fire Resistance Directory as a minimum spacing of 610 mm on center and not more than one device per each 6 sq. m of floor area in each span.
- .3 Prior to and during installation, refer to system layout and/or approval drawings. Installer shall comply with detailed manufacturer's instruction sheet included with each device.

END OF SECTION

INSTALLATION OF CABLES IN TRENCHES AND IN DUCTS

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 33 71 19 – Concrete Encased Duct Banks and Maintenance Chambers.

PART 2 - PRODUCTS

2.1 Cable Protection

- .1 Protect existing cables in manholes and trenches with 38 mm x 140 mm planks pressure treated with 5 % pentachlorophenol solution, water repellent preservative.

2.2 Markers

- .1 Concrete type cable markers: 600 x 600 x 100 mm with words: cable, joint or conduit impressed in top surface, with arrows to indicate change in direction of cable and duct runs.

PART 3 - EXECUTION

3.1 Cable Installation In Ducts

- .1 Install cables as indicated in ducts.
- .2 Pull a steel mandrel through each duct less than 300 mm long and of a diameter 6 mm less than internal diameter of duct, followed by stiff bristle brush to remove sand, earth and other foreign matter. Pull stiff bristle brush through each duct immediately before pulling-in cables.
- .3 Install a polypropylene pull string in each duct if one does not exist. Pull string to remain after cable has been installed.
- .4 Do not pull spliced cables inside ducts.
- .5 Install multiple cables in duct simultaneously.
- .6 Use CSA approved lubricants of type compatible with cable jacket to reduce pulling tension.
- .7 To facilitate matching of colour coded multi-conductor control cables reel off in same direction during installation.
- .8 Before pulling cable into ducts and until cables are properly terminated, seal ends of lead covered cables with wiping solder; seal ends of non-leaded cables with moisture seal tape.
- .9 After installation of cables, seal duct ends with duct sealing compound.

INSTALLATION OF CABLES IN TRENCHES AND IN DUCTS

3.2 Markers

- .1 Mark cable every 150 m along cable or duct runs and changes in direction.
- .2 Mark underground splices.
- .3 Where markers are removed to permit installation of additional cables, reinstall existing markers.
- .4 Lay concrete markers flat and centered over cable with top flush with finish grade.

END OF SECTION

IDENTIFICATION

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.

1.2 References

- .1 Manitoba Electrical Code.
- .2 Manitoba Building Code.
- .3 Winnipeg Electrical By-law.
- .4 Manitoba Building Code.

1.3 Shop Drawings And Product Data

- .1 Submit Shop Drawings and product data in accordance with Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.

1.4 Warranty

- .1 Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Equipment Identification

- .1 Identify electrical equipment with nameplates as follows:
 - .1 Lamacoid 3 mm thick plastic engraved sheet, black or red face, white core, mechanically attached with self-tapping screws or rivets.
 - .2 White letters 12 mm high for major switchboards, panelboards and power transformers.
 - .3 White letters 12 mm high for terminal boxes, junction boxes, grid boxes, splitter boxes, disconnect switches starters and contactors.
 - .4 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
 - .5 Allow for minimum of twenty-five (25) letters per nameplate and label.
 - .6 Identification to be in English.

IDENTIFICATION

- .7 Black nameplates for normal power.
- .8 Red nameplates for emergency power.
- .9 Blue nameplates for UPS Power.
- .10 Sample:

SWITCHBOARD AA
3000A, 600/347V, 3 PH, 4W, 50kA
FED FROM SWITCHBOARD AAA
MANUFACTURED IN MM/YYYY; SERIAL NUMBER ##-####

- .11 Wording on nameplates to be approved by Contract Administrator prior to manufacture.
- .12 Nameplates for splitters, terminal cabinets, grid boxes, pull boxes, and junction boxes are to indicate the system and/or voltage characteristics.
- .13 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
- .14 Transformers: indicate capacity, primary and secondary voltages, and upstream source where Transformer is fed from.
- .15 Mechanical equipment: indicate equipment name and full circuit number including panel board identification.
- .16 Switchboards, Distribution Panels, and Panelboards: Name designation, rated ampacity, voltage, number of phases, and number of wires, if neutral is rated for 200%, interrupting capacity in units of kA, upstream source from which panelboard is fed, month and year manufactured, and serial number.
- .17 Manual Transfer Switches (MTS): Name designation, rated ampacity, voltage, transfer switch arrangement (e.g. 3 pole with no neutral, 3 pole with solid neutral, 3 pole with overlapping neutral, 4 pole), withstand rating in units of kA, upstream normal power source from which MTS is fed, upstream emergency power source from which MTS is fed, month and year manufactured, and serial number.
- .18 Provide nameplates on all electrical equipment including:
 - .1 Splitters, terminal cabinets, grid boxes, pull boxes, and junction boxes
 - .2 Disconnects, starters and contactors, and Mechanical equipment
 - .3 Transformers
 - .4 Switchboards, Distribution Panels, and Panelboards
 - .5 Manual Transfer Switches
 - .6 Inverter
 - .7 UPS equipment
 - .8 Lighting control systems

IDENTIFICATION

.2 Labels:

- .1 A printed label, similar to a Brady label 6 mm high letters unless specified otherwise, for internal components, such as relays, fuses, terminal blocks.

2.2 Wiring Identification

- .1 Identify wiring with permanent legible identifying markings, either numbered or coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour code: in conformance with CSA C22.1.
- .4 Use colour coded wires in communication cables and control wiring, matched throughout system.

2.3 Conduit And Cable Identification

- .1 Colour code conduits, boxes and metallic sheathed cables.
- .2 Code with plastic tape, paint, or coiled conduit markers at points where conduit or cable enters wall, ceiling, or floor, and at 15 m intervals.
- .3 Colours: 25 mm wide prime colour and 20 mm wide auxiliary colour:
 - .1 up to 250 V Normal Power = Green
 - .2 up to 600 V Normal Power = Blue
 - .3 up to 250 V Emergency Power = Black
 - .4 up to 600 V Emergency Power = Orange
 - .5 High Voltage, greater than 750 V = Large independent label clearly identifying the voltage
 - .6 Telephone/Data = Green
 - .7 Fire alarm = Red
 - .8 Other security systems = Yellow
 - .9 Controls = Purple

2.4 Receptacle Identification

- .1 All receptacles including systems furniture receptacles and whip connections are to be labelled with the respective circuit numbers with a printed label, similar to a Brady label, with 12 mm characters. Circuit number to include full circuit number including panel board identification.
- .2 Label to be placed on wall above cover plate or on cover plate. Location of label to be consistent throughout project.

2.5 Manufacturers And CSA Labels

- .1 Visible and legible after equipment is installed.

IDENTIFICATION

2.6 Warning Signs

- .1 Provide warning signs, as specified, and/or to meet the requirements of the Inspection Authorities.

2.7 Fuse Size Labelling

- .1 Contractor to install a label on all equipment with fuses to identify the fuse sizes and class that are installed in the respective equipment.
- .2 Contractor to also install a label on all equipment with fuses to identify the maximum allowable fuse size based on the size of the respective feeders.

PART 3 - EXECUTION

3.1 Not Used

END OF SECTION

ACCESS DOORS AND ACCESSIBILITY

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.

1.2 Shop Drawings And Product Data

- .1 Submit Shop Drawings and product data in accordance with Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
- .2 Submit drawings showing size, type and location of all access doors, for review, before installation.

1.3 Warranty

- .1 Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Materials

- .1 Access doors shall be Acudor, or LeHage or Mifab. Coordinate with other trades on site. All access doors on site shall be from the same manufacturer.
- .2 Doors in solid walls shall be equal to Acudor Model UF5000 with 14 U.S. gauge, prime painted steel door panel, rust resistant concealed hinges and screwdriver operated lock.
- .3 Doors in plaster partitions or ceiling shall be equal to Acudor model AP5010 16 US gauge, prime painted steel, concealed hinges and screwdriver operated lock.
- .4 Doors in drywall partitions or ceiling shall be equal to Acudor model DW 5040, 20 US gauge, prime painted steel, concealed hinges and screwdriver operated lock.
- .5 Access doors in fire rated walls or ceilings shall be equal to Acudor Model FW 5050 and ULC labeled with insulated door panel, concealed hinge, self-closing, self-latching, and prime painted. Provide master key operated catch in areas accessible to the public.
- .6 All doors in tiled walls shall be 16 US gauge, stainless steel, type 304 with #4 satin finish, concealed hinges, wall frame and screw driver operated lock.
- .7 Minimum size of doors shall be 300 mm x 450 mm. Wherever possible 600 mm x 600 mm doors shall be used.

PART 3 - EXECUTION

3.1 Installation

- .1 All parts of the installation requiring periodic maintenance shall be accessible. Wherever pull boxes, junction boxes and other appurtenances are concealed by building construction, access doors shall be furnished by this section and installed under the respective Trade Sections (i.e. masonry, plaster, drywall, tile, etc.). This section is responsible for the proper location of the access doors.

ACCESS DOORS AND ACCESSIBILITY

- .2 Wherever possible, items requiring access shall be located in easily accessible areas (i.e. exposed or T-bar ceilings).
- .3 Group items in order to minimize the number of access doors required.
- .4 Each access door shall be installed to provide complete access to equipment for maintenance and servicing.
- .5 Make any changes to locations of access doors as directed by the Contract Administrator.
- .6 The final installed locations of all access doors shall be shown on the As-Built Drawings.

END OF SECTION

ELECTRICAL POWER SYSTEM STUDIES

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.

1.2 References

- .1 CSA Z462 – Workplace Electrical Safety, latest edition.
- .2 IEEE 1584 – IEEE Guide for Performing Arc Flash Hazard Calculations, latest edition.
- .3 NFPA 70E – Standard for Electrical Safety in the Workplace, latest edition.

1.3 Summary

- .1 The electrical power system studies for the project shall be performed by an approved electrical power systems Subcontractor. The type and content of each study is specified in the following articles.
- .2 The extent of the power systems studies shall include from the main utility connection down to the branch circuit panels. All relays and fuse sizes to be included to ensure the best operation of the entire system.
- .3 Contractor to label and re-label with the appropriate City approved label all equipment that is new or the calculated values have changed from what is currently shown.
- .4 A separate power system study is to be completed for the Recreation Centre distribution system and for the Child Care distribution system.
- .5 The Recreation Study shall also be performed to include the operation of the temporary emergency power generation system, assuming a generator size of 500kW.

1.4 Shop Drawings And Product Data

- .1 Submit Shop Drawings and product data in accordance with Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
- .2 Completed electrical power system studies shall be bound and submitted to the Contract Administrator. Submit initial version(s) of the power system studies during the project shop drawing stage. Submit another “final” version of the power system studies at the end of the project utilizing the final/installed values. The study must be stamped and signed by a Professional Engineer in the applicable jurisdiction of the project for all submissions.
- .3 Contractor providing electrical power systems study to allow for revisions/adjustments based on review comments and actual transformer impedances.
- .4 Provide a minimum of three (3) bound coloured copies of all submissions to The City and Contract Administrator for review. Modify studies based on comments received and continue to re-issue until an accepted version is agreed upon.
- .5 Provide a copy of the working electronic file in native program format along with each of the final copies of the studies. Identify what software was used to complete the studies. The information contained within the project file remains the property of The City and can be used by The City for future system modifications.

ELECTRICAL POWER SYSTEM STUDIES

- .6 Provide samples of the proposed arc flash labels. All labels to match The City's standard labels.
- .7 Contractor shall submit initial power system study at the same time as shop drawings for electrical distribution equipment, such that the Contract Administrator can review the adequacy of equipment interrupting capacity or withstand ratings, prior to equipment being released for manufacture. In situations where the entire study cannot be submitted with the electrical distribution shop drawings, Subcontractor shall submit at a minimum a preliminary short circuit study for review.

1.5 Warranty

- .1 Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

PART 2 - PRODUCT

2.1 Electrical Power System Studies

- .1 Short-Circuit Analysis
 - .1 Calculation of maximum RMS symmetrical three-phase short-circuit and single line to ground fault current at each significant location in the electrical system shall be made using a digital computer.
 - .2 Appropriate motor short-circuit contribution shall be included at the appropriate locations in the system so that the computer calculated values represent the highest short-circuit current the equipment will be subjected to under fault conditions.
 - .3 A tabular computer printout shall be included which lists the calculated short-circuit currents, X/R ratios, equipment short-circuit interrupting or withstand current ratings, and notes regarding the adequacy or inadequacy of the equipment.
 - .4 The study shall include a computer printout of input circuit data including conductor lengths, number of conductors per phase, conductor impedance values, insulation types, transformer impedances and X/R ratios, motor contributions, and other circuit information as related to the short-circuit calculations.
 - .5 Include a computer printout identifying the maximum available short-circuit current in RMS symmetrical amperes and the X/R ratio of the fault current for each bus/branch calculation.
 - .6 The system one-line diagram shall be computer generated and will clearly identify individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location and other information pertinent to the computer analysis.
 - .7 A comprehensive discussion section evaluating the adequacy or inadequacy of the equipment must be provided and include recommendations as appropriate for the improvements to the system.

ELECTRICAL POWER SYSTEM STUDIES

- .8 The Subcontractor shall be responsible for supplying conductor information (lengths, types, number per phase, etc.) in a timely manner to allow the short-circuit analysis to be completed prior to final installation.
- .9 Any inadequacies shall be called to the attention of the Contract Administrator and recommendations made for improvements as soon as they are identified.
- .10 A summary table identifying the calculated short circuit ratings, the ratings of the equipment's and pass/fail analysis.
- .2 Protective Device Time-Current Coordination Analysis
 - .1 The time-current coordination analysis shall be performed with the aid of a digital computer and will include the determination of settings, ratings, or types for the over-current protective devices supplied.
 - .2 A sufficient number of computer generated log-log plots shall be provided to indicate the degree of system protection and coordination by displaying the time-current characteristics of series connected over-current devices and other pertinent system parameters.
 - .3 Computer printouts shall accompany the log-log plots and will contain descriptions for each of the devices shown, settings of the adjustable devices, the short-circuit current availability at the device location when known, and device identification numbers to aid in locating the devices on the log-log plots and the system one-line diagram.
 - .4 The study shall include a separate, tabular computer printout containing the suggested device settings of all adjustable over-current protective devices, the equipment where the device is located, and the device number corresponding to the device on the system one-line diagram.
 - .5 A computer generated system one-line diagram shall be provided which clearly identifies individual equipment buses, bus numbers, device identification numbers and the maximum available short-circuit current at each bus when known.
 - .6 A discussion section which evaluates the degree of system protection and service continuity with over-current devices, along with recommendations as required for increasing system protection or device coordination.
 - .7 Significant deficiencies in protection and/or coordination shall be called to the attention of the Contractor Administrator and recommendations made for improvements as soon as they are identified.
- .3 Arc Flash/Incident Energy Study
 - .1 An Arc Flash/Incident Energy Study shall be performed to determine the incident energy and arc flash protection boundary at each piece of electrical equipment and to identify the level of PPE required by people working on that respective equipment.
 - .2 The study shall take into account all the information set forth in the short circuit study and the coordination study. Contractor to use the minimum and maximum fault currents provided by the utility to determine the worst incident energy levels. Provide two columns in your arc flash summary sheet identifying the current at both fault levels. Contractor to revisit the coordination study and revise coordination to provide the minimum incident energy levels as possible. Provide

ELECTRICAL POWER SYSTEM STUDIES

- recommendations to reduce the incident energy levels even further at the risk of affecting the coordination to allow The City and Contract Administrator to review options and provide feedback.
- .3 Calculate the arc flash hazard, incident energy level and the flash protection boundary as per IEEE 1584. PPE level recommendations as per NFPA 70E / CSA Z462.
- .4 All electrical equipment to be identified with the incident energy, flash protection boundary and level of PPE required.
- .5 Purpose made labels to be provided on all electrical equipment. All equipment where levels were not calculated are to be provided with a standard warning label. Label samples to be submitted for review by The City and Contract Administrator.

2.2 Approved Electrical Power Systems Contractors

- .1 The power system studies shall be completed by qualified and experienced personnel.
- .2 The specified electrical power system studies shall be performed by:
 - .1 Schneider-Electric Services.
 - .2 Eaton - Cutler-Hammer Service Group.
 - .3 ABB.
 - .4 G.T. Wood.K-Line – K-Tek.
 - .5 Pelikan Inc.
 - .6 General Electric (GE).
 - .7 Eastenghouse.
 - .8 AC Tesla.Brosz Technical Services.
 - .9 JR Stephenson (JRS).

PART 3 - EXECUTION

3.1 General

- .1 Electrical Subcontractor to include for all on site surveys and investigations in order to obtain all the relevant information to complete all the studies.
- .2 The relays and equipment will be set up on site by the Electrical Subcontractor.
- .3 Review work on site to ensure equipment has been set up as per the coordination study. Test systems at random to ensure the coordination study has been adhered to.
- .4 Submit a report and a letter reporting to the Contract Administrator and The City that the coordination study information has been followed and implemented accordingly.
- .5 Contractor to revise fuse sizes as identified in the report and modify the drawings to represent as-built conditions.

3.2 Labelling

- .1 Have power system study specialist install arc flash labels on all equipment. Coordinate with the Electrical Subcontractor.

ELECTRICAL POWER SYSTEM STUDIES

- .2 Where manufacturer listed series ratings are permitted by other specification sections within this specification, install UL series rating labels on all devices/equipment that are part of a series rated combination. Ensure that labels comply with the "Series rated combinations" rule within the Electrical Code Training
- .3 Provide one day of in-depth training for each distribution system (Recreation and Child Care) on arc-flash safety detailing the industry and code requirements including the details of the specific project for The City and The City's representatives.
- .4 Refer to 01 79 00 - Demonstration and Training.

END OF SECTION

SLEEVES

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.2 Warranty

- .1 Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Materials

- .1 Sleeves passing through stud partitions shall be 0.75 mm 22 US Gauge steel.
- .2 Sleeves passing through masonry walls shall be Schedule 40 steel pipe.
- .3 Sleeves passing through floors in finished areas and concealed spaces may be sheet metal or factory fabricated reusable type.
- .4 Where a housekeeping pad cannot be installed, sleeves passing through floors with waterproof membrane shall have a flashing collar, 50 mm wide at the membrane level. Flashing collar shall be continuously welded to sleeve. Sleeves shall extend 50 mm above the finished floor and shall be Schedule 40 steel pipe.
- .5 Where conduits pass through exterior foundation walls 6 mm thick steel sleeve of inside diameter not less than 75 mm greater than the outside diameter of the pipe shall be used and shall be complete with anchor collar. Thunderline Link-Seal wall seal or approved equal shall be used for the annular space between the sleeve and the conduit. A reinforced concrete bridge shall be installed between the wall and the adjacent undisturbed soil.
- .6 Provide adequate bracing for support of sleeves during concrete and masonry work.
- .7 Unless otherwise specified on the drawings, sleeves passing through the roof shall be liquid tight flexible conduit flashing consisting of a gooseneck shaped aluminum flashing sleeve with an integral deck flange, EPDM end cap seal and EPDM base seal.

PART 3 - EXECUTION

3.1 Installation

- .1 Arrange for all chases and formed openings in walls and floors as required by the Electrical Division for the Electrical services. These chases and openings shall not be larger than necessary to accommodate the equipment and services. Advise on these requirements well in advance, before the concrete is poured and the walls are built. All necessary sleeves and inserts shall be supplied by this Division.
- .2 Chases and openings not located in accordance with the above provisions shall be made at the expense of this Division. Cutting of structural members shall not be permitted without specified written acceptance of the Contract Administrator.

SLEEVES

- .3 Provide sleeves for all service penetrations through walls, partitions, floor slabs, plenums and similar barriers. At non-rated barriers fill the annular space between the service and the sleeve with fire rated insulation as specified for rated separations and caulk around the edges with a minimum 12 mm thick of fire rated compound or acoustic non-setting mastic.
- .4 Where-holes are to be installed in existing structure, Contractor is to core drill the-holes required. Contractor is required to scan all areas prior to coring and confirm layout with Contract Administrator prior to completing work. When installing sleeves in existing structures, sleeves shall be provided as specified complete with a combination puddle/anchor flange bolted to the floor. Seal watertight between the flange and the floor.
- .5 All sleeves are to extend 150 mm above finished floor to accommodate a 100 mm concrete pad. Contractor to pour the concrete pad with the pad extending 100 mm on all sides of the sleeve.

END OF SECTION

CUTTING AND PATCHING

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.2 Warranty

- .1 Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Materials

- .1 All services and materials used for the cutting and patching shall meet all requirements specified in Div. 01, and Section 26 05 01, and shall be carried out by experienced workers.
- .2 Include for all cutting and patching for all Electrical services.

PART 3 - EXECUTION

3.1 Installation

- .1 Cut all openings no larger than is required for the services. Core drill for individual services.
- .2 Obtain approval from the structural Contract Administrator before cutting or core drilling any openings or-holes in slabs or structural elements.
- .3 Locate all openings in structure elements requiring cutting and patching, and x-ray the structure to obtain Structural Contract Administrator's approval prior to cutting or core drilling of existing structure. Make adjustments to location of openings as required to minimize cutting of rebar, and completely avoiding electrical conduit.
 - .1 Cut-holes through slabs only.
 - .2 Do not cut-holes through beams.
 - .3 Holes to be cut are 200 mm (Diameter) or smaller only.
 - .4 Maintain at least 100 mm clear from all beam faces. Space at least 3-hole diameters on Centre.
 - .5 For-holes that are required closer than 25% of slab span from the supporting beam face, use cover meter above the slab to clear slab top bars.
 - .6 For-holes that are required within 50% of slab span, use cover meter underside of slab to clear slab bottom bars.

CUTTING AND PATCHING

- .4 X-ray scanning:
 - .1 X-rays shall be performed by a qualified technician, in a safe manner and in accordance with all applicable regulations governing this activity. The company shall be licensed by the Canadian Nuclear Safety Commission (CNSC), and all radiography work shall be performed in accordance with the Nuclear Safety and Control Act.
 - .2 Follow any safety requirements stipulated by the property manager.
 - .3 Minimum requirements: All people must be evacuated within a radius of 10 m from each exposure location. Prior to conducting exposures verify this "safe zone". If the 10 m radius includes public areas such as a sidewalk, lobby, or elevator, these areas must be controlled (e.g. elevators shut down or prevented from stopping on floors at which exposures are taking place). In addition, if exposure locations are near the walls of adjacent tenants, ensure the notification and evacuation of people within the 10 m radius. The 10 m radius applies to the camera floor and the floor directly below only. The qualified technician shall ensure adequate precautions for the additional floors above and below the camera floor.
- .5 Patch all openings after services have been installed to match the surrounding finishes.
- .6 In existing areas all cutting, and core drilling for individual services except where specifically noted, is part of this division work.
- .7 The cost of x-ray scanning, cutting, patching and finishing is included in this division Contract.

END OF SECTION

COMMISSIONING

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 03 – AS-BUILT DRAWINGS.
- .3 Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
- .4 Section 26 01 00 – OPERATING AND MAINTENANCE INSTRUCTIONS.
- .5 Section 01 91 13 – GENERAL COMMISSIONING REQUIREMENTS

1.2 Scope

- .1 The commissioning process for the Electrical Systems shall include:
 - .1 Verification that the installation meets the requirements of the Contract Documents.
 - .2 Verification that the systems performance meets the design intent.
 - .3 Provision of building operator training.
 - .4 Provision of As-Built documentation, operating and maintenance manuals, and systems operating manuals.
- .2 The Contractor, Contract Administrator and Commissioning Agent shall provide the services to complete the process. The execution portion of this Section defines the areas of responsibility.
- .3 Provide labour, equipment and material to conduct the Contractor commissioning process as outlined in this Section.
- .4 The City has engaged a commissioning agent, referred to as the Building Commissioning Consultant. Refer to Section 01 91 13 – GENERAL COMMISSIONING REQUIREMENTS. All requirements outlined within the specifications section 01 91 13 shall be complied to and shall take precedent to the requirements outlined within.

1.3 Warranty

- .1 Provide a warranty in accordance with the requirements of Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Materials

- .1 The Contractor and manufacturers shall provide all instrumentation and equipment necessary to conduct the tests as specified in the Electrical Sections. The Contractor shall advise the Contract Administrator or Commissioning Agent of instrumentation to be used and the dates the instruments were calibrated.

PART 3 - EXECUTION

3.1 Installation

- .1 This Section describes the commissioning process to be performed by the Contractor. The process shall provide a high level of quality control during the construction.

COMMISSIONING

- .2 The commissioning process shall consist of:
 - .1 Shop Drawings/As-Built Drawings.
 - .2 Installation inspection and equipment verification.
 - .3 Power distribution system commissioning.
 - .4 Emergency Power system commissioning.
 - .5 Fire alarm system verification and commissioning.
 - .6 Commissioning Agent performance testing.
 - .7 Commissioning meetings.
 - .8 Operating and maintenance manuals.
 - .9 Training.
 - .10 Systems acceptance.

3.2 Installation inspection And Equipment Verification

- .1 The Contractor shall complete the equipment verification forms for each piece of equipment. The completed forms shall be forwarded to the Contract Administrator for review and be included in the operating and maintenance manual.

3.3 Test Forms And Verification Forms

- .1 The Commissioning Agent will prepare a test form manual, which will contain a form for every test identified in the Specification. A copy of this manual will be given to the Contractor, the Contractor and the Contract Administrator.
- .2 The Contractor shall prepare test forms for every test identified in this Specification. The Contractor shall complete each form as tests are completed and forward a copy to the Contract Administrator for review on a monthly basis.
- .3 The forms shall be signed by either the authorities, the Contract Administrator or the Commissioning Agent.

3.4 Testing Of Equipment And Systems

- .1 Conform to Section 26 01 00 – OPERATING AND MAINTENANCE INSTRUCTIONS.
- .2 The Contractor shall hire the services of the manufacturer's technicians to test the equipment and associated systems. The technician shall record the results of the tests on the testing forms. The tests shall be witnessed by the Contract Administrator or the Commissioning Agent. When the tests have been completed satisfactorily the technician and witnessing authority shall sign the forms.
- .3 When equipment or systems fail a test, the test shall be repeated after repairs or adjustments have been made. The additional tests shall be witnessed by the Contract Administrator or the Commissioning Agent.
- .4 Tests which have not been witnessed shall not be accepted and shall be repeated.

COMMISSIONING

3.5 Commissioning Meetings And Scheduling

- .1 The Contractor shall include the schedule for all tests and equipment start-up tests in the construction schedule.
- .2 The commissioning meetings shall occur during the regular construction meetings. The testing schedules and results of all tests shall be reviewed.

3.6 Operating And Maintenance Manuals

- .1 Conform to Section 26 01 00 – OPERATING AND MAINTENANCE INSTRUCTIONS.
- .2 Submit Operating and Maintenance Manuals to Commissioning Agent for review.

3.7 Operator Training

- .1 Conform to Section 26 01 00 – OPERATING AND MAINTENANCE INSTRUCTIONS.
- .2 Submit Operating and Maintenance manuals to Commissioning Agent for review.
- .3 The training shall be conducted in a classroom and at the equipment or system.
- .4 Training will begin when the operating and maintenance manuals have been delivered to The City and reviewed by the Contract Administrator.
- .5 Submit a course outline to the Contract Administrator before training commences. Provide course documentation for up to eight people.
- .6 Each training session will be structured to cover:
 - .1 The operating and maintenance manual.
 - .2 Operating procedures.
 - .3 Maintenance procedures.
 - .4 Trouble-shooting procedures.
 - .5 Spare parts required.
- .7 The training sessions will be scheduled and co-ordinated by the Commissioning Agent. The Subcontractor will video record the session.
- .8 Training shall be provided for the following systems:

System	Minimum Training Times
Fire alarm	4 hours
The electrical system	8 hours
UPS systems	4 hours
LV lighting control system	4 hours

3.8 Commissioning Agent

- .1 A Commissioning Agent will be hired by The City.
- .2 The commissioning agent responsibilities shall include:
 - .1 Preparing the commissioning plan.
 - .2 Co-ordinating with the Contractor to schedule tests.
 - .3 Preparing a test form manual.

COMMISSIONING

- .4 Witnessing selected tests.
- .5 Receiving all test forms.
- .6 Conducting performance test.
- .7 Co-ordinating the Contractor's training.
- .8 Attend commissioning meetings.
- .9 Preparing the systems operating manuals.
- .3 The Contractor shall co-ordinate and co-operate with the Commissioning Agent.

3.9 Performance Testing

- .1 The Commissioning Agent will conduct performance tests on each electrical system to verify that the design intent performance has been met. The performance tests will cover all seasonal modes.
- .2 The Contractor shall conduct performance tests on all electrical systems and document the results on the performance forms provided by the Commissioning Agent in accordance with this Specification.
- .3 The Contractor shall provide assistance to the Commissioning Agent and have personnel available during the performance testing procedures during construction and the warranty period.
- .4 Performance testing will begin when all electrical systems have been completed, tested by the Contractor reviewed by the Contract Administrator and substantial completion has been achieved.

3.10 Commissioning Process Allocation

- .1 The commissioning process shall be allocated a value as follows:

\$7,500	For electrical Contract value less than \$250,000
3% of electrical Contract value	For electrical Contract value from \$250,000 to \$10,000,000
\$500,000	For electrical Contract value more than \$10,000,000

- .2 This value shall be itemized in the Statement of Prices which forms the basis for progress payment for the various portions of work. The Contractors may draw from this allocation as the commissioning process is completed.
 - .1 The Contractors shall submit all test and verification forms. The Contract Administrator will use these forms to calculate a percentage complete.
 - .2 The Contractor may claim up to 50 % of the value indicated above, as per Schedule of Breakdown, on a monthly basis, from this allocation leading up to performance testing. The remaining amount shall not be paid out until the performance testing, O&M manuals and training have been completed satisfactorily.

END OF SECTION

POWER MONITORING SYSTEM - WEB BASED

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.

1.2 System Description

- .1 Furnish and install a complete Power Monitoring System (PMS) as detailed on the drawings and as described in this specification. The system is defined to include, but not be limited to, remote devices for monitoring, device communication interface hardware, inter-communication wiring and ancillary equipment. The manufacturer shall demonstrate the system is not a prototype and that similar systems have been field installed and successfully operated for at least five years.
- .2 The PMS shall interconnect all meters, electronic trip units, transformer temperature monitors, motor protection devices, and digital relays, included within the new power equipment and the existing devices shown on the drawings that have the capability to communicate through the network.
- .3 The PMS shall utilize Ethernet as the high-speed backbone network that supports view of all the information through a web-based interface.
- .4 All products shall not violate any U.S. or Canadian patents.

1.3 References

- .1 All Power Meters and Circuit Monitors shall be UL 508 Listed, CSA approved, and have CE marking. They shall also have certified revenue accuracy as per ANSI C12.16.
- .2 The system shall comply with the applicable portions of NEMA standards. In addition, the control unit shall comply with FCC Emission Standards specified in Part 15, Sub-part J for Class A application.

1.4 Shop Drawings And Product Data

- .1 Submit Shop Drawings and product data in accordance with Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
- .2 Indicate electrical characteristics and connection requirements. When the power equipment manufacturer installs PMS components, the power equipment shop drawings shall clearly identify the components, the internal connections, and all contractor connections.
- .3 The PMS drawings shall show all PMS components including necessary component dimensions; type, size, and weight, as well as, a single line diagram indicating external wiring requirements. Drawings shall identify terminal blocks used for interconnections and wire type to be used.
- .4 Product Data: Provide catalog sheets and technical data sheets to indicate physical data and electrical performance, electrical characteristics, and connection requirements.
- .5 Submit design of proposed web interface for review by the Contract Administrator and The City.

POWER MONITORING SYSTEM - WEB BASED

- .6 Submit to the Contract Administrator a calibration report confirming that the meters and Power Monitoring System have been calibrated based on the electrical system parameters at the project site. This calibration is to include site parameters such as voltage, CT Ratio, PT Ratio, and any other meter specific items.

1.5 Quality

- .1 Power monitoring components included within the power equipment lineups shall be factory installed, wired and tested prior to shipment to the job site.

1.6 Warranty

- .1 Provide a warranty in accordance with the requirements of Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Power Quality Meter

- .1 The Power Quality Meter shall be installed as part of a power monitoring system as indicated on the drawings.
- .2 The Power Quality Meter shall communicate using MODBUS protocol over serial or TCP networks.
- .3 The Power Quality Meter shall include an integral Ethernet jack and shall include an embedded webpage. It shall also be capable to act as a gateways as part of the overall power monitoring system network.
- .4 The Power Quality Meter shall be a PowerLogic ION 7650 or approved equal.
- .5 Power quality meter shall be installed on the main breakers of normal switchboard.

2.2 Ethernet Connectivity And Web Enabling

- .1 Ethernet capability shall include an embedded web server inside the unit, capable of serving HTML pages with dynamic meter data displays and logging data.
- .2 It shall be capable of accepting HTML files, PDF files, ActiveX CRG, GIF, JPG graphics, MS Office files (doc, xls, ppt, etc.).
- .3 It shall feature one 10/100 Mbit UTP port.
- .4 It shall feature 16 MB of internal memory.
- .5 It shall support all meters and other MODBUS devices through one 2-wire or 4-wire RS-485 communication port via standard daisy-chain connections.
- .6 It shall feature one RS-485 serial port and a second port configurable for RS-232 or RS-485 (support for 2-wire or 4-wire).
- .7 It shall be assigned a single IP address, and provide high speed Ethernet support for up to 192 devices.
- .8 It shall be compatible with Ethernet TCP/IP networks and allows users to access power monitoring information from any location on a local area network (LAN) or a wide area network (WAN).
- .9 It shall also be possible via the Ethernet port to upgrade the firmware of the Ethernet communication card in the field to accommodate new system features.

POWER MONITORING SYSTEM - WEB BASED

2.3 Embedded Web Pages

- .1 Embedded WEB Pages shall be provided for any meter and any device connected to the main gateway meter. Where applicable to certain device types, the WEB pages shall include the following:
 - .1 Energy and Power Summary with Trending and Period Comparisons.
 - .2 Power Quality Summary with Trending and Comparisons.
 - .3 Harmonics and Power Flow Summary.
 - .4 Voltage Disturbance, Transient, and Flicker Summaries.
 - .5 Alarm Summary with Trending and Period Comparisons.
 - .6 ITIC/SEMI and Motor De-rating Curves.
 - .7 Real Time Trending with Forecasting.
 - .8 Real Time Energy Cost Summary Worksheet.
 - .9 EN50160 and IEEE519 Power Quality Index Tables, Trends and Summary Alarms.

2.4 Communications To The Building Automation System

- .1 Provide gateway to communicate to building automation system using Modbus RTU protocol to access metering data by building automation vendor.

2.5 Manufacturers

- .1 The PMS shall be:
 - .1 POWERLOGIC as manufactured by Schneider Electric.
 - .2 FORESEER as manufactured by Eaton.
 - .3 ACCESS as manufactured by Siemens.
 - .4 ABB.

PART 3 - EXECUTION

3.1 Ethernet Gateways

- .1 Contractor interconnection wiring requirements shall be clearly identified on the PMS system drawings.
- .2 Advanced Ethernet gateways are to be used when meters and other components on the system do not contain internal memory.
- .3 Provide adequate internal memory to store historic data for a minimum of 30 days for all meters.

3.2 System Start-Up And Training

- .1 On-site start-up and training of the PMS shall be included in the project bid.
- .2 Start-up shall include a complete working demonstration of the PMS with simulation of possible operating conditions that may be encountered.

POWER MONITORING SYSTEM - WEB BASED

- .3 Submit to the Contract Administrator a calibration report confirming that the meters and Power Monitoring System have been calibrated based on the electrical system parameters at the project site. This calibration is to include site parameters such as voltage, CT Ratio, PT Ratio, and any other meter specific items.
- .4 Training shall include any documentation and hands-on exercises necessary to enable electrical operations personnel to assume full operating responsibility for the PMS after completion of the training period.
- .5 The project bid shall include 2 days start-up assistance and 2 days training to include 3 separate trips.

3.3 Design Services

- .1 The power monitoring system vendor shall make all alterations and changes needed to make the system perform as needed at each location. These changes may include:
 - .1 Custom enclosures and panels.
 - .2 Modifications to existing switchgear and equipment, including installation.
 - .3 Communication interface installation and configuration.
 - .4 Communication network design.
- .2 The power monitoring system vendor to provide development, integration, and installation services required to complete and turn over a fully functional system, including but not limited to:
 - .1 All technical coordination, installation, integration and testing of all components.
 - .2 Detailed system design, including a full design of the proposed web interface in conjunction with The City and Contract Administrator.
 - .3 System drawings.

3.4 Installation

- .1 PMS components, including meters, electronic trip units, transformer temperature monitors, motor protection devices, and digital relays, included within the power equipment lineups shall be factory installed, wired and tested prior to shipment to the job site.
- .2 All control power, CT, PT and data communications wire shall be factory wired and harnessed within the equipment enclosure.
- .3 Where external circuit connections are required, terminal blocks shall be provided and the manufacturer's drawings must clearly identify the interconnection requirements including wire type to be used.

3.5 Wiring

- .1 The Electrical Subcontractor shall install all wiring required to externally connect equipment lineups, external meters and any other wiring as required by the PMS vendor including all RS 485 communications network loops and Ethernet communications wiring to meters.
- .2 All wiring external to equipment is to be run in conduit.

END OF SECTION

LIGHTING CONTROL EQUIPMENT - ADDRESSABLE LOW VOLTAGE

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
- .3 Section 26 51 13 – LIGHTING EQUIPMENT.
- .4 Lighting Control Sequence of Operations as attached to Specifications or as shown on drawings.

1.2 References

- .1 CAN/CSA-C22.2 No. 141, Emergency Lighting Equipment, latest edition.
- .2 CAN/CSA-C22.2 No. 205, Signal Equipment, latest edition.
- .3 American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE)
- .4 International Electrotechnical Commission (IEC)
- .5 National Electrical Manufacturers Association (NEMA)
- .6 Underwriters Laboratories, Inc. (UL)
- .7 UL 508 – Standard for Industrial Control Equipment
- .8 UL 916 – Standard for Energy Management Equipment
- .9 UL 924 – Standard for Emergency Lighting and Power Equipment

1.3 Summary

- .1 This specification is intended to fully describe all of the design, engineering, programming, hardware, software, ancillary devices and associated technical services required to provide a building-wide networked lighting control system. This system is specified to perform scheduled and automated lighting control sequences.
- .2 Lighting Control System includes computer-based software that provides control, configuration, monitoring and reports. System includes the following components:
 - .1 Energy Control Unit
 - .2 System Server
 - .3 0-10 V Dimming, Fixed Output Ballasts or 0-10 V LED Drivers
 - .4 System Field Devices (Input and Output Modules)
 - .5 Occupancy Sensors – Low Voltage
 - .6 Photo Sensors – Low Voltage
 - .7 Wallstations – Low Voltage
 - .8 Lighting Control System Software - Graphical User Interface based
 - .9 Communication Wire

LIGHTING CONTROL EQUIPMENT - ADDRESSABLE LOW VOLTAGE

- .10 Area Lighting Controllers and/or Room Controllers (to dim/switch a group of luminaires)
- .11 Interface to Audio Visual equipment (for integration with 3rd party LCD Touch Screen Panel)
- .12 Interface to BACnet
- .13 Interface to customizable Energy dashboard

1.4 Description Of System

- .1 The work covered in this section is subject to the requirements in the General Conditions of the Specifications. Contractor shall coordinate the work in this section with the trades covered in other sections of the specification to provide a complete and operable system.
- .2 Extent of the lighting control system work is indicated by drawings and by the requirements of this section. It is the intent of this section to provide an integrated, energy saving lighting control system as described herein from a single supplier. Contractor is responsible for confirming that all components and accessories of the lighting control system interoperate as a single system.
- .3 Subcontractor shall ensure that lighting system control devices and assemblies are fully compatible and can be integrated into a system that operates as described in the lighting control notes on drawings and as described within this specification. Any incompatibilities between devices, assemblies, and system controllers shall be resolved between the Subcontractor and the System Provider, as required to ensure proper system operation and maintainability.
- .4 The lighting control system shall include a fully distributed WAN/LAN network of global controller/routers, individually addressable System Field Devices that are not integral to luminaires, sensors, switches, relays and other ancillary devices required for a complete and operable system. The system WAN/LAN start-up shall be by the control system Manufacturer or Contractors certified by the Manufacturer.
- .5 The lighting control system shall utilize non-proprietary industry standard 0-10 V dimming or fixed output ballasts and/or 0-10 V LED drivers, occupancy sensors, daylight sensors, etc.
- .6 UL 924 listed devices shall have the ability to control 120 V / 277 V load.
- .7 System software interface shall have the ability to notify communication failures to system users via system & email messages. Email messages shall be available in html and text formats.
- .8 On-going system expansion, service and support shall be available from multiple factory certified vendors. Recommended service agreements may be submitted at the time of bid complete with manufacturers suggested inventory and pricing for system parts and technical support labor.

LIGHTING CONTROL EQUIPMENT - ADDRESSABLE LOW VOLTAGE

- .9 The electrical drawings may show a lighting control system designed with a specific manufacturer as a Basis of Design. There are pre-approved alternate manufacturers listed herein, which are acceptable lighting control systems to be used; however, by using pre-approved alternate manufacturers, the Contractor accepts responsibility and associated costs for all required modifications to circuitry, devices, and wiring, etc. as required to suit the alternate pre-approved manufacturer's lighting control system. The Contractor shall provide complete engineered shop drawings (including power and control wiring) with deviations from the original design highlighted for review and approval prior to rough-in. Where additional components or devices are required to meet the same design intent as indicated in the drawings and specifications, the Contractor shall include for all costs.

1.5 Lighting Control Applications

- .1 Provide a minimum application of lighting controls as follows:
- .1 Space Control Requirements – Provide occupancy/vacancy sensors as shown and noted on the electrical drawings. Occupancy/vacancy sensors to provide Manual- or Partial-ON functionality or Automatic-ON as described in the drawings and specifications.
 - .2 Bi-Level Lighting – Provide multi-level controls in all spaces as indicated in the electrical drawings and specifications.
 - .3 Task Lighting / Plug Loads – Where indicated on the drawings, provide automatic shut off of plug loads and task lighting. For spaces with multiple occupants a single shut off consistent with the overhead lighting may be used for the area.
 - .4 Daylit Areas – Provide daylight-responsive automatic control in all spaces (conditioned or unconditioned) and as indicated in the drawings, where daylight contribution is available. Daylighting control shall operate as follows:
 - .1 All luminaires within defined daylight zones shall be controlled separately from luminaires outside of daylit zones.
 - .2 Daytime setpoints for total ambient illumination (combined daylight and electric light) levels that initiate dimming shall be programmed in compliance with relevant local building energy codes and/or as indicated in the drawings and specifications.
 - .3 Multiple-level switched daylight harvesting controls may be utilized for areas marked on drawings.
 - .4 Provide smooth and continuous daylight dimming for areas marked on drawings. Daylighting control system may be designed to turn off electric lighting when daylight is at or above required lighting levels, only if system functions to turn lamps back on at dimmed level, rather than turning full-on prior to dimming.
- .2 All enclosed rooms shall have controls that allow for independent control of each local control zone. Rooms larger than 300 square feet shall instead have at least four preset lighting scenes unless otherwise specified. Occupancy / vacancy sensors shall be provided to turn off all lighting in the space. Spaces with up to four moveable walls shall include controls that can be reconfigured when the room is partitioned.

LIGHTING CONTROL EQUIPMENT - ADDRESSABLE LOW VOLTAGE

1.6 Shop Drawings And Product Data

- .1 Submit Shop Drawings and product data in accordance with Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
- .2 Submit manufacturer's data on lighting control system and components and the product data specified below at the same time as a package. Shop drawing submission shall include but not limited to the following:
 - .1 Complete list of all parts needed to fully install selected system components.
 - .2 Composite wiring and/or schematic diagram of each control circuit as proposed to be installed. Submitted shop drawings shall detail control system, as supplied, including one-line diagrams, wire counts, coverage patterns, interconnection diagrams showing field-installed wiring and physical dimensions of each item.
 - .3 Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.
 - .1 Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
 - .2 For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.
 - .3 Show exact location of all digital devices, including at minimum sensors, load controllers, and switches for each area on reflected ceiling plans. Contractor must provide AutoCAD and PDF format reflected ceiling plans. For sensors, prove sensor is suitable for the proposed application.
- .3 Provide room/area details including products and sequence of operation for each room or area. Illustrate typical acceptable room/area connection topologies.
- .4 Network riser diagram including floor and building level details. Include network cable specification and end-of-line termination details, if required. Illustrate points of connection to integrated systems. Coordinate integration with mechanical and/or other trades as required.
- .5 Software Operational Documentation:
 - .1 Software operating and upgrade manuals
 - .2 Program Software Backup: On portable memory storage device, USB stick, complete with data files.
 - .3 Printout of software application and graphic screens, or upon request, a live demonstration of Control, Configure and Analyze functionality or a video demonstrating above stated system capabilities.
- .6 Catalog sheets, specifications and installation instructions.
- .7 Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.
- .8 Copy of applicable warranty.
- .9 Additional information As Required On A Project Specific Basis.

LIGHTING CONTROL EQUIPMENT - ADDRESSABLE LOW VOLTAGE

1.7 Project Conditions

- .1 Do not install equipment until following conditions can be maintained in spaces to receive equipment:
 - .1 Ambient temperature: 0° to 40° C (32° to 104° F).
 - .2 Relative humidity: Maximum 90 percent, non-condensing.

1.8 Warranty

- .1 Provide a five year limited manufacturer's warranty on all equipment to be free of defects in materials and workpersonship.
- .2 On-going system expansion, service and support shall be available from multiple factory certified vendors. Recommended service agreements shall be submitted at the time of bid complete with manufacturers suggested inventory and pricing for system parts and technical support labor.

PART 2 - PRODUCTS

2.1 Materials

- .1 Control system: by one manufacturer and assembled from compatible components.

2.2 Central Lighting Control Software

- .1 The system shall offer central lighting control for the facility lighting administrator to perform energy management, configuration maintenance, monitoring operations, and providing support to building occupants.
- .2 Native central control software shall be utilized for energy reporting status and complete programming without the need for any third party hardware or software. Systems that require any third party linked software or graphics is not acceptable.
- .3 Software shall provide information on general system settings via mouse click on a floor plan. Left clicking over a device on the graphical software interface shall show a description of the selected device/function attribute.
- .4 The system shall provide an Interactive, Web-based graphical user interface (GUI) showing floor plans and lighting layouts that are native to the lighting control software. The only means required to program and operate the lighting control system shall be programmed and operated from a user interface that is based on a plan view graphical screen on the user's computer or the lighting control system's main computer. Shall include the navigational features listed below to allow for user's orientation within the controlled space, geographic heading and/or landmarks:
 - .1 Interactive;
 - .2 Vector based;
 - .3 Zoom;
 - .4 Rotate;
 - .5 Pan;
 - .6 Tilt.

LIGHTING CONTROL EQUIPMENT - ADDRESSABLE LOW VOLTAGE

- .5 The system shall allow the building operator to navigate through an entire facility both in two- dimensional and three-dimensional multi-floor view, allowing for fast and easy navigation.
- .6 Three-dimensional view shall exclude walls and other structural features to avoid shadowing and cluttering of the plan view.
- .7 Shall display multiple floors in single view resulting in easier system performance visualization for the entire site as well as individual zones or spaces.
- .8 The system shall allow system performance visualization across a portfolio of buildings via a single interface.
- .9 All programming, assignments of lighting loads to control strategies, lighting status and lighting energy reporting shall be native to the software and executed from this GUI. Editing shall be available from this GUI in a drag and drop format or from drop down menus without the need for any third party software. Systems that utilize or require third party linked graphics are unacceptable. The GUI shall continuously indicate the status of each connected device on the system and a warning indicator on the software if a device goes offline. Systems requiring spreadsheet editing for programming and that don't offer real time feedback are not acceptable.
- .10 Software settings and properties shall be selectable per individual device, room based, floor based or global building based.
- .11 Lighting Control Software interface shall provide current status and enable configuration of all system zones including selected individual luminaire availability, current light level, maximum light level, on/off status, occupancy status, and emergency mode (response to an emergency signal) status.
- .12 The system shall have the ability to display various lighting system parameters such as Lighting status (ON/OFF); Lighting levels, Load shedding status, or Lighting energy consumption, Occupancy status in a colorized gradient ("weather" map) type of graphical representation.
- .13 Energy Analysis data shall be exportable in CSV or image file formats.
- .14 The system shall allow import of native AutoCAD files.
- .15 Reporting feature shall be native to the lighting control software and capable of reporting the following parameters for each device and zone individually without requiring any third party hardware and software:
 - .1 Energy consumption broken down by energy management strategy.
 - .2 Energy demand broken down by energy management strategy.
 - .3 Occupancy data by zone.
 - .4 Building wide occupancy status
 - .5 Time Schedule configuration status
 - .6 Lighting energy consumption in a color gradient ("weather map" type) view
 - .7 Energy performance reports shall be printable in a printer friendly format and downloadable for use in spreadsheet applications, etc.
- .16 The software shall offer user configurable fade times (up to 86400 seconds) for individual or group of luminaire during transition between scenes.

LIGHTING CONTROL EQUIPMENT - ADDRESSABLE LOW VOLTAGE

- .17 The system shall be programmable for Time Clock Scheduling of lights on or off via the Lighting Control Software interface.
- .18 There shall be an "Emergency Mode", when activated through the system, that will immediately adjust lights to full light output and retain that level until the mode is deactivated in the event of an emergency. This setting shall override all other inputs. The system shall interface with the building emergency monitoring system at a convenient point and not require multiple connections.
- .19 All ballasts and/or drivers shall be centrally addressable, on a per luminaire or multiple luminaire/zone basis, through the Central Control Software. The basis of design shall utilize 0-10V Dimming, Fixed Output Ballasts and/or 0-10V LED Drivers connected to an Output Module. To simplify ongoing maintenance, the system shall not require manual recording of addresses for the purpose of start-up or reconfiguration.
- .20 System shall be capable of operating independent of building's existing network infrastructure if desired and shall not rely on Tenant supplied PCs for operation.
- .21 Firewall Technologies & VLAN Configuration methods shall be utilized to separate tenants from the lighting control network and ensure the integrity of lighting control network.
- .22 The assignment of individual or group of system components to zones shall be performed via the Central Control Software such that physical rewiring will not be necessary when workspace reconfiguration or re-zoning is performed. Removal of covers, faceplates, ceiling tiles, etc. shall not be required.
- .23 Occupancy sensor time delays shall be configurable through software. Light level sensor parameters shall be configurable through software.
- .24 System shall auto-configure lighting controls for spaces that have been combined or divided temporarily by moving wall or similar systems.
- .25 System shall automatically lock wallstations and/or disable sensors based on one of the following system inputs: contact closure, a time schedule or the status of a monitored space.
- .26 The light management system shall be capable of interfacing digitally with a building automation system via BACnet/IP. The lighting control system shall be capable of communicating the status of output devices (lighting loads) as well as input devices (dry contacts, switches, occupancy sensors, vacancy sensors, and photocells) to the BAS. Building Automation System shall utilize data from lighting control system input devices such as occupancy sensors to determine the status (occupied/unoccupied) of the mechanical control zones and perform climate adjustments accordingly.

2.3 Digital Wallstations

- .1 The system shall connect with the wallstations via field bus that carry low voltage control signals.
- .2 Software configurable wallstations shall provide on/off switching and dimming control for up to six lighting zones/ five lighting scenes per wallstation or more with allowable multi-gang configurations.
- .3 Shall allow manual dimming of light levels and override of the time schedule.
- .4 Scenes/zones in the system control software shall be synchronized with the buttons on the wallstation.

LIGHTING CONTROL EQUIPMENT - ADDRESSABLE LOW VOLTAGE

- .5 All wallstations shall be individually addressable & reconfigurable via System Control Software.
- .6 All wall stations shall feature status LED's
- .7 All wallstations shall be Class 2 Low Voltage devices.
- .8 All wallstations power source will be from the communication bus.
- .9 Communication shall be via NEC/CEC Class 2 communication wire.
- .10 Wallstation configuration shall be via GUI in a drag and drop format.
- .11 Custom button cap configuration shall allow combination of scene & zone in one wallstation.
- .12 Custom commands shall be applied to individual wallstation buttons.
- .13 Wall station shall display its current status (zone/scene under system control or OFF) when motion is detected in the close proximity of the wallstation
- .14 The following User Interface and custom labelling options shall be available:
 - .1 Up to five (5) scenes switching & dimming
 - .2 Up to six (6) zone switching
 - .3 One (1) zone switching
- .15 Shall allow vacancy sensor configuration.
- .16 Dimensions shall meet NEMA WD-6 spec.
- .17 The following mounting options shall be supported:
 - .1 Mount in standard size wall box
 - .2 On mounting brackets for low voltage devices
- .18 Shall be used with "Decorator" style wall plate.

2.4 System Field Devices

- .1 Shall provide a common interface to low voltage occupancy sensors and photo sensors via Input Modules. These modules shall automatically detect the type of devices they are connected to (i.e., photo sensor, occupancy sensor). Addresses to the field devices shall be assigned during system start-up. Upon establishing two way communication with the Energy Control Unit (ECU), these individually addressable modules shall enable each lighting component to be independently controlled and configured to best meet the needs of the facility. These modules shall connect directly to the NEC/CEC Class 2 communication bus.
- .2 System Field Devices shall be individually addressable via System Control Software.
- .3 System shall automatically address individual nodes during system start-up thus eliminating the need to pre-address devices or record serial numbers during installation.
- .4 Electrically rated for up to 24 VDC.
- .5 Shall connect to NEC/CEC Class 2 communication wire.
- .6 Shall retain all system settings in non-volatile memory.
- .7 Suitable for fixture or junction box mounting in standard 1/2" knockout (7/8" dia.)

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2.5 Area Lighting Controller/Room Controller

- .1 Shall provide a common interface (DIM/SWITCH) to a group of 0-10V Dimming, Fixed Output Ballasts and/or 0-10V LED Drivers via field bus that carry low voltage control signals.
- .2 Area Lighting Controllers shall be addressable via Control Software.
- .3 System shall automatically address individual area lighting controllers during system start-up thus eliminating the need to pre-address devices or record serial numbers during installation.
- .4 Electrical Maximum Load Ratings:
 - .1 20A 120-347 Vac Ballast
 - .2 20A 120-347 Vac Resistive
 - .3 20A 120-347 Vac Tungsten
 - .4 20A 120-347 Vac General Purpose
 - .5 1.5 HP 120-277 Vac Motor
- .5 Communication shall be via NEC/CEC Class 2 communication wire.
- .6 Control Options for:
 - .1 ON/OFF Switching
 - .2 Continuous 0-10V dimming
 - .3 Shall be able to communicate with 0-10V ballasts/drivers
- .7 Shall be used for general purpose plug load control.
- .8 Shall control up to 30 ballast/LED Drivers.
- .9 Shall retain all system settings in non-volatile memory.
- .10 Mechanically has mounting for standard 1/2" electrical box knockout.
- .11 Colour to be selected by Contract Administrator.
- .12 UL916, UL924 & UL2043 listed.

2.6 Digital Daylighting Sensors

- .1 Digital daylighting sensors shall work to provide automatic switching, bi-level, or tri-level or dimming daylight harvesting capabilities for any load type.
- .2 Daylighting sensors shall be interchangeable without the need for rewiring.
- .3 The indoor sensor range shall be between 0 and 750 FC.
- .4 The outdoor sensor range shall be between 0 and 750 FC.
- .5 Atrium sensor range shall be from 2 to 2,500 FC.
- .6 Skylight sensor range shall be between 10 and 7,500 FC.
- .7 The capability of ON/OFF, bi-level or tri-level switching, or dimming, for each controlled zone, depending on the selection of load controller(s) and load binding to controller(s).
- .8 For dimming daylight harvesting, the photosensor shall provide the option, when the daylight contribution is sufficient, of turning lights off or dimming lights to a field-selectable minimum level.

LIGHTING CONTROL EQUIPMENT - ADDRESSABLE LOW VOLTAGE

- .9 Photosensors shall have a digital, independently configurable fade rate for both increasing and decreasing light level in units of percent per second.
- .10 Photosensors shall provide adjustable cut-off time. Cut-off time is defined by the number of selected minutes the load is at the minimum output before the load turns off. Selectable range between 0-240 minutes including option to never cut-off.
- .11 Optional wall switch override shall allow occupants to reduce lighting level to increase energy savings or, if permitted by system administrator, raise lighting levels for a selectable period of time or cycle of occupancy.

2.7 Digital Wall or Ceiling Mounted Occupancy Sensor

- .1 Wall or ceiling mounted (refer to drawings) passive infrared (PIR), ultrasonic or dual technology digital (passive infrared and ultrasonic) occupancy sensor.
- .2 Digital Occupancy Sensors shall provide graphic LCD display for digital calibration and electronic documentation. Features include the following:
 - .1 Digital calibration and pushbutton configuration for the following variables:
 - .1 Sensitivity – 0-100% in 10% increments
 - .2 Time delay – 1-30 minutes in 1 minute increments
 - .3 Test mode – Five second time delay
 - .4 Detection technology – PIR, Ultrasonic or Dual Technology activation and/or re-activation.
 - .5 Walk-through mode
 - .2 Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.
 - .3 Programmable control functionality including:
 - .1 Each sensor may be programmed to control specific loads within a local network.
 - .2 Sensor shall be capable of activating one of 16 user-definable lighting scenes.
 - .3 Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically within a configurable period of time (default 10 seconds) after turning off.
 - .4 On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use the following technologies:
 - .5 Ultrasonic and Passive Infrared
 - .6 Ultrasonic or Passive Infrared
 - .7 Ultrasonic only
 - .8 Passive Infrared only
 - .9 Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal (NH) and After Hour (AH) time periods.

LIGHTING CONTROL EQUIPMENT - ADDRESSABLE LOW VOLTAGE

- .4 Communication shall be via Class 2 communication bus.
- .5 Manual override of controlled loads.
- .6 All digital parameter data programmed into an individual occupancy sensor shall be retained in non-volatile FLASH memory within the sensor itself. Memory shall have an expected life of no less than 10 years.
- .7 Units shall not have any dip switches or potentiometers for field settings.
- .3 Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology local network. No additional configuration will be required.

2.8 Communication Wire

- .1 The system shall have the capability to use both NEC/CEC Class 1 and Class 2 wiring to integrate peripheral devices such as ballasts/LED drivers, occupancy sensors, photo sensors, relay-based controls, area lighting controllers, and wallstations into a complete, networked programmable lighting control system.
- .2 Electrically uses NEC/CEC Class 2 Communication bus.
- .3 Multi-conductor cable with stranded-copper conductors.
- .4 Shall power photo sensors, PIR and dual-technology occupancy sensors.
- .5 Shall allow random devices connection without the need for special network channel termination.
- .6 Flame rated jacket for plenum use NFPA 262 (UL: FT6, CSA: CMP).

2.9 Energy Control Unit (ECU)

- .1 The Energy Control Unit (ECU) shall collect, process and distribute lighting control information to the system field devices and wall stations over NEC/CEC Class 2 communication bus. Each CU shall feature multiple NEC/CEC Class 2 communication channels that can control a large quantity of nodes (sensors, wall stations, 0-10V Dimming, Fixed Output Ballasts, 0-10V LED Drivers, etc.) per channel, per the manufacturers recommended maximum.
- .2 The ECU shall be the central intelligence point for the area it controls collecting signal information from sensors, wallstations and personal control software and determining appropriate brightness levels or on/off status for each luminaire or zone. The CU shall connect with a facility's or tenant's Local Area Network (LAN) via Ethernet to enable desktop personal control.
- .3 Ethernet communication ports that employ TCP/IP protocol shall be provided to simultaneously enable the following connections:
 - .1 Lighting Control Network
 - .2 Tenant LAN Access Point
- .4 Shall have 8 ports that accept 18 AWG, pre-fabricated, polarity independent quick connecting NEC/CEC Class 2 communication bus.
- .5 Each CU channel shall support up to 100 nodes or 800 nodes in total.

LIGHTING CONTROL EQUIPMENT - ADDRESSABLE LOW VOLTAGE

- .6 Shall have status LEDs for the following:
 - .1 Network activity on CU's Ethernet port/s
 - .2 CU channel status
 - .3 CU status
- .7 Shall enable the following functionalities:
 - .1 Backup to and Restore from USB flash drives
 - .2 Cycle lights through 100%, 25% & 0% steps
 - .3 Disable/enable all controller functionalities
 - .4 IP Address Reset
 - .5 Electronically deactivate individual channels
- .8 Shall have configuration stored in non-volatile flash memory.
- .9 Shall mount in a standard 19" rack (1U width), or alternatively where no rack is shown, via an individual wall mount.
- .10 UL916 and UL924 listed.

2.10 System Server (SSU)

- .1 The System Server shall host the lighting control system database for all the lighting control devices. In addition, it shall provide remote accessing capability to change system settings and/or parameters.
- .2 Server shall have the ability to:
 - .1 Analyze system performance or energy data or generate system report;
 - .2 Record energy consumption with average sampling every 5 minutes for unlimited duration;
 - .3 Host the web interface required for the web enabled Personal Control Software or web based Central Control Software;
 - .4 Reside on a City server (virtual server);
 - .5 Interconnect with Control Units over standard Ethernet connection that employs TCP/IP protocol;
- .3 Each System Server shall have two Ethernet 10/100Base - Tx Cat 5 RJ45 ports that employ TCP/IP protocol.
- .4 Shall mount in a standard 19" rack (1U width), or alternatively where no rack is shown, via an individual wall mount.

2.11 Emergency Lighting Control Devices

- .1 Emergency Lighting Control Unit – A UL 924 listed device that monitors a switched circuit providing normal lighting to an area. The unit provides normal ON/OFF control of emergency lighting along with the normal lighting. Upon normal power failure the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include:
 - .1 120/277 volts, 50/60 Hz, 20 amp ballast rating
 - .2 Push to test button
 - .3 Auxiliary contact for remote test or fire alarm system interface

LIGHTING CONTROL EQUIPMENT - ADDRESSABLE LOW VOLTAGE

2.12 Manufacturers

- .1 The following are acceptable manufacturers:
 - .1 Legrand– Encelium
 - .2 Cooper Lighting Solutions
 - .3 Lutron – Athena
 - .4 Acuity – nLight
 - .5 Crestron – Commercial Lighting Controls

PART 3 - EXECUTION

3.1 Pre-Installation Meeting

- .1 A factory authorized manufacturer's representative shall provide the Electrical Subcontractor a functional overview of the lighting control system prior to installation. The Subcontractor shall schedule the pre-installation site visit after receipt of approved submittals to review the following:
 - .1 Confirm the location and mounting of all digital devices, with special attention to placement of occupancy and daylighting sensors.
 - .2 Review the specifications for low voltage control wiring and termination.
 - .3 Discuss the functionality and configuration of all products, including sequences of operation, per design requirements.
 - .4 Discuss requirements for integration with other trades.

3.2 Installation and services

- .1 Locate and install equipment in accordance with manufacturer's recommendations and as indicated.
- .2 Install all devices and wiring in a professional manner. All line voltage connections to be tagged to indicate circuit and switched legs.
- .3 Install all room/area devices using manufacturer's factory-tested cable with pre-terminated connectors. If pre-terminated cable is not used for room/area wiring, test each field-terminated cable following installation and supply the lighting controls manufacturer with test results. Contractor to install any room to room network devices using manufacturer-supplied network wire. Low voltage wiring topology must comply with manufacturer's specifications. Contractor shall route network wiring as shown in submittal drawings as closely as possible, and shall document final wiring location, routing and topology on as built drawings.
- .4 Install the work of this Section in accordance with manufacturer's printed instructions unless otherwise indicated. Before start up, Subcontractor shall test all devices to ensure proper communication.
- .5 Calibrate all sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings.
 - .1 Adjust time delay so that controlled area remains lighted while occupied.

LIGHTING CONTROL EQUIPMENT - ADDRESSABLE LOW VOLTAGE

- .6 Provide written or computer-generated documentation on the configuration of the system including room by room description including:
 - .1 Sensor parameters, time delays, sensitivities, and daylighting setpoints.
 - .2 Sequence of operation, (e.g. manual ON, Auto OFF. etc.)
 - .3 Load Parameters (e.g. blink warning, etc.)
- .7 Post start-up tuning – After 30 days from occupancy, Subcontractor shall adjust sensor time delays and sensitivities to meet The City's requirements. Provide a detailed report to the Contract Administrator/The City of post start-up activity.

3.3 Factory Services

- .1 Upon completion of the installation, the manufacturer's factory authorized representative shall start up and verify a complete fully functional system.
- .2 The Electrical Subcontractor shall provide both the manufacturer and the Contract Administrator with three weeks written notice of the system start up and adjustment date.
- .3 Upon completion of the system start up, the factory-authorized technician shall provide the proper training to The City's personnel on the adjustment and maintenance of the system.

3.4 System Start Up and Commissioning

- .1 If applicable, a commissioning agent will verify the installation and programming of all building systems, which includes the lighting control system. Manufacturer should include an extra day of technician's time to review the functionality and settings of the lighting control hardware with the commissioning agent, including reviewing submittal drawings and ensuring that instructions on how to configure each device are readily available. Manufacturer is NOT responsible for helping the commissioning agent inspect the individual devices. It will be the commissioning agent's responsibility to create and complete any forms required for the commissioning process, although the manufacturer or Contractor may offer spreadsheets and/or printouts to assist the agent with this task.
- .2 The commissioning agent shall work with the Electrical Subcontractor during installation of the lighting control hardware to become familiar with the specific products. The agent may also accompany the manufacturer's technicians during their start-up work to better understand the process of testing, calibration and configuration of the products. However, the Contractor and manufacturer shall ensure that interfacing with the agent does not prevent them from completing the requirements outlined in the Contract documents.

3.5 Testing

- .1 Upon completion of all line, load and interconnection wiring, and after all luminaires are installed and lamped, a qualified factory representative shall completely configure and test the system.
- .2 At the time of checkout and testing, The City's representative shall be thoroughly instructed in the proper operation of the system.
- .3 For additional requirements, refer to 01 91 13 - GENERAL COMMISSIONING REQUIREMENTS.

LIGHTING CONTROL EQUIPMENT - ADDRESSABLE LOW VOLTAGE

3.6 Training

- .1 Provide four half days of training for The City and The City's maintenance staff on the operation and maintenance of the system.
- .2 Training to be recorded for use by The City in the future.

END OF SECTION

DRY TYPE TRANSFORMERS - 600V PRIMARY

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
- .3 Section 26 05 53 – IDENTIFICATION.

1.2 Reference

- .1 CSA C22.2 No. 47, Air-Cooled Transformers (Dry-Type), latest edition.
- .2 CSA C802.2, Minimum Efficiency Values for Dry Type Transformers, latest edition.
- .3 U.S. Department of Energy (DOE) "DOE 2016 Efficiency", latest edition.
- .4 Natural Resource Canada Regulation SOR/2018-201 (NRCAN 2019), latest edition.
- .5 CSA C9, Dry-Type Transformers, latest edition.

1.3 Shop Drawings And Product Data

- .1 Submit Shop Drawings and product data in accordance with Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.

1.4 Storage

- .1 Store and handle in strict compliance with manufacturer's instructions and recommendations. Protect from potential damage from weather and construction operations. Store so condensation will not form on or in the transformer housing and if necessary, apply temporary heat where required to obtain suitable storage or service conditions.
- .2 Handle transformer using proper equipment for lifting and handling, use necessary lifting eye and/or brackets provided for that purpose.

1.5 Warranty

- .1 The transformer shall carry a 1 year warranty from the time of Total Performance.

PART 2 - PRODUCTS

2.1 Transformers

- .1 Use transformers of one manufacturer throughout project.
- .2 Design
 - .1 Type: ANN. All transformers to be delta-wye configuration unless otherwise noted on the drawings. Scott T constructed transformers will not be accepted.
 - .2 3 phase, kVA and voltages as indicated on the plans, 60 Hz.
 - .3 Provide voltage taps of $2 \pm 2 \frac{1}{2} \%$ FCAN (full capacity above normal) & FCBN (full capacity below normal).
 - .4 Insulation: Class 220 deg. C (former designation: Class H), 150 deg. C. or less temperature rise.

DRY TYPE TRANSFORMERS - 600V PRIMARY

- .5 All windings are to be copper unless stated otherwise on the Contract documents.
- .6 Basic Impulse Level (BIL): standard.
- .7 Hipot: standard.
- .8 Average sound level to comply with the latest edition of CSA C9 for the appropriate voltage class.
- .9 Impedance at 60 Hz: minimum impedance as shown in the table below, unless noted on single line diagram.

Transformer size	Minimum impedance (%Z)
Up to 75 kVA	2.5 %
112.5 to 150 kVA	4 %
151 to 300 kVA	4 %
301 to 600 kVA	5 %
601 to 2500 kVA	6 %
Greater than 2500 kVA	Per CSA C9

- .10 Provide minimum K-4, K-rated transformers unless otherwise indicated on the drawings.
- .11 Enclosure: CSA Type 3R, removable metal front panel.
- .12 Mounting: floor or wall, as indicated.
- .13 Transformer to meet energy efficiency requirements of the energy efficiency standards referenced in this specification, whichever is more stringent, at 35% of rated load unless shown otherwise on drawings.
- .14 Finish: in accordance with Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2.2 Accessories

- .1 Provide analogue type winding temperature indicator with 2 sequence contacts for transformers of 225 kVA and larger. Provide sensor in the centre winding to monitor the temperature.
- .2 Grounding terminal: inside enclosure.
- .3 External vibration pads equal to Mason Super 'W'.
- .4 Nameplate shall be stainless steel.

2.3 Equipment Identification

- .1 Provide equipment identification in accordance with Section 26 05 53 – IDENTIFICATION.
- .2 Label size: 6 mm letters.

DRY TYPE TRANSFORMERS - 600V PRIMARY

2.4 Finish

- .1 Finish enclosure exterior in accordance with Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Transformer to be painted ANSI-61 grey.

2.5 Manufacturers

- .1 The following are acceptable manufacturers:
 - .1 Hammond Power Solutions
 - .2 Delta Transformers
 - .3 Schneider-Electric
 - .4 Eaton Cutler-Hammer
 - .5 Rex Power Magnetics
 - .6 STI Power
 - .7 Siemens
 - .8 PowerSmiths Socomec Group ABB

PART 3 - EXECUTION

3.1 Installation

- .1 Mount dry type transformers as indicated. Transformers larger than 75kVA are to be floor mounted unless identified otherwise. Where a transformer larger than 75kVA is shown as mounted off the floor, the Contractor is to provide an engineered structure from the floor and wall to support the transformer. Structure to be stamped and signed by a Professional Engineer and submitted as a shop drawing. Design of structure to take into account the building structure within the respective room.
- .2 Provide external vibration isolation pads under transformer.
- .3 Ensure adequate clearance around transformer for ventilation. Install transformer to meet ventilation clearance requirements given by transformer manufacturer. Where transformer manufacturer does not have requirements, follow clearances required by the local electrical code.
- .4 Install transformers in level upright position.
- .5 Remove shipping supports only after transformer is installed and just before putting into service.
- .6 Loosen isolation pad bolts until no compression is visible.
- .7 Make primary and secondary connections with flexible conduit and in accordance with wiring diagram.
- .8 Energize transformers after installation is complete.

END OF SECTION

HARMONIC MITIGATING DRY TYPE TRANSFORMERS

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
- .3 Section 26 05 53 – IDENTIFICATION.

1.2 Reference

- .1 CSA-C22.2 No. 47 – Air-Cooled Transformers (Dry Type), latest edition.
- .2 CSA C9 – Dry-Type Transformers, latest edition.
- .3 CSA-C802.2 - Minimum Efficiency Values for Dry Type Transformers, latest edition.
- .4 U.S. Department of Energy (DOE) “DOE 2016 Efficiency”, latest edition.
- .5 Natural Resource Canada Regulation SOR/2018-2001 (NRCAN 2019), latest edition.

1.3 Shop Drawings And Product Data

- .1 Submit Shop Drawings and product data in accordance with Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.

1.4 Storage

- .1 Store and handle in strict compliance with manufacturer’s instructions and recommendations. Protect from potential damage from weather and construction operations. Store so condensation will not form on or in the transformer housing and if necessary, apply temporary heat where required to obtain suitable storage or service conditions.
- .2 Handle transformer using proper equipment for lifting and handling, use necessary lifting eye and/or brackets provided for that purpose.

1.5 Warranty

- .1 The transformer shall carry a 1 year warranty from the time of Total Performance.

PART 2 - PRODUCTS

2.1 Transformers

- .1 Use transformers of one manufacturer throughout project.
- .2 Design
 - .1 3rd, 9th, & 15th harmonics and other zero sequence currents shall be treated within the secondary windings through cancellation of the zero sequence fluxes. Simply trapping these currents in the delta primary winding is NOT acceptable.
 - .2 For 5th, 7th, 17th & 19th harmonics, provide the appropriate primary-secondary phase shift in order to cancel these harmonic currents with those of other loads fed from the same primary supply.

HARMONIC MITIGATING DRY TYPE TRANSFORMERS

- .3 Harmonic mitigation shall be achieved by electromagnetic means only. No capacitors or electronics shall be used.
- .4 Evidence of relevant application experience must be available upon request.
- .5 Primary Voltage: As shown on drawings.
- .6 Secondary Voltage: As shown on drawings.
- .7 kVA rating: As shown on drawings.
- .8 System Frequency: 60 Hertz.
- .9 Positive & negative sequence impedance at 60 Hz: minimum impedance as shown in the table below, unless noted on single line diagram.

Transformer size	Minimum impedance (%Z)
Up to 112.5 kVA	2.8 %
150 kVA	3.2 %
151 to 300 kVA	4 %
301 to 600 kVA	5 %
601 to 2500 kVA	6 %
Greater than 2500 kVA	Per CSA C9

- .10 Zero sequence impedance/reactance at 60Hz: Less than 1.0% and 0.5% respectively.
- .11 Load compatibility: K factor up to 20, Crest factor up to 4.5.
- .12 Neutral connection shall be rated at twice the ampacity of the secondary phase current.
- .13 Primary-secondary phase-shift at 5th and 7th harmonics: 0 deg. and -30 deg. for similar sized transformers fed from the same upstream panelboard or switchboard.
- .14 Three-phase, common core construction. Convection air cooled.
- .15 Copper Windings.
- .16 Insulation Class: 220 deg. C. system.
- .17 Temperature rise: 130 deg. C.
- .18 Transformer to meet energy efficiency requirements of the energy efficiency standards referenced in this specification, whichever is more stringent, at 35% of rated load unless shown otherwise on drawings.
- .19 Taps: 2 x $\pm 2.5\%$ (2FCAN, 2FCBN) for 75 - 300 kVA and 1 x $\pm 5\%$ for up to 45 kVA.
- .20 Sound level at 5 ft.: max. 45 dB up to 45 kVA, 50 dB from 75 to 150 kVA and 55 dB from 150 to 300 kVA.
- .21 Enclosure: ventilated, CSA type 3R enclosure.
- .22 Finish: ANSI 61 Grey.

HARMONIC MITIGATING DRY TYPE TRANSFORMERS

- .23 Anti-vibration pads shall be used between the core and the enclosure.
- .24 UL listed and CSA approved.
- .25 Built to NEMA ST-20 and in accordance with all applicable UL, CSA and ANSI/IEEE standards.
- .26 Warranty: 10 year pro-rated, with standard limited liability clauses.
- .27 Electrostatic shielding: [single: 60dB attenuation] [dual: 120dB attenuation].
- .28 Over-temperature alarm - wired to internal terminal strip.
 - .1 Contact (one per set point): normally closed [normally open].
 - .2 Set point: 180 deg. C.
- .29 Mounting: floor or wall, as indicated on the drawings.
- .30 Finish: in accordance with Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2.2 Accessories

- .1 Provide analogue type winding temperature indicator with 2 sequence contacts for transformers of 225 kVA and larger. Provide sensor in the centre winding to monitor the temperature. Wire alarm contacts to the Building Automation System.
- .2 Grounding terminal: inside enclosure.
- .3 External vibration pads equal to Mason Super 'W'.
- .4 Nameplate shall be stainless steel.

2.3 Equipment Identification

- .1 Provide equipment identification in accordance with Section 26 05 53 – IDENTIFICATION.
- .2 Label size: 6 mm letters.

2.4 Acceptable Manufacturers

- .1 HARMONY-1™ transformer by MIRUS International Inc.
- .2 Sentinel H by Hammond Power Solutions Inc.
- .3 T1000 by PowerSmiths Socomec Group.
- .4 Distribution Transfilter by Power Quality International Inc.
- .5 Mitigator Series by Delta Transformers.
- .6 STI Power.

HARMONIC MITIGATING DRY TYPE TRANSFORMERS

PART 3 - EXECUTION

3.1 Installation

- .1 Mount dry type transformers as indicated. Transformers larger than 75kVA are to be floor mounted unless identified otherwise. Where a transformer larger than 75kVA is shown as mounted off the floor, the Contractor is to provide an engineered structure from the floor and wall to support the transformer. Structure to be stamped and signed by a Professional Engineer and submitted as a Shop Drawing. Design of structure to take into account the building structure within the respective room.
- .2 Provide external vibration isolation pads under transformer.
- .3 Ensure adequate clearance around transformer for ventilation. Install transformer to meet ventilation clearance requirements given by transformer manufacturer. Where transformer manufacturer does not have requirements, follow clearances required by the electrical code.
- .4 Install transformers in level upright position.
- .5 Remove shipping supports only after transformer is installed and just before putting into service.
- .6 Loosen isolation pad bolts until no compression is visible.
- .7 Make primary and secondary connections with flexible conduit and in accordance with wiring diagram.
- .8 Energize transformers after installation is complete.
- .9 Set transformer taps to produce rated secondary voltage, as shown on the drawings, at no load.

END OF SECTION

SWITCHBOARDS

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
- .3 Section 26 05 53 – IDENTIFICATION.
- .4 Section 26 28 21 – MOULDED CASE AND INSULATED CASE CIRCUIT BREAKERS.

1.2 Reference

- .1 CSA C22.2 No. 31 – Switchgear Assemblies, latest edition.
- .2 CSA C22.2 No. 244 – Switchboards (Trinational standard with UL 891 and NMJ-J-118/2-ANCE), latest edition.
- .3 Seismic compliance: International Building Code (IBC) and California Building Code (CBC), latest edition.

1.3 Shop Drawings And Product Data

- .1 Submit shop drawings and product data in accordance with Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
- .2 Indicate on Shop Drawings:
 - .1 Floor or wall anchoring method and foundation template.
 - .2 Dimensioned cable entry and exit locations.
 - .3 Dimensioned position and size of bus.
 - .4 Overall length, height and depth.
 - .5 Dimensioned layout of internal and front panel mounted components.
- .3 Include time-current characteristic curves for circuit breakers and fuses.
- .4 Provide certificates of compliance with the requirements as stated within the IBC and CBC and demonstrated the ability to function after the test.
- .5 Submit initial power system study at the same time as shop drawings for electrical distribution equipment, such that the Contract Administrator can review the adequacy of equipment interrupting capacity or withstand ratings, prior to equipment being released for manufacture. In situations where the entire study cannot be submitted with the electrical distribution shop drawings, submit at a minimum a preliminary short circuit study for review.

1.4 Maintenance Data

- .1 Submit 3 copies of the maintenance data for the complete assembly including components, and include in the project operating and maintenance manuals.

1.5 Maintenance Materials

- .1 Include:
 - .1 breaker types.

SWITCHBOARDS

1.6 Source Quality Control

- .1 Submit 3 copies of certified test results, and include in the project operating and maintenance manuals.

1.7 Warranty

- .1 Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Switchboard

- .1 Ratings as identified on the drawings and/or schedules.
- .2 Switchboard and breakers to have short circuit current rating as shown on the Drawings, and if not shown on the Drawings than with a minimum rating of 35 kA at 600 V. Short circuit rating is to be coordinated with Power System study.
- .3 Enclosures to be dead-front, CSA Type 1 with drip hood, sprinkler proof enclosure, size as indicated.
- .4 Hinged access panels with captive knurled thumb screws.
- .5 Bus bars and main connections: copper.
- .6 Bus from load terminals of main breaker via metering section to main lugs of distribution section.
- .7 Identify phases with colour coding.
- .8 Provide lugs that comply with the requirements of Section 26 05 21 – WIRES AND CABLES UNDER 2000 V. Size as per the Drawings.
- .9 Breakers sections shall be bolt-on, unless indicated otherwise
- .10 Make provisions to extend the main bus to future cubicles on each end of the switchboard.
- .11 For Service Entrance Switchboards with secondary utility metering, provision for installation of power supply authority metering transformers in barriered section of switchboard, conforming to power supply authority requirements. Provide 850 mm x 360 mm x 305 mm (32 in. x 14 in. x 12 in.) wall mounted metering cabinet with plywood backboard for power authority use. Interconnect cabinet and instrument transformer compartment with 38 mm (1-1/2 in.) empty conduit.

2.2 Circuit Breakers

- .1 Circuit breakers to be supplied as per Section 26 28 21 – MOULDED CASE AND INSULATED CASE CIRCUIT BREAKERS.
- .2 Main breaker for SWBD-REC to be a draw-out Insulated Case Circuit Breaker.
- .3 All other breakers are to be Moulded Case Circuit Breaker.
- .4 All breakers to be factory installed and tested.
- .5 Circuit breaker conductor terminations to be dual rated for Copper/Aluminum (Cu/Al).

SWITCHBOARDS

2.3 Grounding

- .1 Copper ground bus extending full width of cubicles and located at bottom.
- .2 Size ground cable terminations as per the Drawings.

2.4 Infrared Windows

- .1 Provide infrared windows in the switchboard main incoming section in sufficient sizes and quantities, to provide view of the main feeder terminations.
- .2 The window lens shall be compatible with most popular IR cameras, fusion capable and shall transmit electromagnetic radiation in:
 - .1 Short, Mid and Long Wave Infrared
 - .2 Visual
 - .3 UVA and UVB Ultraviolet
- .3 Label each window to provide the thermographer with full information necessary to properly set, and aim the infrared camera and correctly interpret readings. The information shall include but not be limited to:
 - .1 IR window location and number:
 - .2 Lens material, range and the effective wavelength:
 - .3 Lens Transmission Rate and proper compensation values:
 - .4 Target(s): name, location (in respect to window) and target(s) emissivity.
- .4 Infrared windows shall be CSA approved to C22.2 No. 14 latest edition, UL/cUL listed, comply with IEEE Std. C37.20.2. Range, size, NEMA/IP and voltage rating suitable for the application. Infrared windows with plastic or polymer components shall also comply with UL746C.
- .5 Acceptable manufacturers;
 - .1 Hawk IR International Limited / Fluke,
 - .2 FLIR,
 - .3 Lumasense Technologies Inc.
 - .4 IRISS Inc.

2.5 Finishes

- .1 Apply finishes in accordance with Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Switchboard to be painted: baked grey enamel.

2.6 Equipment Identification

- .1 Provide equipment identification in accordance with Section 26 05 53 – IDENTIFICATION.
- .2 Label all branch feeders with names as indicated on drawings.

SWITCHBOARDS

2.7 Manufacturers

- .1 The switchboards shall be manufactured by:
 - .1 Schneider Electric.
 - .2 Eaton Cutler-Hammer.
 - .3 Siemens.
 - .4 ABB.

PART 3 - EXECUTION

3.1 Installation

- .1 Locate switchboard and secure in position.
- .2 Connect main incoming feeder to line terminals of main breaker, if applicable.
- .3 Connect load terminals of distribution switches or breakers to feeders.
- .4 Check factory made connections for mechanical security and electrical continuity.
- .5 Check trip unit settings and fuse sizes against co-ordination study to ensure proper working and protection of components.
- .6 For Service Entrance Switchboards only where a grounded conductor is installed from the exterior utility transformer (i.e. 4 wires only), provide system bonding jumper between neutral bus and ground bus.

3.2 Testing

- .1 Contractor to review and test that all wiring has been connected as per the manufacturer drawings.
- .2 Contractor to oversee all testing and correct any deficiencies noted.

END OF SECTION

PANELBOARDS - BREAKER TYPE

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
- .3 Section 26 05 05 – MOUNTING HEIGHTS.
- .4 Section 26 05 53 – IDENTIFICATION.
- .5 Section 26 28 21 – MOULDED CASE AND INSULATED CASE CIRCUIT BREAKERS.

1.2 References

- .1 CSA C22.2 No. 29 – Panelboards and Enclosed Panelboards, latest edition.
- .2 CSA C22.2 No. 5 – Molded-case circuit breakers, molded-case switches and circuit-breaker enclosures, latest edition.

1.3 Shop Drawings And Product Data

- .1 Submit Shop Drawings and product data in accordance with Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
- .2 Drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.
- .3 Submit initial power system study at the same time as shop drawings for electrical distribution equipment, such that the Contract Administrator can review the adequacy of equipment interrupting capacity or withstand ratings, prior to equipment being released for manufacture. In situations where the entire study cannot be submitted with the electrical distribution shop drawings, submit at a minimum a preliminary short circuit study for review.

1.4 Warranty

- .1 Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Panelboards

- .1 Panelboards: product of one manufacturer.
- .2 Install circuit breakers in panelboards before shipment.
- .3 In addition to CSA requirements manufacturer's nameplate must show fault current that the panel including all breakers have been built to withstand.
- .4 Panelboards to have the following minimum ratings for interrupting capacity or as indicated on the drawings or panel schedules.
 - .1 120/208 V panelboards – 10 kA
 - .2 347/600 V panelboards – 30 kA

PANELBOARDS - BREAKER TYPE

- .5 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.
- .6 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated. Provide an additional 20% of space within each panelboard in addition to what is shown on the drawings when a separate panel schedule is not provided for a specific panelboard.
- .7 Two keys for each panelboard and key panelboards alike.
- .8 Panelboards to be copper bus unless identified otherwise.
- .9 Where identified on the drawings or schedules, provide a copper neutral bus sized to 200 % of the mains rating for panels.
- .10 Mains: suitable for bolt-on breakers.
- .11 Trim with concealed front bolts and hinges, for all panelboards other than those used in residential suites.
- .12 Trim and door finish: baked grey enamel.
- .13 Enclosure to be CSA Type 1 with drip hood with the exception of recessed panel enclosures which are to be CSA Type 1.
- .14 Provide Surge Protection Device where shown on Drawings.
- .15 Series ratings aren't acceptable.
- .16 All lugs to be dual rated for Copper/Aluminum (Cu/Al).
- .17 Where panelboards shown on the Drawings are indicated as Power Panels (PPs) or Distribution Panels (DPs), provide panelboard models that by default accommodate a minimum of 3 feeder circuit breakers rated for a minimum of 200 A – 3P, in addition to those shown on the Drawings.

2.2 Moulded Case Circuit Breakers

- .1 Bolt-on moulded case circuit breaker: quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40 deg. C. ambient.
- .2 Common-trip breakers: with single handle for multi-pole applications.
- .3 Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.
- .4 Main breaker, where indicated: separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.
- .5 Lock-on devices for 10 % of 15 to 30 A breakers installed. Turn over unused lock-on devices to The City.
- .6 Provide one breaker per designated breaker space. Multiple breakers contained in one housing or twin breakers are not acceptable.
- .7 Breaker terminals to be dual rated for Copper/Aluminum (Cu/Al).
- .8 Comply with Section 26 28 21 - MOULDED CASE AND INSULATED CASE CIRCUIT BREAKERS.

PANELBOARDS - BREAKER TYPE

2.3 Equipment Identification

- .1 Provide equipment identification in accordance with Section 26 05 53 – IDENTIFICATION.
- .2 Complete circuit directory with typewritten legend showing location and load of each circuit.

2.4 Manufacturers

- .1 The following are acceptable manufacturers:
 - .1 Schneider Electric
 - .2 Eaton Cutler-Hammer
 - .3 Siemens
 - .4 ABB

PART 3 - EXECUTION

3.1 Installation

- .1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.
- .2 Install surface mounted panelboards on galvanized strut channel stand-offs or on fire rated plywood backboards. The plywood backboards are to be as per Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .3 Mount panelboards at height specified in Section 26 05 05 – MOUNTING HEIGHTS.
- .4 Distribution Panels (DP) are to be floor mounted.
- .5 Connect loads to circuits.
- .6 Connect neutral conductors to common neutral bus with respective neutral identified.

END OF SECTION

SURGE PROTECTIVE DEVICE

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.

1.2 Standards

- .1 The specified system shall be designed, manufactured, tested and installed in compliance with the following codes and standards:
 - .1 Institute of Electrical and Electronic Engineers (ANSI/IEEE), latest edition
 - .1 C62.11 Standard for Metal-Oxide Surge Arresters for AC Power Circuits (>1 kV), C62.41.1 Guide on the Surge Environment in Low-Voltage (1000V and Less) AC Power Circuits, latest edition.
 - .2 C62.41.2 Recommended Practice on Characterization of Surges in Low-Voltage (1000V and Less) AC Power Circuits, latest edition.
 - .3 C62.45 Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000V and Less) AC Power Circuits, latest edition.
 - .2 Federal Information Processing Standards Publication 94 (FIPS PUB 94) – Guideline on Electrical Power for ADP Installations, latest edition.
 - .3 National Fire Protection Association, latest edition:
 - .1 75 Standard for The Protection of Information Technology Equipment, latest edition.
 - .4 MIL Standard 220B Method of Insertion Loss Measurement, latest edition.
 - .5 Underwriters Laboratories UL 1283 – Standard for Electromagnetic Interference Filters and UL 1449 – Standard for Surge Protective Devices, latest edition.
 - .6 CSA C22.2 No. 269 Series – Surge protective devices, latest editions.
 - .7 cUL.

1.3 Overview

- .1 The specifications in this section describe the electrical and mechanical requirements for a protection system provided by high-energy Surge Protective Devices (SPD) formerly called Transient Voltage Surge Suppressors (TVSS). The specified system shall provide effective, high-energy surge current diversion and be suitable for application in ANSI/IEEE C62.41 Category A, B and C environments.
- .2 SPDs are designed for repeated limiting of transient voltage surges on 60 Hz Power circuits not exceeding 1000 V and designated as follows:
 - .1 Type 2 – SPDs hard-wired to distribution equipment after the load side of the service equipment overcurrent device.
 - .2 Type 3 – Plug-in SPDs.
 - .3 Type 4 – Component SPDs and component assemblies.

SURGE PROTECTIVE DEVICE

1.4 Environmental Requirements

- .1 The operating temperature range shall be -25 deg. C. to 60 deg. C.
- .2 The unit shall be capable of operation up to 3,960 m above sea level.
- .3 No appreciable magnetic fields shall be generated.

1.5 Shop Drawings And Product Data

- .1 Submit Shop Drawings and product data in accordance with Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
- .2 Product Data: Provide catalogue sheets and supporting documentation showing:
 - .1 System voltage.
 - .2 UL1449 listing.
 - .3 UL 1449 Voltage Protection Ratings.
 - .4 UL 1449 I-n rating.
 - .5 Dimensions showing construction, lifting and support points, and enclosure details.
 - .6 Per mode and per phase peak surge current ratings.
 - .7 Modes of discrete suppression circuitry.
 - .8 Warranty period and replacement terms.
 - .9 Conductor size, conductor type, and recommended lead length.
 - .10 SPD is suitable for the application including system grounding configuration.
- .3 Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product. Indicate maximum size of circuit breaker or fuse to be connected for each unit.
- .4 List and detail all protection systems such as fuses, disconnecting means and protective features.
- .5 Provide verification that the SPD device complies with the required UL1449 latest edition, latest revision, and CSA or cUL approvals.
- .6 SPD shall have UL 1283 EMI/RFI filtering with minimum attenuation of -40 dB at 100 kHz.
- .7 For retrofit and side-mounting applications, provide electrical/mechanical drawings showing unit dimensions, weights, installation instruction details, and wiring configuration.
- .8 Operation and maintenance manuals shall include details for each SPD shipped.

1.6 Delivery, Storage And Handling

- .1 Equipment shall be handled and stored in accordance with manufacturer's written instructions. One (1) copy of manufacturer's written instructions shall be included with the equipment at time of shipment.

SURGE PROTECTIVE DEVICE

1.7 Quality Assurance And Warranty

- .1 The manufacturer shall provide a full ten (10) year warranty from the date of shipment against any SPD part failure when installed in compliance with manufacturer's written instructions and any applicable national or local code.

PART 2 - PRODUCT

2.1 General

- .1 The SPD shall be listed by CSA or cUL to UL's 1283 and UL's 1449 standards, and not merely the components or modules. Listing must be verified by a third party approved laboratory.
- .2 The SPD shall be CSA or cUL/UL 1449 labelled with 200 kA Short Circuit Current Rating (SCCR). Fuse ratings shall not be considered in lieu of demonstrated withstand testing of SPD.
- .3 Every suppression component of every mode, including N-G, shall be protected by internal overcurrent and thermal over-temperature controls. SPDs relying upon external or supplementary installed safety disconnect do not meet the intent of this specification.
- .4 Obtain all surge suppression devices from a single manufacturer.
- .5 The maximum continuous operating voltage (MCOV) of all components for solidly grounded systems shall not be less than 125% for a 120 V system and 120% for 220 and 240 V systems, and 125% for 347 and 600 V systems. All components for resistance grounded systems shall have an MCOV not less than 125% of the line-to-line voltage.
- .6 All SPD's shall be equipped with a comprehensive monitoring system which shall include a visual panel display providing information on unit status and phase loss/protection loss.
- .7 Unit Operating Voltage – Refer to drawings for operating voltage and unit configuration.
- .8 The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards.
- .9 Protection Modes – The SPD must protect all modes of the electrical system being utilized. The required protection modes are indicated by bullets in the following table:

	Protection Modes			
Configuration	L-N	L-G	L-L	N-G
Wye	•	•	•	•
Delta	N/A	•	•	N/A
Single Split Phase	•	•	•	•
High Leg Delta	•	•	•	•

SURGE PROTECTIVE DEVICE

- .10 The SPD shall protect all modes L-G, L-N, L-L, and N-G, have discrete suppression circuitry in L-G, L-N and N-G, and have bidirectional, positive and negative impulse protection. Line-to-neutral-to-ground protection is not acceptable where line-to-ground is specified, and accordingly reduced mode units with suppression circuitry built into only 4 modes are not acceptable. In delta systems, line-to-ground-to-line protection is not acceptable where line-to-line is specified.
- .11 Nominal Discharge Current (In) – All SPDs applied to the distribution system shall have a 20 kA In rating regardless of their SPD Type (includes Types 2 and 4) or operating voltage. SPD shall be UL 1449 labelled with this kA I-nominal (I-n) rating.
- .12 ANSI/UL 1449 Voltage Protection Rating (VPR) – The maximum ANSI/UL 1449 VPR for the device shall not exceed the following:

Modes	208Y/120	480Y/277	600Y/347
L-N; L-G; N-G	700	1200	1500
L-L	1200	2000	2500

- .13 Surge Current Capacity – The minimum surge current capacity the device is capable of withstanding shall be as shown in the following table:

Minimum surge current capacity based on ANSI / IEEE C62.41 location category			
Category	Application	Per Phase	Per Mode
C	Service Entrance Locations or distribution equipment rated at 1,000 Amps or more.	300 kA	150 kA
B	Distribution equipment rated less than 1,000 Amps but greater than 400 Amps	200 kA	100 kA
A	Branch Location Panelboards, or Busway rated at 400 Amps or less	100 kA	50 kA

- .14 Internal Fusing - Overcurrent Protection
- .1 Every suppression component of every mode, including N-G, shall be protected by internal overcurrent and thermal over-temperature controls. SPDs relying upon external or supplementary installed safety disconnect do not meet the intent of this specification.
- .15 SPD shall be separate from or integral to the electrical equipment. Where an Integral SPD is supplied, unit shall be UL 1449 labelled as Type 1 intended for Type 2 applications without need for external or supplemental overcurrent controls.
- .16 The suppressor shall include Form C dry contacts (N.O. or N.C.) for remote monitoring capability.
- .17 SPD lugs and terminals shall be dual rated for Copper/Aluminum (Cu/Al).

2.2 Category C locations

- .1 Provide SPD on the service entrance equipment or distribution equipment rated at 1,000 Amps or more.
- .2 The SPD shall have an internal audible alarm with mute on front cover.
- .3 SPD's for service entrance locations shall have a transient event counter with LCD panel display and reset button on the front cover.

SURGE PROTECTIVE DEVICE

2.3 Category B Locations

- .1 SPDs for distribution equipment rated less than 1,000 Amps but greater than 400 Amps shall be as indicated on project Drawings.
- .2 The SPD shall have an internal audible alarm.

2.4 Category A Locations

- .1 SPDs for the branch location panelboards, or busway rated at 400 Amps or less shall be as indicated on project drawings and panel schedules.
- .2 The SPD shall have an internal audible alarm.

2.5 Data & Signal Line Protection (For 24 V applications)

- .1 The unit shall have a data transmission rate up to 10.0 Mbps.
- .2 Each conductor shall have less than 2.4 ohm of internal series resistance per wire, and each pair of conductors shall have a peak surge current of no less than 10,000 amps per wire (20,000 amps per pair), 8 x 20 μ s waveform.
- .3 SPD Voltage Protection level shall be less than < 46 V.
- .4 The response time of the components of the unit shall be less than one nanosecond.

2.6 Phone Line Protection

- .1 The unit shall be listed under UL 497A, Standard for Secondary Protectors for Communications Circuits.
- .2 The unit shall have a data transmission rate up to 16.0Mbps.
- .3 Each conductor shall have less than 1 ohm of internal series resistance per wire.
- .4 Each pair of conductors shall have a peak surge current of no less than 200 amps, 8 x 20 μ s waveform.
- .5 The maximum let-through voltage on an IEC 10 x 700 μ s impulse (2kV/80A) shall be 260 volts tip-ring, 260 volts tip to ground, and 260 volts ring to ground.
- .6 The response time of the components of the unit shall be less than one nanosecond.

2.7 Enclosures

- .1 All enclosed equipment shall have CSA Type 1 with drip hood, sprinkler proof enclosure, unless otherwise noted.
- .2 For integral mounted SPD unit, it should be mounted in separate compartment with separate removable cover. For remote mounted SPD unit provide separate enclosure mounted as near to the electrical equipment as possible.

2.8 Manufacturers

- .1 Approved Vendors:
 - .1 Eaton Cutler-Hammer
 - .2 Innosys Power Inc.
 - .3 Schneider Electric

SURGE PROTECTIVE DEVICE

- .4 Siemens
- .5 Surge-Pure
- .6 ABB
- .7 Mersen
- .8 Citel

PART 3 - EXECUTION

3.1 Installation

- .1 Install the SPD with the conductors as short and straight as practically possible. Gently twist conductors together. SPD performance is drastically reduced with increased conductor length.
- .2 Installer shall reasonably rearrange breaker locations to minimize the lead length to SPDs.
- .3 Follow the SPD manufacturer's recommended installation practice as outlined in the equipment installation manual. The Electrical Subcontractor shall ensure that all neutral conductors are bonded to the system ground at the service entrance or the serving isolation transformer prior to installation of the associated SPD.
- .4 Main service entrance units shall be installed on a breaker, or, where indicated, shall be installed on a fused disconnect switch that meets or exceeds the fault current rating of the switchgear. Size of breaker to be confirmed by manufacturer and coordinated with distribution equipment supplier.
- .5 Distribution, branch panel, and motor control center units shall be installed on dedicated circuit breakers. Size of breaker to be confirmed by manufacturer and coordinated with distribution equipment supplier. A 3-pole breaker position shall be provided for connection of SPD.
- .6 The installing Subcontractor shall comply with all applicable codes.

END OF SECTION

MULTI-OUTLET ASSEMBLIES

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
- .3 Section 26 27 26 – WIRING DEVICES.
- .4 Section 26 05 21 – WIRES AND CABLES UNDER 2000 V.

1.2 Reference

- .1 CSA C22.2 No. 62 – Surface Metal Raceways, latest edition.
- .2 ANSI/TIA 569-C – Commercial Building Standard for Telecommunications Pathways and Spaces, latest edition.

1.3 Shop Drawings And Product Data

- .1 Submit shop drawings and product data in accordance with Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
- .2 If variations from the reviewed shop drawings occur during the installation of the system, final as built drawings shall be submitted for each floor that has been altered.

1.4 Warranty

- .1 Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Surface Raceway For Wiring Devices

- .1 The raceway and all system components must be CSA listed.
- .2 Raceway to be constructed of galvanized steel unless stainless steel is identified on the drawings. Raceway base shall have a minimum thickness of 1.3 mm (0.050 in.) and the cover shall have a minimum thickness of 1 mm (0.040 in.).
- .3 Raceways shall be painted with the colour to be determined by the Contract Administrator at the time of shop drawing stage. Submit available colour selections with the shop drawing submittal.
- .4 The raceway shall have a minimum of two compartments unless additional compartments are identified on the drawings. Assembled base and cover shall be a 120 mm (4¾ in.) wide for two section raceway and additional 60 mm (2-3/8 in.) for every additional compartment with a minimum depth of 45 mm (1¾ in.) unless specified otherwise on the drawing.

MULTI-OUTLET ASSEMBLIES

- .5 The raceway shall be a modular design with separate covers for each compartment divided with fixed barriers. The compartment covers to be snap on design, which snap side by side on a common base. Raceway covers shall be enhanced tamper resistant form, where screws are only necessary on access plates and the covers of certain fittings, but not on standard cover lengths. A tool shall be provided to form the shape in the cover flange necessary to maintain enhanced tamper resistance when the cover is field cut. Another tool shall be provided for cutting covers to ensure square field cuts.
- .6 Provide all required fittings including, but not limited to flat, internal and external elbows, couplings for joining raceway sections, wire clips, blank end fittings, entrance fittings, and a full complement of device mounting brackets and plates. All fittings shall be an enhanced tamper resistant form and shall be divided with barriers and made to match the size of the accompanying raceway base.
- .7 Provide full capacity corner elbows and tee fittings to maintain a controlled 50 mm (2 in.) cable bend radius, which meets the specifications for Fiber Optic cabling and exceeds the TIA 569 requirements for communications pathways.
- .8 Device brackets shall be provided in sizes to match the width of the raceway and with mounting-holes appropriately located to ensure proper mounting of devices in all compartments.
- .9 Device plates shall be made in any length from 152.4 mm (6 in.) to 1.5 m (60 in.) with cut outs to accommodate various combinations of power and/or communication devices in all compartments. Device plates shall be 152.4 mm (6 in.) and 304.8 mm (12 in.) long with a flange to overlap the joint of the adjacent cover. Provide 5% additional device plates for future additions or modifications for all types of devices installed.

2.2 Manufacturers

- .1 The following are approved manufacturers:
 - .1 CER - Canadian Electric Raceways.
 - .2 Legrand – Wiremold.
 - .3 Hubbell.

PART 3 - EXECUTION

3.1 Installation

- .1 Prior to and during installation, refer to system layout or approval drawings containing all elements of the system. Installer shall comply with detailed manufacturer's instruction sheets, which accompany system components, as well as complete system instruction sheets, whichever is applicable.
- .2 All raceway systems shall be mechanically continuous and connected to all electrical outlets, boxes, device mounting brackets, and cabinets, also in accordance with manufacturer's installation sheets.
- .3 All metal raceway shall be electrically continuous and bonded in accordance with the respective electrical code for proper grounding.
- .4 Provide a separate insulated bonding conductor in the entire length of the raceway.
- .5 Raceway shall be securely supported at intervals not exceeding 1500 mm (5 ft.) or in accordance with manufacturer's installation sheets.

MULTI-OUTLET ASSEMBLIES

- .6 All raceway systems shall be installed complete, including insulating bushings and inserts where required by manufacturer's installation sheets. All unused raceway openings shall be closed.
- .7 Locate wireway and wiring devices as shown.
- .8 Install supports, elbows, tees, connectors and fittings. Keep the number of elbows, offsets and connections to a minimum.
- .9 Install wiring and wiring devices as indicated.
- .10 Install barriers to separate different wiring systems.

END OF SECTION

WIRING DEVICES

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
- .3 Section 26 05 05 – MOUNTING HEIGHTS.
- .4 Section 26 05 53 – IDENTIFICATION.
- .5 Section 26 51 13 – LIGHTING EQUIPMENT.

1.2 References

- .1 CSA C22.2 No. 42, General use receptacles, attachment plugs, and similar wiring devices, latest edition.

1.3 Shop Drawings And Product Data

- .1 Submit shop drawings and product data in accordance with Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.

1.4 Warranty

- .1 Provide a warranty in accordance with the requirements of Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Switches

- .1 20 A, single pole, double pole, three-way, or four-way specification grade switches. Voltage rating of the switch to be as per the Contract documents.
- .2 Manually-operated general purpose 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 Decora Style specification grade Rocker switch.
 - .6 Colour to be selected by Contract Administrator.
- .3 Toggle operated locking fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads.

WIRING DEVICES

2.2 Receptacles

- .1 All receptacles to be specification grade.
- .2 Duplex receptacles, Decora style CSA Type 5-15 R, 125 V, 15 A, U ground, with following features:
 - .1 Thermoplastic with impact-resistant nylon face moulded housing.
 - .2 Suitable for No. 10 AWG for back and side wiring.
 - .3 Eight back wired entrances, four side wiring screws.
 - .4 Triple wipe contacts and riveted grounding contacts.
- .3 Duplex receptacles with USB charging outlets, Decora style CSA Type 5-15 R, 125 V, 15 A, U ground, with following features:
 - .1 Thermoplastic with impact-resistant nylon face moulded housing.
 - .2 Suitable for No. 10 AWG for back and side wiring.
 - .3 Six back wired entrances, four side wiring screws.
 - .4 Triple wipe contacts and riveted grounding contacts.
 - .5 One USB A charging outlet and one USB C charging outlet, 5 V DC, 6 A shared between the two ports.
- .4 Single receptacles CSA Type 5-15 R, 125 V, 15 A, U ground with following features:
 - .1 Thermoplastic moulded housing.
 - .2 Suitable for No. 10 AWG for back and side wiring.
 - .3 Four back wired entrances, 2 side wiring screws.
- .5 Other receptacles with ampacity and voltage as indicated.
- .6 Receptacles to be coloured as follows:
 - .1 Normal Power – Colour to be selected by Contract Administrator.
 - .2 Isolated Ground – Orange.
 - .3 UPS – Blue.
- .7 All receptacles of CSA configuration 5-15R and 5-20R shall be tamper resistant receptacles and shall be so marked; receptacles dedicated for microwaves, refrigerators, freezers or those receptacles located in an attic or crawl space shall not be required to be tamper-resistant.
- .8 Electrical Subcontractor shall coordinate with furniture supplier to identify switched circuits prior to installation.

2.3 Manufacturers

- .1 The switches and wiring devices shall be of one manufacturer throughout the project.
- .2 The following are acceptable manufacturers:
 - .1 Legrand.
 - .2 Hubbell.
 - .3 Cooper.
 - .4 Leviton.

WIRING DEVICES

2.4 Special Wiring Devices

- .1 Pilot lights as indicated, with neon type 0.04 W, 125 V lamp and red plastic lens flush type.

2.5 Cover Plates

- .1 Cover plates for wiring devices.
- .2 Cover plates from one manufacturer throughout project.
- .3 Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.
- .4 Provide stainless steel cover plates, suitable for the respective device, for all devices mounted in flush-mounted outlet boxes located in finished areas.
- .5 Sheet metal cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.
- .6 Weatherproof rain tight while-in-use metal cover, complete with gaskets for duplex receptacles located outside or as indicated.
- .7 Weatherproof rain tight while-in-use metal cover, complete with gaskets for single receptacles or switches located outside or as indicated.

PART 3 - EXECUTION

3.1 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 Where line voltage controls are used, install an identified conductor at each location of a manual or automatic control device in accordance with electrical code requirements.
 - .4 Mount toggle switches at height specified in Section 26 05 05 – MOUNTING HEIGHTS or as indicated.
- .2 Receptacles:
 - .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
 - .2 Mount receptacles at height specified in Section 26 05 05 – MOUNTING HEIGHTS or as indicated.
 - .3 Where split receptacle has one portion switched, mount vertically and switch upper portion.

WIRING DEVICES

.3 Cover plates:

- .1 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.
- .2 Install suitable common cover plates where wiring devices are grouped.
- .3 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

.4 Labelling

- .1 Provide labels with panel name and circuit number on all receptacles in conformance with Section 26 05 53 – IDENTIFICATION.

END OF SECTION

ELECTRICAL VEHICLE (EV) CHARGING STATIONS

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
- .3 Section 26 05 53 – IDENTIFICATION.

1.2 Reference

- .1 CSA-C22.2 No. 0. General Requirements - Canadian Electrical Code, Part II.
- .2 CSA C22.2 No. 107.1 Power Conversion Equipment or equivalent.
- .3 CSA C22.2 No. 280. Standard for Electric Vehicle Supply Equipment.
- .4 CSA C22.2 No. 281.1. Personnel Protection Systems for Electric Vehicle (EV) Supply Circuits: General Requirements.
- .5 CSA C22.2 No. 281.2. Personnel Protection Systems for Electric Vehicle (EV) Supply Circuits: Particular Requirements for Protection Devices for Use in Charging Systems.
- .6 CSA C22.2 No. 282. Plugs, Receptacles, and Couplers for Electric Vehicles.
- .7 UL 2202 – Standard for Electric Vehicle (EV) Charging System Equipment
- .8 UL 2231 – Personnel Protection Systems for Electric vehicles supply circuits
- .9 UL 2594 – EV Supply Equipment
- .10 UL 991 – Safety Related Controls Employing Solid-State Devices
- .11 ICES-003 – Interference-Causing Equipment Standard or equivalent
- .12 OCPP 1.6 – Standard for Communication between an EV charging station and an EV Charging Station Management System (CSMS).

1.3 Shop Drawings And Product Data

- .1 Submit Shop Drawings and product data in accordance with Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.

1.4 Site Conditions

- .1 Rate equipment for continuous operation and storage under the following conditions unless otherwise indicated:
 - .1 Ambient Temperature: Not exceeding minus 40 to plus 122 deg F (minus 40 to plus 50 deg C).
 - .2 Humidity: Not exceeding 95 percent (noncondensing).

1.5 Warranty

- .1 Provide a warranty in accordance with the requirements of Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

ELECTRICAL VEHICLE (EV) CHARGING STATIONS

PART 2 - PRODUCTS

2.1 EV Charging Stations

- .1 Voltage: 208V AC with SAE J1772 connector
- .2 Ambient Temperature: Minus 40 to 122 deg F (Minus 40 to 50 deg C).
- .3 Surge Withstand: 6 kV at 3000 A.
- .4 Electrical Components, Devices, and Accessories: Listed and labeled by a qualified testing agency, and marked for intended location and use.
- .5 EV Charging Levels: Single vehicles/Single charging ports or Double Vehicles/Double charging ports (as shown on the drawings), AC Level 2 up to 7.2 kW per port.
- .6 The EV charging shall be connected to web-based EV system.
- .7 Enclosure: enclosure must be rated for outdoor operation and achieve a minimum NEMA 3R.
- .8 Enable Open Charge Point Protocol (OCPP) – version 2.0.1 or higher
- .9 Cable length as noted on drawings.
- .10 Electricity metering accuracy of +/- 2%.
- .11 Cellular network enabled/connectivity (4G/LTE or better).
- .12 RFID access in accordance with ISO 14443 A/B, ISO 15693, NEC, NEMA interoperability protocol
- .13 LED status indicator
- .14 Display screen with capability of conveying messages, and user instructions.
- .15 Provide bollard mounting kit.

2.2 EV Charging Station Management System

- .1 EV Charging Station Management System requirement are to be confirmed with The City during shop drawing review.
- .2 The following data points are to be ongoingly tracked, stored, and remain accessible to The City in .xls or .csv format in perpetuity by the EV Charging Station Management System:
 - .1 EV Charger Identification (ID)
 - .2 EV Charger location
 - .3 Unique customer identifier (a non-personal identifier (e.g. Network user ID))
 - .4 Charging session date
 - .5 Charging session start time
 - .6 Charging session end time
 - .7 Amount of power provided during charging session (kWh)
 - .8 Amount of revenue generated (CAD)
 - .9 Encountered malfunctions (including issue codes and descriptions,
 - .10 and duration of downtime

ELECTRICAL VEHICLE (EV) CHARGING STATIONS

- .3 The EV Charging Station Management System will include a dashboard that communicates and/or displays at a minimum:
 - .1 A map showing the number and location of EV charging stations
 - .2 Real-time EV Charger status (e.g. in-use, available, inoperable, charge per use or free type etc.)
- .4 Cumulative electricity provided to vehicles, revenue generation, and GHG emissions avoidances are preferred. The EV Charging Station Management System and/or subsidiary reporting features must provide the following analytical functions at a minimum:
 - .1 Isolate all data points by the entire EV charging station portfolio, specific site where chargers are installed, charger type, and individual charger.
 - .2 Determine the charging utilization ratio, between a specified calendar or time interval, across the EV Charger portfolio, a specific site, or individual EV Charger (e.g. between 8:30am and 4:30pm at a specified site location, determine what percentage of time are chargers in use).
 - .3 Determine the length of time EVs are plugged in but not actively charging across the EV Charger portfolio, a specific site, or individual EV Charger.
 - .4 Report on revenue generation between a specified calendar or time interval.
 - .5 The ability to report on greenhouse gas (GHG) emissions avoidances is preferred.
- .5 The EV Charging Station Management System must provide the following management functions at a minimum:
 - .1 Automatically program and manually adjust the maximum power output in EV Charging Stations.
 - .2 Automatically program to share the power between the EV chargers.
 - .3 Automatically program to throttle EV charger loads to within given limits.
 - .4 Automatically and dynamically controlling the EV charger loads in response to external signal from utility, upstream or other power source.
 - .5 Automatically controlling the EV Charger loads dynamically and instantaneously in response to monitoring of other uncontrolled loads in the electrical installation.
 - .6 Enable or disable EV Charger operation.
 - .7 Adjust messaging that appears on EV Charger display.
 - .8 Automatically notify operations staff and EV Charger Service Provider of charger malfunctions and loss of functionality.
 - .9 The ability to integrate EV Charger operation with electric utility demand response programs is preferred.
 - .10 The ability to integrate with fleet fuel cards, telematics, and asset management systems is preferred.

ELECTRICAL VEHICLE (EV) CHARGING STATIONS

2.3 User Services

- .1 User Services are to be confirmed with The City during shop drawing review. Any ongoing fees are to be negotiated with The City.
- .2 The City requires the following functionalities from the EV Charger Service Provider's networking platform to be provided for users of EV charging stations on the site:
 - .1 Free subscription to the networking platform.
 - .2 Locating and providing directions to EV Chargers, communicating accessibility (e.g. hours of operation, public or private), and conveying fees for use via an online and mobile application accessible map.
 - .3 Authorizing access for station use and facilitating payment for use via a mobile application.
 - .4 Real-time visibility of the vehicle battery's state of charge, power provided, and fees incurred during a charging session via a mobile application.
 - .5 Notifications sent to EV drivers once a vehicle is fully charged, or reached a user determined battery charge level, via short message service (SMS) or a mobile application.
- .3 The EV Charger Service Provider will have the option to provide an access card to users that can enable EV Charger use via RFID, without the use of a mobile application.
- .4 The EV Charger Service Provider will operate a toll-free 24/7 customer support call-center for users who need assistance accessing the EV Charging Stations.

2.4 Remote Upgrades, Monitoring and Troubleshooting

- .1 The EV Charger Service Provider will:
 - .1 Perform required firmware and software upgrades remotely.
 - .2 Attempt to resolve any EV Charger issues remotely within four business hours of issue detection.
 - .3 If the issue cannot be remotely resolved, notify The City's designated operator/property manager of the issue.

2.5 Equipment Identification

- .1 Provide equipment identification in accordance with Section 26 05 53 – IDENTIFICATION.
- .2 Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 – IDENTIFICATION.

2.6 Manufacturers

- .1 The following are acceptable manufacturers:
 - .1 Single Port Station: Charge Point CAT# CT4011-GW1
 - .2 Dual Pot Station: Charge Point CAT# CT4025-GW1
 - .3 Power Management System: Charge Point CAT#CT-4000-PMGMT

ELECTRICAL VEHICLE (EV) CHARGING STATIONS

2.7 Warranty

- .1 Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components of EVSE that fail(s) in materials or workmanship within specified warranty period.
 - .1 Extended Warranty Period: Two year(s) from date of warranty transfer from Contractor to The City on date of Total Performance.

PART 3 - EXECUTION

3.1 Installation

- .1 Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- .2 Examine roughing-in for EVSE electrical conduit to verify actual locations of conduit connections before equipment installation.
- .3 Examine floor finish for suitable conditions where EVSE will be installed.
- .4 Proceed with installation only after unsatisfactory conditions have been corrected.
- .5 Install EVSE equipment in accordance with manufacturer's written instructions.
- .6 EV charging station shall be installed to the wall or on the floor as indicated on the drawings.
- .7 Verify that all electrical connections have been made in accordance with the manufacturer's instructions. Remove all burrs, shavings, and detritus from inside the enclosure.
- .8 After confirming all connections, install covers and tighten fasteners to in accordance with manufacturer's instructions.

3.2 Field Quality Control

- .1 Perform tests and inspections with the assistance of a factory-authorized service representative.
- .2 Tests and Inspections:
 - .1 For each unit of EVSE, perform the following tests and inspections:
 - .1 Unit self-test.
 - .2 Operation test with EV
 - .3 Network communications test.
 - .2 EVSE will be considered defective if it does not pass tests and inspections.
 - .3 Prepare test and inspection reports.

3.3 Training

- .1 Engage a factory-authorized service representative to train The City's maintenance personnel to adjust, operate, and maintain EV charging equipment.

END OF SECTION

FUSES LOW VOLTAGE

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.

1.2 References

- .1 CSA C22.2 No. 248, Low Voltage Fuses, latest edition.

1.3 Shop Drawings And Product Data

- .1 Submit shop drawings and product data in accordance with Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
- .2 Submit fuse performance data characteristics for each fuse type and size above 100 A. Performance data to include: average melting time-current characteristics, I₂t (for fuse coordination), and peak let-through current.

1.4 Maintenance Materials

- .1 Three spare fuses of each type and size installed 600 A. and above.
- .2 Six spare fuses of each type and size installed up to and including 400 A.

1.5 Delivery And Storage

- .1 Ship fuses in original containers.
- .2 Do not ship fuses installed in switchboard.
- .3 Store fuses in original containers in moisture free location.

1.6 Warranty

- .1 Provide a warranty in accordance with the requirements of Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

PART 2 - PRODUCTS

- .1 Fuses General Fuses: product of one manufacturer.
- .2 Fuses to have an indicating window to identify when the fuse has been blown.

2.2 Fuse Types

- .1 Class L fuses.
 - .1 Type L1, time delay, capable of carrying 500 % of its rated current for 10 s minimum.
 - .2 Type L2, fast acting.
- .2 Class J fuses.
 - .1 Type J1, time delay, capable of carrying 500 % of its rated current for 10 s minimum.
 - .2 Type J2, fast acting.

FUSES LOW VOLTAGE

- .3 Class R fuses. For UL Class RK1 fuses, peak let-through current and I²t values not to exceed limits of CSA C22.2 No. 248.
 - .1 Type R1, (UL Class RK1), time delay, capable of carrying 500% of its rated current for 10 s minimum, to meet UL Class RK1 maximum let-through limits.
 - .2 Type R2, time delay, capable of carrying 500 % of its rated current for 10 s minimum.
 - .3 Type R3, (UL Class RK1), fast acting Class R, to meet UL Class RK1 maximum let-through limits.
- .4 Class C fuses.
- .5 Fuses for Motors:
 - .1 All fuses for motor loads are to be time-delay type.

2.3 Fuse Storage Cabinet

- .1 Fuse storage cabinet, manufactured from 2.0 mm thick aluminum 750 mm high, 600 mm wide, 300 mm deep, hinged, lockable front access door, B-LINE model 243012 + 2 shelves FCS2412, finished in accordance with Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2.4 Fuse Puller

- .1 Provide a fuse puller for each size of fuse to be located in the fuse storage cabinet. Fuse puller to be clearly labelled for the appropriate building and fuse cabinet. Fuse puller to be equal to the Ideal Safe-T-Grip Fuse Puller.

2.5 Manufacturers

- .1 The following are acceptable manufacturers:
 - .1 Mersen
 - .2 Cooper-Bussman
 - .3 Littelfuse

PART 3 - EXECUTION

3.1 Installation

- .1 Install fuses in mounting devices immediately before energizing circuit.
- .2 Ensure correct fuses fitted to physically match mounting devices.
 - .1 Install Class R rejection clips for Class R fuses.
- .3 Ensure correct fuses fitted to assigned electrical circuit.
- .4 Where UL Class RK1 fuses are specified, install warning label "Use only UL Class RK1 fuses for replacement" on equipment.

END OF SECTION

MOULDED CASE AND INSULATED CASE CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.

1.2 References

- .1 CSA C22.2 No. 5 – Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures, latest edition.

1.3 Shop Drawings And Product Data

- .1 Submit Shop Drawings and product data in accordance with Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS
- .2 Include time-current characteristic curves for breakers with ampacity of 400 A and over or with interrupting capacity of 22,000 A symmetrical (RMS) and over at system voltage.
- .3 Submit initial power system study at the same time as shop drawings for electrical distribution equipment, such that the Contract Administrator can review the adequacy of equipment interrupting capacity or withstand ratings, prior to equipment being released for manufacture. In situations where the entire study cannot be submitted with the electrical distribution shop drawings, submit at a minimum a preliminary short circuit study for review.

1.4 Warranty

- .1 Provide a warranty in accordance with the requirements of Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS

PART 2 - PRODUCTS

2.1 Breakers General

- .1 Bolt-on moulded case circuit breaker: quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40 deg. C. ambient.
- .2 Common-trip breakers: with single handle for multi-pole applications.
- .3 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting. Trip settings on breakers with adjustable trips to range from 3-8 times current rating.
- .4 Circuit breakers with interchangeable trips as indicated.
- .5 Where a circuit breaker shown on the Drawings is rated 1200 A or higher, provide the following:
 - .1 Energy reducing maintenance switching (ERMS) system that provides a means to reduce arcing fault clearing time, with the following features:
 - .1 Positive feedback status indication LED light to indicate the status of the system, built into the equipment housing the breaker.

MOULDED CASE AND INSULATED CASE CIRCUIT BREAKERS

- .2 A selector switch to be located remote from the equipment and a 24 V DC circuit, to turn the system on and off.
- .3 Ability for circuit breaker trip unit to have two trip curves – the first for normal operation and the second for when a qualified person is working within the arc flash boundary (maintenance mode).
- .4 Ability for second trip curve to be set so that the breaker operates faster and more sensitively.
- .5 Pickup settings as low as 2.5 times breaker rating plug.
- .6 Provide system with documentation and equipment lamacoids that explain how the system works.

2.2 Thermal Magnetic Breakers

- .1 Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.

2.3 Magnetic Breakers

- .1 Moulded case circuit breakers to operate automatically by means of magnetic tripping devices to provide instantaneous tripping for short circuit protection.

2.4 Fused Thermal Magnetic Breakers

- .1 Fused thermal magnetic breakers with current limiting fuses internally mounted. Time current limiting characteristics of fuses coordinated with time current tripping characteristics of circuit breaker. Coordination to result in interruption by breaker of fault-level currents up to interrupting capacity of breaker. Fuses individually removable and interlocked with breaker. The removal of fuse cover, blowing of a fuse or removal of a fuse, shall trip the breaker.

2.5 Solid State Trip Breakers

- .1 Circuit breaker to operate by means of an adjustable solid-state trip unit with associated current monitors and self-powered shunt trip to provide inverse time current trip under overload condition.
- .2 Electronic trip with true RMS sensing.
- .3 Use current transformers to ensure accurate measurement from low current up to high currents.
- .4 Electronic trip with thermal memory/imaging.
- .5 Adjustable solid state trip unit complete with:
 - .1 Adjustable long time pick-up
 - .2 Adjustable long time delay
 - .3 Adjustable short time pick-up (where S indicated on Drawings)
 - .4 Adjustable short time delay (where S indicated on Drawings)
 - .5 Adjustable instantaneous pick-up (where I indicated on Drawings)
 - .6 Adjustable ground fault pick-up (where G indicated on Drawings)

MOULDED CASE AND INSULATED CASE CIRCUIT BREAKERS

- .7 Adjustable ground fault delay (where G indicated on Drawings)
- .8 Long time, short time, instantaneous tripping for phase and ground fault short circuit protection as noted above.
- .6 Trip unit consisting of adjustable protection settings set by rotating switch or digital keypad, and rating plug.
- .7 Provide features listed below:
 - .1 Provide instantaneous maintenance mode (arc flash reduction maintenance system) including settings as low as 2.5 times breaker rating plug with switch built into respective switchboard. Provide LED light that confirms that maintenance mode is engaged.
 - .2 Provide trip unit with local trip indication and ability to locally and remotely indicate reason for trip (e.g. overload, short circuit, or ground fault).

2.6 Insulated Case Circuit Breakers General

- .1 Use insulated case circuit breakers where shown on the Drawings.
- .2 Provide draw out type electrically operated circuit breaker with remote open/close key switch.
- .3 Provide circuit breaker operating mechanisms that are two-step, fully-stored energy devices for quick-make, quick-break operation with a maximum of a five-cycle closing time. Open-close-open (O-C-O) cycle possible without recharging. Provide motor operator that automatically charges when circuit breaker is closed. Charge the closing springs (step one) upon actuation of the operating handle or an operation cycle of the circuit breaker motor and close the circuit breaker contact (step two) upon operation of a local "close" button. Automatically charge the opening springs when closing the circuit breaker contacts.
- .4 Provide breaker that is 100% continuous current rated in its enclosure.
- .5 Provide kirk keys where indicated on the Drawings.
- .6 Completely isolate current-carrying components from the accessory mounting area and double insulate current-carrying components from the operator with accessory cover in place.
- .7 Provide padlocking provisions furnished to receive up to three padlocks when circuit breaker is in the open position, positively preventing unauthorized closing of the circuit breaker contacts.
- .8 Provide provisions for up to two key locks allowing locking in the disconnected position. Provide provisions for locking in the connected, test and disconnected positions by padlock or key lock.
- .9 Provide buttons, with lockable clear cover, located on the face of the circuit breaker, to open and close the circuit breaker and indicators to show the position of the circuit breaker contacts, status of the closing springs, and circuit breaker position in the cell. Provide an indicator that shows "charged-not OK to close" if closing springs are charged but circuit breaker is not ready to close. Provide circuit breaker racking system that has positive stops at the connected, test, disconnected and withdrawn positions.

MOULDED CASE AND INSULATED CASE CIRCUIT BREAKERS

- .10 Equip circuit breaker with an interlock to discharge the stored energy spring before the circuit breaker can be withdrawn from its cell. Provide circuit breaker that provides a positive ground contact check between the circuit breaker and cell when the accessory cover is removed while the circuit breaker is in the connected, test or disconnected positions.
- .11 Provide interlocks to prevent circuit breaker draw out when in closed position and to prevent closing unless fully engaged or in test position. Provide breaker that is trip free during racking operation.
- .12 Provide as an option, primary connectors that can be rotated to provide flexible vertical or horizontal connections. Ensure front connections are available as an option for shallow depth equipment designs.
- .13 Provide ready-to-close contact that indicates remotely that the circuit breaker is "ready to close." The circuit breaker is ready to close when it is open, spring mechanism is charged, a maintained closing order is not present, a maintained opening order is not present, and the circuit breaker is in an operational position.
- .14 Provide secondary control wiring that is front accessible and available in cage clamp or ring terminal connections. Provide secondary wiring that is inaccessible when switchboard door is closed.
- .15 Provide long service life circuit breaker. Provide circuit breakers certified to perform a minimum of 10,000 operations without maintenance where circuit breaker frames are 3000 A and below.
- .16 Equip circuit breaker with a visual contact wear indicator.
- .17 Provide circuit breaker arc chutes that don't contain asbestos.
- .18 Trip Unit
 - .1 Comply with the requirements noted above in the Solid State Trip Breakers section.
 - .2 Provide trip units that are removable to allow for field upgrades.
 - .3 Provide trip units that are capable of the following types of ground-fault protection: residual, zero sequence, source ground return, and modified differential. Ground-fault sensing systems may be changed in the field.
 - .4 Ensure neutral current transformers are available for four-wire systems.
 - .5 Provide trip units that have real time metering and metering functions that include current, voltage, power and frequency. Provide metering accuracy of 1.5% current, 0.5% voltage, and 2% power. Accuracies listed are total system including CT and meter and are of reading, not full scale, in a range of 5 – 500%.
 - .6 Provide trip unit with provisions for communications on a network.

2.7 Accessories

- .1 Include:
 - .1 shunt trip, when electrically operated or when indicated.
 - .2 auxiliary switches, when electrically operated or when indicated.
 - .3 motor-operated mechanism, when electrical operation indicated.

MOULDED CASE AND INSULATED CASE CIRCUIT BREAKERS

- .4 on-off locking device.
- .5 handle mechanism.

2.8 Manufacturers

- .1 The following are acceptable manufacturers:
 - .1 Schneider Electric
 - .2 Eaton Cutler-Hammer
 - .3 Siemens
 - .4 ABB

PART 3 - EXECUTION

3.1 Installation

- .1 Install circuit breakers as indicated.
- .2 Contractor to wire any neutral CT's to the breaker trip unit where required by the breaker ground fault detection system or as otherwise required by the manufacturers instructions.

END OF SECTION

DISCONNECT SWITCHES - FUSED AND NON-FUSED

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
- .3 Section 26 05 53 – IDENTIFICATION.

1.2 Reference

- .1 CSA C22.2 No. 4 – Enclosed Switches, latest edition.
- .2 CSA C22.2 No. 39 – Fuse-holder Assemblies, latest edition.

1.3 Shop Drawings And Product Data

- .1 Submit Shop Drawings and product data in accordance with Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
- .2 Submit initial power system study at the same time as shop drawings for electrical distribution equipment, such that the Contract Administrator can review the adequacy of equipment interrupting capacity or withstand ratings, prior to equipment being released for manufacture. In situations where the entire study cannot be submitted with the electrical distribution shop drawings, submit at a minimum a preliminary short circuit study for review.

1.4 Warranty

- .1 Provide a warranty in accordance with the requirements of Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Disconnect Switches

- .1 Fusible, horsepower rated disconnect switch in CSA Type 3R enclosure, size as indicated.
- .2 Non-fusible, horsepower rated disconnect switch in CSA Type 3R enclosure, with minimum 10 kA Short Circuit Current Rating (SCCR), with manufacturer listed series rating with upstream breaker / fuse where available fault current exceeds 10 kA and with UL series rating label on disconnect switch, size as indicated.
- .3 Provision for padlocking in on-off switch position by three locks.
- .4 Mechanically interlocked door to prevent opening when handle in ON position.
- .5 Fuses: size as indicated, class J, current limiting, in accordance with Section 26 28 14 – FUSES LOW VOLTAGE.
- .6 Fuse-holders: suitable without adaptors, for type and size of fuse indicated.
- .7 Quick-make, quick-break action.
- .8 ON-OFF switch position indication on switch enclosure cover.

DISCONNECT SWITCHES - FUSED AND NON-FUSED

2.2 Equipment Identification

- .1 Provide equipment identification in accordance with Section 26 05 53 – IDENTIFICATION.
- .2 Indicate name of load controlled on nameplate.
- .3 Provide a Lamacoid nameplate that indicates the replacement fuse size as well as the maximum allowable fuse size for that disconnect based upon the sizing of the feeder.

2.3 Manufacturers

- .1 The following are acceptable manufacturers:
 - .1 Schneider Electric.
 - .2 Eaton Cutler-Hammer.
 - .3 Siemens.
 - .4 ABB.

PART 3 - EXECUTION

3.1 Installation

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

END OF SECTION

MOTOR STARTERS TO 600 V

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
- .3 Section 26 05 53 – IDENTIFICATION.

1.2 References

- .1 IEC 947-4-1, Part 4: Contactors and motor-starters, latest edition. Select IEC or NEMA rated devices depending on the project requirements
- .2 CSA C22.2 No. 60947-4-1 – Low-voltage switchgear and control gear – Part 4-1: Contactors and motor-starters – Electromechanical contactors and motor-starters, latest edition.

1.3 Shop Drawings And Product Data

- .1 Submit shop drawings and product data in accordance with Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
 - .1 Indicate:
 - .1 Mounting method and dimensions.
 - .2 Starter size and type.
 - .3 Layout of identified internal and front panel components.
 - .4 Enclosure types.
 - .5 Wiring diagram for each type of starter.
 - .6 Interconnection diagrams.
 - .2 Submit initial power system study at the same time as shop drawings for electrical distribution equipment, such that the Contract Administrator can review the adequacy of equipment interrupting capacity or withstand ratings, prior to equipment being released for manufacture. In situations where the entire study cannot be submitted with the electrical distribution shop drawings, submit at a minimum a preliminary short circuit study for review.

1.4 Operation And Maintenance Data

- .1 Provide operation and maintenance data for motor starters for incorporation into manual.
- .2 Include operation and maintenance data for each type and style of starter.

1.5 Maintenance Materials

- .1 Provide listed spare parts for each different size and type of starter:
 - .1 Stationary contacts.
 - .2 Movable contacts.
 - .3 Auxiliary contacts.

MOTOR STARTERS TO 600 V

- .4 Control transformer.
- .5 Operating coil.
- .6 Fuses.
- .7 Indicating lamp bulbs used.

1.6 Warranty

- .1 Provide a warranty in accordance with the requirements of Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Materials

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

2.2 Equipment

- .1 All starters (with the exception of manual motor starters) are to be combination starters with fusible disconnect switches.
 - .1 All fusible disconnects are:
 - .1 To be of the quick make and quick break type.
 - .2 To have an operating handle on the outside of the enclosure.
 - .3 To have fuse clips suitable for High Rupturing Capacity (HRC) Class J fuses.
 - .2 The operating handle of the fusible disconnect switch must be:
 - .1 Capable of being locked in the "OFF" position.
 - .2 Have provisions of accepting 3 pad locks.
 - .3 Have provision for preventing switching to "ON" position while enclosure door is open.
- .2 All starters, with the exception of manual motor starters, are to be provided with a single phase, dry type control circuit transformer with:
 - .1 A fused primary.
 - .2 Primary voltage as indicated.
 - .3 120 V secondary.
 - .4 Secondary fusing.
- .3 Size the control transformer for control circuit load plus 20 % spare capacity, minimum capacity 150 VA.
- .4 All starters shall be equipped with indicating lamps that are long life cluster LED style.
- .5 All starters shall be provided with 3 phase bimetallic overload relays which are adjustable and are ambient temperature compensated. Manual resets for the overload relays are to be mounted on the enclosure door such that they can be reset from outside of the enclosure and have externally visible trip indication.

MOTOR STARTERS TO 600 V

- .6 All starters shall have identification for each wire and terminal for external connection, within starter, with permanent number marking identical to diagram.

2.3 Manual Motor Starters

- .1 Single or 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 overload heater per phase, manual reset, trip indicating handle.
- .2 Accessories:
 - .1 Toggle switch: heavy duty oil tight labeled as indicated on the Starter Schedule.
 - .2 Indicating light: oil tight type and colour as indicated on the Starter Schedule.
 - .3 Locking tab to permit padlocking in "ON" or "OFF" position.

2.4 Full Voltage Magnetic Starters

- .1 Magnetic and 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 bimetallic protective relay.
 - .3 Wiring and schematic diagram inside starter enclosure in a visible location.
- .2 Accessories:
 - .1 Pushbuttons or Selector switches: heavy duty oil tight labeled as indicated on the Starter Schedule.
 - .2 Indicating lights: oil tight type and color as indicated on the Starter Schedule.
 - .3 2-N/C and 2 N/O spare auxiliary contacts unless otherwise indicated on the Starter Schedule.

2.5 Full Voltage Reversing Magnetic Starters

- .1 Full voltage reversing magnetic starters of size, type, rating and enclosure type as indicated with components as follows:
 - .1 Two - 3 pole magnetic contactors mounted on a common base.
 - .2 Mechanical and electrical interlocks to prevent both contactors from operating at same time.
 - .3 Motor overload bimetallic protective relay.
 - .4 Wiring and schematic diagram inside starter enclosure in a visible location.
- .2 Accessories
 - .1 Pushbuttons or Selector switches: heavy duty oil tight labeled as indicated on the Starter Schedule.
 - .2 Indicating lights: heavy duty oil tight type and color as indicated on the Starter Schedule.
 - .3 Auxiliary control devices as indicated on the Starter Schedule.

MOTOR STARTERS TO 600 V

2.6 Multi-Speed Starters

- .1 (2) Speed starters of size type, rating and enclosure type as indicated. Starter suitable for variable torque type motor, unless otherwise indicated, and with components as follows:
 - .1 One 3-pole contactor for each winding for separate winding motors.
 - .2 One 3-pole and one 5-pole contactor for each re-connectable winding for consequent pole type motors.
 - .3 Three overload relays.
- .2 Accessories:
 - .1 Pushbuttons or Selector switches: heavy duty oil tight labeled as indicated on the Starter Schedule.
 - .2 Indicating lights: heavy duty oil tight, type and color as indicated on the Starter Schedule.
 - .3 Auxiliary control devices as indicated on the Starter Schedule.
 - .4 Low speed compelling relay and automatic sequence accelerating, decelerating relays for each speed.

2.7 Magnetic Starter, Reduced Voltage, Auto-Transformer

- .1 Auto-transformer starter closed circuit transition type, of size, type, rating and enclosure type as indicated and with following components:
 - .1 Three 3-pole contactors.
 - .2 Auto-transformer with 50%, 65% and 80% taps.
 - .3 One adjustable pneumatic timing relay.
 - .4 One 3-pole manual reset overload device.
 - .5 Thermal overload protection of auto- transformers.
- .2 Accessories:
 - .1 Pushbuttons or Selector switches: heavy duty oil tight labeled as indicated on the Starter Schedule.
 - .2 Indicating lights: heavy duty oil tight type and color as indicated on the Starter Schedule.
 - .3 Auxiliary control devices as indicated on the Starter Schedule.

2.8 Magnetic Starter Reduced Voltage Star-Delta

- .1 Reduced voltage star-delta open transition starter, of size, type, rating and enclosure type as indicated, with components as follows:
 - .1 Two 3-pole delta contactors with auxiliary relays and interlocks.
 - .2 One 3-pole star contactor with auxiliary relays and interlocks.
 - .3 Mechanical interlock to interlock one delta contactor and the star contactor.
 - .4 One timing relay.

MOTOR STARTERS TO 600 V

- .5 Three overload relays.
- .2 Reduced voltage star-delta closed transition starter, of size, type, rating and enclosure type as indicated, with components as follows:
 - .1 Two 3-pole delta contactors with auxiliary relays and interlocks.
 - .2 One 3-pole star contactor with auxiliary relay and interlocks.
 - .3 One 3-pole transition contactor.
 - .4 One set of transition resistors.
 - .5 Mechanical interlock, to interlock one delta contactor and the star contactor.
 - .6 One timing relay.
 - .7 Three overload relays.
- .3 Accessories:
 - .1 Pushbuttons or Selector switches: heavy duty oil tight labeled as indicated on the Starter Schedule.
 - .2 Indicating lights: heavy duty oil tight, type and color as indicated on the Starter Schedule.
 - .3 Auxiliary control devices as indicated on the Starter Schedule.

2.9 Magnetic Starter Reduced Voltage Part Winding

- .1 Two-step reduced voltage, part winding starter of size, type, rating and enclosure type as indicated, with components as follows:
 - .1 Two 3-pole contactors.
 - .2 Adjustable pneumatic timer.
 - .3 Six reset overload relays.
- .2 Three step reduced voltage part winding starter of size, type, rating and enclosure type as indicated, with the following components:
 - .1 Three 3-pole contactors.
 - .2 One set starting resistors.
 - .3 Six overload relays.
- .3 Accessories:
 - .1 Pushbuttons or Selector switches: heavy duty oil tight labeled as indicated on the Starter Schedule.
 - .2 Indicating lights: heavy duty oil tight type and color as indicated on the Starter Schedule.
 - .3 Auxiliary control devices as indicated on the Starter Schedule.

2.10 Three Phase Manual Reversing Starter

- .1 Three phase manual reversing starter of size, type, rating and enclosure type as indicated, with components as follows:
 - .1 Two 3-pole manual motor starters, quick make and break.

MOTOR STARTERS TO 600 V

- .2 Six overload relays and manual reset.
- .3 Mechanical interlock to prevent both switches from closing at same time.
- .2 Accessories
 - .1 Pushbuttons or Selector switches: heavy duty oil tight labeled as indicated on the Starter Schedule.
 - .2 Indicating lights: heavy duty oil tight type and colour as indicated on the Starter Schedule.

2.11 Three Phase Manual Two Speed Separate Winding Starters

- .1 Three phase manual two speed separate winding starters of size, type, rating and enclosure type as indicated with components as follows:
 - .1 Two 3-pole manual motor starters, quick make and break.
 - .2 Six overload relays and manual reset.
 - .3 Mechanical interlock to prevent both switches from closing at same time.
- .2 Accessories:
 - .1 Pushbuttons or Selector switches: heavy duty oil tight labeled as indicated on the Starter Schedule.
 - .2 Indicating lights: heavy duty oil tight type and colour as indicated on the Starter Schedule.

2.12 Enclosure

- .1 Starter to come in a CSA Type 3R enclosure, size as indicated.
- .2 Equipment to be painted: baked grey enamel.

2.13 Manufacturers

- .1 The following are acceptable manufacturers:
 - .1 Schneider Electric.
 - .2 Eaton Cutler-Hammer.
 - .3 Siemens.
 - .4 ABB.

PART 3 - EXECUTION

3.1 Installation

- .1 Install starters, connect power to starter and control and provide wiring from starter to motor through a manual disconnecting device if required by code.
- .2 Coordinate with Mechanical Subcontractor to ensure correct fuses and overload devices elements installed.

MOTOR STARTERS TO 600 V

3.2 Field Quality Control

- .1 Contractor to oversee all testing and correct any deficiencies noted.
- .2 Operate switches, contactors to verify correct functioning.
- .3 Perform starting and stopping sequences of contactors and relays.
- .4 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

END OF SECTION

UNINTERRUPTIBLE POWER SYSTEMS - STATIC

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.

1.2 Description Of System

- .1 This specification describes a three phase continuous on-line, solid state uninterruptable power system (UPS), which shall operate in conjunction with the existing building electrical system to provide power conditioning, backup and distribution for electronic loads.

1.3 Standards

- .1 UL 1778 Standard for Uninterruptable Power Supply Equipment, latest edition.
- .2 CSA C22.2-107 Commercial and Industrial Power Supplies, latest edition.
- .3 IEC 801-2 Electromagnetic Compatibility for Industrial Process Measurement and Control Equipment, latest edition.
- .4 IEC 146.4 - Methods of Specifying Performance and Test Requirements of Uninterruptable Power Systems, latest edition.
- .5 FCC Rules and Regulations 47 Part 15, Subpart J, Class A - Certified Compliance, latest edition.
- .6 ANSI C62.41, Recommended Practice on Surge Voltages in Low Voltage Power Circuits, latest edition.

1.4 Shop Drawings And Product Data

- .1 Submit Shop Drawings and product data in accordance with Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
- .2 Show complete information about the system, including outline dimensions, weights, wiring diagrams, control schematics and metering information.

1.5 Operation And Maintenance Manuals

- .1 Provide three (3) copies of instruction manuals to include:
 - .1 Receiving and installation instructions.
 - .2 System single line diagrams.
 - .3 Equipment outline drawings.
 - .4 Interconnection drawings.
 - .5 Battery wiring diagram.
 - .6 Accessory wiring diagrams.
- .2 Provide three (3) copies of operating manuals to include:
 - .1 Operating procedures.

UNINTERRUPTIBLE POWER SYSTEMS - STATIC

- .2 Performance and technical data.
- .3 General description.
- .4 UPS module description.
- .5 Accessory description.
- .6 Provide three (3) copies of the communications manual to enable The City to interface remote communications equipment with the communications panel and the RS232C and RS485 communication ports.
- .7 Battery information and maintenance information.

1.6 Warranty

- .1 System - warranty shall be no less than 24 months after acceptance and must include all costs including repair, parts, labour, travelling and living expenses for the manufacturer's service personnel.
- .2 Battery – warranty shall provide coverage against manufacturing defects and workmanship for a period not exceeding 10 years. Provide no charge replacement if defects occur in the first 36 months and prorated on the remaining service life of the battery.

PART 2 - PRODUCTS

2.1 Uninterruptible Power Supply

- .1 The UPS shall consist of the following major components:
 - .1 Output power distribution section.
 - .2 Output manual bypass section with input and bypass transformers and make-before-break transfer switch.
 - .3 Rectifier / inverter section with static bypass.
 - .4 The following elements shall be included in the overall assembly:
 - .1 Control panel.
 - .2 Monitor panel.
 - .3 Communication panel.
 - .4 Low input harmonic current distortion filter.
- .2 The UPS shall operate as a fully automatic system in the following modes:
 - .1 Normal - the critical load shall be continuously supplied by the inverter. The rectifier / charger shall derive power from the utility AC source and shall supply DC power to the inverter while simultaneously float charging the battery.
 - .2 Battery - upon failure of the utility supply, the critical load shall continue to be supplied by the inverter, which shall obtain power from the batteries without operator intervention. There shall be no interruption to the critical load upon failure or restoration of the utility supply.
 - .3 Recharge - upon restoration of the utility supply, the rectifier / charger shall simultaneously supply the inverter and recharge the batteries with no disturbance to the critical load.

UNINTERRUPTIBLE POWER SYSTEMS - STATIC

- .4 Static Bypass - failure of the UPS shall automatically initiate a static bypass to the utility supply without interruption to the critical load.
- .5 Manual (maintenance) Bypass - provide a manually initiated no- break transfer switch to seamlessly transfer the critical load to and from the bypass source.
- .3 Rectifier / charger - shall convert incoming AC power to regulated DC output for supplying the inverter and for charging the battery. The rectifier / charger shall be a six pulse, phase controlled solid state design, with the following ratings:
 - .1 Incoming AC current limit - 125% of full load input current.
 - .2 Battery current limit - battery charge current shall be limited to 25% of the line system full load current, regardless of the actual load on the system.
 - .3 Capacity - support a fully loaded inverter and recharge the battery to 90% capacity within 10 times the discharge time when input current is set to 125% of full load.
- .4 Input Filter with Power Factor Correction - shall reduce the current total harmonic distortion of the rectifier that is reflected onto the utility to about 10 %. The filter shall improve the input power factor to approximately 0.95.
- .5 Inverter - shall be transistorized three leg, pulse width modulated (PWM) design and shall be capable of providing the specified output power while operating from any DC source voltage (rectifier or battery) within the specified DC operating range.
- .6 Bypass - shall consist of a naturally-commutated static switch for high speed transfers with wrap-around switchgear for continuous duty. The static switch element shall be plug-in type of construction. Provide make- before-break switchgear to permit non-emergency transfer and retransfer operations. Uninterrupted transfers shall occur for the following conditions:
 - .1 Output overload period expired.
 - .2 Critical bus voltage out of limits.
 - .3 Over temperature period expired.
 - .4 Total battery discharge.
 - .5 UPS failure.
- .7 Uninterrupted manual transfers shall be initiated from the control panel
 - .1 Uninterrupted automatic retransfer shall take place whenever the inverter is capable of assuming the load.
 - .2 Uninterrupted automatic retransfers shall be inhibited when:
 - .1 Transfer to bypass is activated manually or remotely.
 - .2 Limit the cycling of transfer-retransfer operations to three (3) operations in any 10 minute period. The fourth transfer shall lock the load on the bypass source.
 - .3 All transfers and retransfers shall be inhibited for:
 - .1 Bypass voltage out of limits (+/-10%).
 - .2 Bypass frequency out of limits (+/-0.5 Hz).
 - .3 Bypass out of sync.

UNINTERRUPTIBLE POWER SYSTEMS - STATIC

- .4 Bypass phase sequence / installation error.
- .8 Maintenance Bypass - in addition to the above indicated sync and manual bypass feature, provide a separate bypass transformer and make-before-break transfer switch arranged to completely isolate the critical load from the UPS to permit transparent operation of the critical load during maintenance, repair and testing of the UPS and its associated bypass circuits. After verification the UPS shall be reapplied to the critical load. To this end, the UPS shall be supplied with two separate circuits, from the same bus - one for UPS input and one for the maintenance bypass.
- .9 Monitoring and Control Components:
 - .1 Micro-controller driven circuitry.
 - .2 Monitor panel with status indicators.
 - .3 Video alarm and metering display.
 - .4 Building alarm monitoring.
 - .5 Input circuit breakers.
 - .6 Battery, inverter, bypass and back feed disconnect contactors.
 - .7 RS232C and RS485 communication ports.
 - .8 Power factor correction input filter with disconnect contactor.
- .10 Additional Optional Components:
 - .1 Input isolation transformer.
 - .2 Maintenance bypass input transformer and no-break maintenance bypass switch.
 - .3 Output power distribution section, containing two (2) 42 circuit Square D NQOB panelboards with 225 A mains and main breakers. Branch circuit breakers shall be supplied by others. Provide for future addition of similar output distribution section.

2.2 System Ratings & Operating Characteristics

- .1 System Continuous Ratings - 20 KVA / 20 kW], field upgradeable to 30 KVA / 30 kW
- .2 System Input:
 - .1 Nominal Input Voltage: 208V VAC, 3 phase, 4 wire plus ground.
 - .2 Input Voltage Operating Range: + 10%, - 15% of average nominal without battery discharge.
 - .3 Operating Input Frequency Range: 60 +/- 3 Hz, adjustable, factory set.
 - .4 Input Power Factor: 0.95 lag minimum at full load with input filter.
 - .5 Maximum Input Current Total Harmonic Distortion: 10%.
 - .6 Power Walk-in: 15 seconds to full load.
 - .7 Input Surge Withstand Capability: per ANSI C62.41.
- .3 System Output:
 - .1 Nominal Output Voltage: 208Y120 VAC, 3 phase, 4 wire plus ground.

UNINTERRUPTIBLE POWER SYSTEMS - STATIC

- .2 Steady State Voltage Regulation: +/- 2% average from nominal.
- .3 Manual Output Voltage Adjustment: +/- 5% from nominal.
- .4 Transient Voltage Response: +/- 5% from nominal for 100% load step, full load transfers and full drop on battery.
- .5 Transient Voltage Recovery: 25 ms to within +/- 1% of steady state.
- .6 Line Synchronization Range: +/- 0.5 Hz.
- .7 Frequency Regulation: +/- 0.1 Hz free running.
- .8 Frequency Slew Rate: 1 Hz per second maximum.
- .9 Phase Angle Control:
 - .1 Balanced linear loads: +/- 1 deg. from nominal 120 deg.
 - .2 Unbalanced linear loads: +/- 3 deg. for 100% load unbalance.
- .10 Phase Voltage Control:
 - .1 Balanced linear loads: +/- 1% from average phase voltage.
 - .2 Unbalanced linear loads: +/- 3% for 100% load unbalance.
- .11 Output Voltage Total Harmonic Distortion: 3%.
- .12 Non-linear Load Capability: Provide double size neutral connection for 100% non-linear line to neutral loads. THD – 5 % for 100 % non- linear load.
- .13 Overload Current Capability: Maintain voltage regulation for 125% for 10 minutes and 150% for 10 seconds, assuming nominal line voltage and fully charged battery.
- .14 Fault Clearing Current Capability: 160% phase to phase for 10 cycles and 300% phase to neutral for 10 cycles.
- .15 Static Transfer Time: less than 4 ms.
- .16 Common Mode Noise Attenuation: -65 dB up to 20 kHz, -40 dB up to 100 kHz (both for normal and bypass modes of operation).

2.3 Mechanical Design

- .1 Enclosures: the UPS shall be housed in free standing, double front enclosures (safety shields behind doors) equipped with casters and leveling feet. The enclosures shall be designed to line up and match in style and colour for an aesthetically pleasing appearance. Each of the cabinets shall be shipped separately with all hardware necessary for field installation. All enclosures to be fully sprinkler proof enclosures.
- .2 Ventilation: the UPS cabinet shall be designed for forced air cooling with redundant fans. Battery and optional cabinets shall be designed for convection cooling. Air flow shall be designed so that the cabinets may be placed with the rear against a wall.
- .3 Cable Entry: provide for top cable entry. Except for connections direct to circuit breakers, all cables shall be terminated with a long barrel, two-hole high press “Burndy style” compression lug with lug inspection / viewing window. Mechanical lugs are not acceptable. All lugs and terminals to be dual rated for Copper/Aluminum (Cu/Al).
- .4 Front Access: all servicing and replacement of subassemblies shall be from the front.

UNINTERRUPTIBLE POWER SYSTEMS - STATIC

2.4 Environmental Requirements

- .1 The equipment shall withstand any combination of the following external environmental conditions without operational degradation:
 - .1 Operating temperature: 0 deg. C. to +40 deg. C.
 - .2 Storage temperature: -20 deg. C. to +70 deg. C.
 - .3 Relative humidity: 95% maximum, non-condensing.
 - .4 Elevation: 1500 m maximum.
- .2 Acoustical Noise - noise generated by the UPS under normal operation shall not exceed 65 dBA at one metre from any operating surface, measured at 25 deg. C. and full load.
- .3 Electrostatic Discharge (ESD) - the UPS shall meet IEC 801-2 and shall withstand up to 25 kV without damage and with no disturbance or adverse effect to the critical load.
- .4 EMI Suppression - to FCC Standard 47 Part 15J for Class A devices.

2.5 Battery

- .1 Provide batteries in compliance with:
 - .1 The requirements below: Battery type - valve-regulated, high rate discharge lead-acid cells.
 - .2 Nominal battery string voltage - typically 240 cells, 480 VDC, varies according to manufacturer.
 - .3 Final discharge voltage - 1.75 volts per cell.
 - .4 Nominal float voltage - 2.25 volts per cell.
 - .5 Maximum equalizing voltage - 2.40 volts per cell.
 - .6 Battery capacity protection time - minimum of 15 minutes at 25 deg. C., with a constant load on the UPS output of 20 kVA.
 - .7 Battery recharge time - 10 times the discharge time to 90% of the original protection time.
 - .8 Battery manufacturer - Oldham or Fulmen type EHPC.

2.6 Controls And Indicators

- .1 Micro-controller operated circuitry - provide fully automatic operation of the UPS through the use of micro-controllers to eliminate variances from component tolerance or drift and to provide consistent operational response. All operating and protection parameters shall be software controlled, eliminating the need for manual adjustment. Start-up and transfer shall be automatic functions. The micro-controller shall be arrayed in a redundant configuration to obviate single point failure.
- .2 Monitor panel - provide monitor panel with audible alarm for alarm and trouble indication. Provide the following functions:
 - .1 Normal indicator.
 - .2 Battery indicator.
 - .3 Bypass indicator.

UNINTERRUPTIBLE POWER SYSTEMS - STATIC

- .4 Trouble indications:
 - .1 Bypass not available.
 - .2 Battery under-voltage.
- .5 Alarm indications:
 - .1 Over temperature.
 - .2 Output overload.
 - .3 Inverter failure.
 - .4 Rectifier failure.
 - .5 Shutdown imminent (low battery in emergency mode).
- .6 Standby - to indicate rectifier has been energized, but normal conditions have not been achieved.
- .3 Monitor panel controls:
 - .1 LCD display.
 - .2 Menu and cursor controls.
 - .3 Load off - shuts down UPS.
 - .4 Horn silence.
- .4 UPS control panel:
 - .1 Mode switch - controls transfers to and from bypass.
 - .2 Battery switch - enables or disables battery.
 - .3 Circuit breaker - to enable operation of the rectifier.
 - .4 Load off reset switch.
- .5 UPS communication panel - provide dry contacts for external use for all alarm and trouble indications.
- .6 Liquid crystal display - to display the system status and obtain a printout via a RS232C port for the following screens:
 - .1 Mimic - graphic display of system operation and power flow.
 - .2 Metering - digital metering of:
 - .1 Rectifier input voltage, frequency, amperes, kW, kVA, and power factor.
 - .2 System output voltage, frequency, amperes, kW, kVA, and power factor.
 - .3 Bypass input voltage and frequency.
 - .4 DC link voltage.
 - .5 Battery current.
 - .3 Load current - bar graph showing percentage output current for each phase.
 - .4 Active alarm - lists active alarm and trouble indications.
 - .5 Alarm and event history - displays recent alarms and events with date and time.
 - .6 Battery data - bar graph of battery charge / discharge condition and estimated battery time available.
 - .7 Date and time - to set system clock.

UNINTERRUPTIBLE POWER SYSTEMS - STATIC

- .7 Communication interface - provide RS232C and RS485 ports to access all unit operation information to simple terminals.
- .8 Remote monitors - provide connections for two remote monitor or relay panels.
- .9 Building alarms - provide six input monitors (dry contacts) for the following:
 - .1 Five (5) The City selected functions

2.7 System Protection

- .1 Rectifier input - moulded case circuit breaker and transient suppression circuitry.
- .2 Bypass - fuses on individual phases.
- .3 Battery - moulded case circuit breakers for each battery string or cabinet.
- .4 Output - electronic current limit circuitry and current limiting fuses in inverter legs.

2.8 Accessories

- .1 Remote monitor panel - remote monitor panels are not required for this project, but provide for the future possible connection of two panels, displaying the following:
 - .1 System normal.
 - .2 On bypass.
 - .3 On battery.
 - .4 Bypass unavailable.
 - .5 UPS alarm.
 - .6 Shutdown imminent.
 - .7 On generator.

2.9 Manufacturers

- .1 The following manufacturers are acceptable suppliers:
 - .1 Vertiv - Liebert.
 - .2 Eaton – Powerware.
 - .3 Schneider.
 - .4 Mitsubishi.
- .2 Each manufacturer shall include a statement of compliance, indicating deviations from the specifications.

PART 3 - EXECUTION

3.1 Quality Control

- .1 Visual Inspection - visually inspect all equipment for signs of damage or foreign materials.
- .2 Mechanical inspection - Check all power and control wiring connections for tightness.
- .3 Electrical pre-check
 - .1 Check DC bus for possible short circuit.
 - .2 Check input and bypass power sources for proper voltages and phase sequence.

UNINTERRUPTIBLE POWER SYSTEMS - STATIC

- .3 Check all lamp test functions.
- .4 Initial UPS start-up
 - .1 Verify that all alarms are operational.
 - .2 Energize the system and verify proper DC, walk-up and AC phase on.
 - .3 Check DC link voltage and inverter AC output. Adjust as required.
 - .4 Check for proper synchronization.
 - .5 Check for any voltage difference between inverter output and the bypass source.
- .5 Operational Training - the UPS manufacturer shall train The City's personnel in the operation of the system, which shall be available for demonstration of the modes of operation.

3.2 Field Service

- .1 The UPS manufacturer shall have a service department in Toronto, staffed with factory trained technicians, capable of providing on site emergency response within 24 hours maximum, including backup from factory engineers and parts supply.
- .2 The UPS manufacturer shall be prepared to enter an all-inclusive annual maintenance contract, which shall include not only preventive maintenance procedures, but all parts and labour required for all emergency conditions. The UPS manufacturer shall include the following additional prices in his proposal:
 - .1 Cost per year for each of the two years of warrantee for all-inclusive maintenance contract, as described above.

3.3 Upgrade

- .1 The equipment specifications describe a system rated at 20 kW installed, field upgradeable to 30 kW. The UPS manufacturer shall include the following extra prices for this upgrade, assuming it to occur in the third year after acceptance:
 - .1 UPS assembly.
 - .2 Battery upgrade from 24 to 30 kW, by the addition of an additional battery cabinet.
- .2 If the individual manufacturer cannot field upgrade his unit from 2 kW to 30 kW, they shall quote a separate price for a 30 KVA / 30 kW unit with a 20 kW battery as specified.

END OF SECTION

LIGHTING EQUIPMENT

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 01 00 – OPERATING AND MAINTENANCE INSTRUCTIONS.
- .2 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .3 Section 26 05 04 – SUBMITTALS – SHOP DRAWINGS.
- .4 Section 26 05 21 – WIRES AND CABLES UNDER 2000 V.
- .5 Section 26 06 05.16 – LUMINAIRE SCHEDULE.

1.2 References

- .1 CSA C22.2 No. 74 – Equipment for Use with Electric Discharge Lamps, latest edition.
- .2 The Consortium of Energy Efficiency (CEE) guidelines, latest edition.
- .3 IESNA LM-79 – Approved Method: Electric and Photometric Measurements of Solid-State Lighting Products, latest edition.
- .4 IESNA LM-80 – Approved Method: Measuring Lumen Maintenance of LED Light Sources, latest edition.
- .5 The Certified Ballast Manufacturers Association (CBM) standards, latest edition.
- .6 NEMA 410 – Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts, latest edition.
- .7 CSA C22.2 No. 141 – Emergency Lighting Equipment, latest edition.

LIGHTING EQUIPMENT

1.3 Substitution

- .1 The lighting equipment for this project and specified herein has been carefully selected for its ability to meet the project's luminous environment requirements. Manual and computer calculations have been performed to ensure that the lighting equipment that has been specified complies with established criteria. The Contract Administrator reserves the right not to accept any alternates or substitutions in accordance with the requirements of the Luminaire Schedule. If alternates or substitutions are entertained, then it is the responsibility of the Contractor/Supplier to provide: a comparison table showing the specified and the proposed luminaire performance information, IES files for the proposed luminaires, the information required herein, and detailed layouts and lighting calculations demonstrating that the performance of the alternate luminaire meets or exceeds the original lighting design while not consuming any additional energy. An extra review fee, per luminaire submitted, will be charged to the Contractor (with no additional costs to The City). Reviewed alternates may be rejected, regardless of the payment fee received, when alternates do not meet the project requirements. Invoices must be paid prior to Contract Administrator's review starting or changes in the design documents to incorporate the proposed alternates after their review. The Contractor/Supplier is responsible to ensure the light levels provided in the alternate submittal package will achieve the design light levels. Where the light levels are not achieved, the Contractor is responsible to replace the luminaire with a luminaire that will meet the required levels with no increase in energy use at no cost to The City. Rather than replacing the luminaires, the Contract Administrator may accept the installation of additional luminaires by the Contractor at no cost to The City in order to achieve the required light levels.
- .2 Accompanying the request for a luminaire or lamp substitution, the Subcontractor shall submit a complete lighting calculation report with photometric modeling of the space showing light levels including average, maximum, minimum and max to min values.

1.4 Shop Drawing And Product Data

- .1 Submit Shop Drawings and product data in accordance with Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
- .2 Submit a Shop Drawing for each luminaire specified, including lamp.
- .3 Luminaire submittals are to consist of a physical description, manufacturer's specification sheets, dimensioned drawings, and complete photometric data from an independent test laboratory in the form of IES computer files of the equipment being submitted and hard copy of the photometric report. Coordinate ceiling types to ensure proper supports and luminaire framing.
- .4 Lamp submittals are to consist of manufacturer's technical data with respective luminaire shop drawing. Submittal to include operating wattage, rated life, colour temperature, base type, lamp shape, CRI, and voltage.
- .5 LED submittals are to consist of manufacturer's technical data for diodes and drivers with respective luminaire shop drawing. Submittal to include operating wattage, voltage, maximum distance from drivers, wiring diagrams and lumen output at time of delivery.
- .6 Ballast submittals are to consist of manufacturer's technical data with respective luminaire shop drawing. Submittal to include operating wattage, input voltage, ballast efficiency, maximum distance for remote ballasts, power factor, and operating temperature.

LIGHTING EQUIPMENT

- .7 Where samples are indicated on the luminaire schedule, they are to be provided with shop drawings at time of shop drawing submittals unless noted otherwise.
- .8 Where luminaires consist of multiple field assembled components, include manufacturer supplied installation manual detailing the assembly procedure.

1.5 Operation And Maintenance Data

- .1 Provide operation and maintenance data for lighting equipment in accordance with Section 26 01 00 – OPERATING AND MAINTENANCE INSTRUCTIONS for incorporation into the manual.
- .2 Operation and maintenance instructions shall include documentation related to warranty claim process.

1.6 Warranty

- .1 The manufacturer shall provide a warranty against defects in material and workpersonship, starting at total performance. Parts warranty shall be 5 years and labour warranty shall be 1 year.
- .2 LED's, Drivers, Lamps and ballasts showing signs of premature failure shall be replaced at no cost to The City.
- .3 LED Drivers must have a 5 year warranty.

PART 2 - PRODUCT

2.1 General

- .1 Only utilize Products that are certified for use in Canada in accordance with the requirements of Section 2 of the Electrical Code and that have been tested by a Certification Body accredited by the Standards Council of Canada and acceptable to the Electrical Authority Having Jurisdiction for the approval of electrical equipment. Furthermore, ensure that Products utilized have been approved to a recognized Canadian Standard.

2.2 Lamps and LEDs

- .1 All Lamps are to meet the standards of the Consortium of Energy Efficiency (CEE) guidelines.
- .2 Refer to luminaire schedule for project specific details, and lamps required.
- .3 Lamps are to be in accordance with the lamp specifications detailed in the Luminaire Schedule and as noted below. Luminaire schedule shall take precedence where differences occur.
- .4 All lamps are to be new and are to be from the same manufacturing batch to avoid colour differences. Replace all lamps that exhibit colour shift, or exhibit premature lumen intensity decline, at no cost to The City.
- .5 Light Emitting Diodes (LED)
 - .1 LEDs shall meet the standards of IESNA LM-79 and LM-80.
 - .2 All LED drivers shall be tested and comply with the maximum in-rush current limits as stated in NEMA 410.

LIGHTING EQUIPMENT

- .3 LED's shall be manufactured by Cree, Osram, Nichia, Toshiba, Lumileds, Bridgelux, or Samsung. Colour temperature shall be as indicated on the luminaire schedule. Lamps are to be binned with no visible colour variance (+/- 100K from specified colour temperature). Rated life for 1 watt white LED shall be 50,000 hours. Lumen output to be maximum based on latest technology at time of delivery.
- .4 All LED luminaires that present signs of failure on site, within the warranty period, must be replaced at no cost to The City. If temporary luminaires are required to replace any failed LED luminaires, during the waiting time for parts (i.e. drivers, boards, heat sinks, etc.), the labour cost including installation, temporary luminaire supply, temporary luminaire removal and reinstallation of the LED luminaire must be provided at no cost of The City. Additional electrical costs, associated with higher Wattage temporary luminaires, must be reimbursed with interest to The City by the manufacturer.
- .5 In case of failure of an LED luminaire, complete or part thereof, an independent third party testing Laboratory (approved by Smith + Andersen) shall be commissioned by the manufacturer or vendor to perform tests on samples taken from the failed luminaires installed on corresponding site. All reporting including the test results must be submitted to Smith + Andersen for evaluation and final approval.
- .6 Any additional time involved by Smith + Andersen will be billed at our hourly rates to the manufacturer or vendor.

2.3 Drivers

- .1 All drivers are to be tested and comply with maximum in-rush current limits within NEMA 410 standards. This is to be clearly indicated on shop drawing submittal.
- .2 LED dimming shall be equal in range and quality to a commercial grade incandescent dimmer. Quality of dimming to be defined by dimming range, freedom from perceived flicker or visible stroboscopic flicker, smooth and continuous change in level (no visible steps in transitions), natural square law response to control input, and stable when input voltage conditions fluctuate over what is typically experienced in a commercial environment. Demonstration of this compliance to dimming performance will be necessary for substitutions or prior approval.
- .3 Ten-year expected life while operating at maximum case temperature and 90 percent non-condensing relative humidity.
- .4 Withstand up to a 1,000 volt surge without impairment of performance as defined by ANSI C62.41 Category A.
- .5 No visible change in light output with a variation of plus/minus 10 percent line voltage input.
- .6 Total Harmonic Distortion less than 20 % percent and meet ANSI C82.11 maximum allowable THD requirements at full output. THD shall at no point in the dimming curve allow imbalance current to exceed full output THD.
- .7 Driver must support automatic adaptation, allowing for future luminaire upgrades and enhancements and deliver improved performance:
 - .1 Adjustment of forward LED voltage, supporting 3 V through 55 V.

LIGHTING EQUIPMENT

- .2 Adjustment of LED current from 200 mA to 1.05 A at the 100 percent control input point in increments of 1 mA.
- .3 Adjustment for operating hours to maintain constant lumens (within 5 percent) over the 50,000 hour design life of the system, and deliver up to 20 percent energy savings early in the life cycle.
- .8 Driver must be able to operate for a (+/- 10%) supply voltage of 120 V through 277 VAC at 60 Hz.
- .9 Driver must be UL Recognized under the component program and shall be modular for simple field replacement. Drivers that are not UL Recognized or not suited for field replacement will not be considered.
- .10 Driver shall include ability to provide no light output when the analog control signal drops below 0.5 V, or the DALI/DMX digital signal calls for light to be extinguished and shall consume 0.5 watts or less in this standby. Control deadband between 0.5 V and 0.65 V shall be included to allow for voltage variation of incoming signal without causing noticeable variation in fixture to fixture output.
- .11 Over the entire range of available drive currents, driver shall provide step-free, continuous dimming to black from 100 percent to 0.1 percent and 0 % relative light output, or 100 – 1% light output and step to 0 % where indicated. Driver shall respond similarly when raising from 0% to 100%
 - .1 Driver must be capable of 20 bit dimming resolution for white light LED drivers or 15 bit resolution for RGBW LED drivers.
- .12 Driver must be capable of configuring a linear or logarithmic dimming curve, allowing fine grained resolution at low light levels
- .13 Drivers to track evenly across multiple fixtures at all light levels, and shall have an input signal to output light level that allows smooth adjustment over the entire dimming range.
- .14 Driver and luminaire electronics shall deliver illumination that is free from objectionable flicker as measured by flicker index (ANSI/IES RP-16-10). At all points within the dimming range from 100-0.1 percent luminaire shall have:
 - .1 LED dimming driver shall provide continuous step-free, flicker free dimming similar to incandescent source.
 - .2 Base specification: Flicker index shall less than 5% at all frequencies below 1000 Hz.
 - .3 Preferred specification: Flicker index shall be equal to incandescent, less than 1% at all frequencies below 1000 Hz.
- .15 Control Input
 - .1 4-Wire (0-10V DC Voltage Controlled) Dimming Drivers
 - .1 Must meet IEC 60929 Annex E for General White Lighting LED drivers
 - .2 Connect to devices compatible with 0 to 10 V Analog Control Protocol, Class 2, capable of sinking 0.6 mA per driver at a low end of 0.3 V. Limit the number of drivers on each 0-10 V control output based on voltage drop and control capacity.

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- .16 Must meet ESTA E1.3 for RGBW LED drivers
- .17 Provide drivers manufactured by Cree, Osram, Nichia, Toshiba, Lumileds, Bridgelux, Samsung, or Eldoleds.

2.4 Luminaires

- .1 All luminaires are to be complete with mounting brackets, transformers, supports, trims, louvers, lenses and other accessories as required to make luminaire operational and allow it to be installed in the respective location.
- .2 Luminaires shall be suitable for the environment where installed, include seals and gaskets, and corrosion resistant baked-on finish as required and as specified.
- .3 Louvers, lenses and diffusers must be of suitable thickness to prevent sagging.
- .4 Where drawings show luminaires mounted end-to-end, luminaires shall be suitable for continuous, seamless and tandem mounting.
- .5 All poles are to come complete with internal vibration dampeners to accommodate wind conditions to avoid damage due to wind-induced vibrations.
- .6 All concrete bases for poles and bollards shall be designed to accommodate the height, weight, etc. of the pole/bollard and its accessories for the soil conditions for which it is installed. Engineered shop drawings shall be provided that is signed by a Structural Engineer registered in the local jurisdiction.
- .7 Where cameras are shown to be installed on poles, the poles shall be stiffened to reduce vibration and sway, and shall be rated for video recording cameras.
- .8 The supply and installation of fixed per unit cost and 'cash allowance' luminaires shall comply with all standards set forth in Electrical Specifications. Electrical Subcontractor is responsible to include in the base bid for delivery, scheduling, receiving, storage, partial assembly, installation, wiring, aiming, cleaning and warranties for all fixed per unit cost and 'cash allowance' luminaires.
- .9 Provide exit signs that comply with building code requirements, including CSA C22.2 No. 141.
- .10 The following is a list of generic type designation for luminaires. The project specific luminaire schedule is to be referenced for the specific types and designations and the respective specifications.
 - .1 Designations beginning with the letter 'L' denote LED type.
 - .2 Designations beginning with the letter 'X' denote exit sign.

PART 3 - EXECUTION

3.1 Installation

- .1 It is the responsibility of the Subcontractor to obtain the information related to the luminaire and luminaire trim finishes/colours from the Contract Administrator prior to the fabrication of luminaires. The Contractor shall provide adequate time for the design team to review and comment on luminaire and luminaire trim finishes.

LIGHTING EQUIPMENT

- .2 The Subcontractor will provide, receive, unload, uncrate, store, protect and install lamps, luminaires, and other related lighting equipment as specified herein. Lamps for all equipment will be provided and installed by the Subcontractor according to equipment manufacturer's instructions.
- .3 The Electrical Subcontractor shall be responsible for the supply and installation of all concrete bases for poles and bollards. Unless otherwise shown on the drawings, concrete bases to be ArtForm style or Approved Equal and shall extend a minimum 900 mm above grade in parking lots and a minimum 150 mm above grade in pedestrian walkways.
- .4 Poles and bollards are to be installed on independent concrete bases unless indicated otherwise on the drawings or schedules. Coordinate brackets for cameras and supports for banners with pole manufacturer.
- .5 Install remote ballasts in racks and wire luminaires to ballasts in conduit. Provide wiring as per manufacturer's recommendations.
- .6 Locate luminaires in accordance with the Architectural Drawings. Coordinate exact locations on site. Refer to Architectural drawings for dimensions of coves and valences.
- .7 Install in accordance with Manufacturer's Instructions, Local Codes, Electrical Division Drawings and Specifications.
- .8 All suspended luminaires shall have cables and support stems vertically aligned.
- .9 Suspend luminaires in mechanical rooms after all the mechanical equipment and ductwork are installed. Luminaires are not to be suspended from mechanical pipes, ductwork or other building services.
- .10 All luminaires shall be installed underneath other services located within ceiling space. Contractor is responsible for interference drawings to ensure all services in ceiling are coordinated.
- .11 Any dimensions provided in the drawings or schedules are intended as general guidelines. For exact dimensioning refer to the Architectural drawings. The detailed information shall be cross referenced with the electrical specifications and the Luminaire Schedule applying the most stringent requirement.
- .12 It is the responsibility of the Electrical Subcontractor to coordinate luminaire trims and mounting system with ceiling finishes. Luminaires delivered on site with the wrong ceiling mounting system shall be replaced without additional costs for The City. Restocking fees will not be accepted.
- .13 For suspended ceiling installations support luminaires from structural slab in accordance with local inspection requirements.
- .14 Where luminaires are mounted in tandem, align luminaires mounted in continuous rows to form straight uninterrupted line.
- .15 Align luminaires mounted individually parallel or perpendicular to building grid lines.
- .16 Ensure light leakage does not occur from openings and trim rings. Contractor is responsible to repair the ceiling at no cost to The City if cut-out is too large.
- .17 Connect luminaires to lighting circuits.

LIGHTING EQUIPMENT

- .18 Provide all wiring in conduit with junction boxes on a grid pattern to limit the run of flexible armoured cable drops from the ceiling mounted junction box to each luminaire to a maximum of 3 m in length unless approved otherwise in writing from the Contract Administrator.
- .19 Modular wiring systems shall be employed only where indicated or with approval of the Contract Administrator.
- .20 Luminaires are not to be used as temporary construction lighting. After being tested to ensure acceptable operation, luminaires will not be used until substantial completion unless permission is received from The City, or Contract Administrator.
- .21 Lamps are to be installed after luminaire is cleaned.
- .22 Clean all luminaires, inside and out at time of substantial completion. Replace all scratched or damaged luminaires, lenses, louvers and diffusers at no cost to The City.
- .23 Installation of exit signs
 - .1 Rough-in and installation of exit signs shall be carefully coordinated on site such that after installation of all equipment/services, including equipment/services from other trades (i.e. sprinkler lines, plumbing pipes, way-finding signs, etc.), shall not interfere with the line-of-sight visibility of the exit sign(s) from approach of the intended egress pathway(s).
 - .2 If exit sign(s) have been installed and do not meet the satisfaction of the Contract Administrator, the Contractor shall lower, raise or relocate the exit sign(s) such that proper and adequate visibility of the exit sign(s) is achieved at no additional cost to The City.

END OF SECTION

SPORTS AND RECREATIONAL LIGHTING

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 51 13 – LIGHTING EQUIPMENT.

1.2 References

- .1 ANSI/IES RP-6 – Recommended Practice – Lighting Sports and Recreational Areas, latest edition.
- .2 Furnish complete lighting system as per luminaire schedule and as specified herein to meet the performance specifications.

PART 2 - PRODUCT

2.1 Substitution

- .1 The lighting equipment for this project and specified herein has been carefully selected for its ability to meet the project's luminous environment requirements. Manual and computer calculations have been performed to ensure that the lighting equipment that has been specified complies with established criteria. **Substitutions are not likely to meet all the required criteria and will not be accepted.**

2.2 Submittals

- .1 Triple Gym lighting submittals shall include the product and engineering information, numbered and in order as follows.
 - .1 Drawings scaled at 1:100 with computer modelling showing point by point light levels on Principal Playing Area (PPA) and spill on surrounding area for each setting (100%, 75%, 50%, 25%) measured in lux, using main luminaires, work lights (if applicable) and emergency lighting.
 - .2 Luminaire mounting heights follow the underside of the structural membranes of the ceiling. Exact height to be confirmed with Contract Administrator. Calculations are to be performed to determine the light levels required for each row of luminaires to optimize the uniformity across the playing surface while maintaining overall lighting levels (100%) as determined by the performance criteria listed below.
 - .3 Drawings for maintained average lighting levels are to be provided, stating all information noted in performance criteria below in each drawing.
 - .4 Dimensioned lighting plan locating luminaires relative to architectural grid lines or sports field outlines.
 - .5 Mounting details.
 - .6 Luminaire assembly including reflector type, distribution, complete photometry reports, from an independent testing facility, manufacturer's name and model number for luminaires, all components and accessories.
 - .7 Control wiring diagrams.

SPORTS AND RECREATIONAL LIGHTING

- .8 ULC/CSA listing.
- .9 Lighting Power Density (LPD) analysis for each setting.
- .10 Driver information.
- .11 Warranty for assembly and replacement policy.
- .12 List of all facilities in Canada utilizing identical luminaire, with contact information and telephone number.
- .13 Aiming diagram of luminaires.
- .2 The submittals shall be assembled and submitted in text searchable PDF format. Failure to submit any of the required documentation will result in rejection.

2.3 Performance Criteria

- .1 Luminaires are to be located so that the underside of the luminaire is at the same height as the underside of the ceiling or ceiling structure. The height of the luminaires from the Principal Playing Area (PPA) will follow the underside of the structural membranes of the ceiling. Exact height to be confirmed with Contract Administrator .
- .2 Drawings indicate general location and quantities. Exact quantity and locations of luminaires will be based on successful manufacturer requirements, as determined by Contract Administrator.
- .3 Luminaires to be located to avoid shadows as well as direct and indirect glare on surfaces.
- .4 All illumination levels (lux) noted below are to be average maintained.
- .5 Gym
 - .1 IES Class III for Basketball.
 - .2 Illumination levels measured at 914 mm above playing surface and an analysis grid with points on 4.6 m x 4.6 m centres. For areas outside of PPA, spill light to be measured to the walls at 4.6 m x 4.6 m centres. Avoid locating luminaires close to scoreboards and avoid locating luminaires in line with (in front or behind) basketball hoops.
 - .3 Minimum 500 lux average.
 - .4 Max/min: $\leq 3:1$.
 - .5 CV: ≤ 0.25 .
 - .6 Criteria: LLF 86%, reflectance's are 50% ceiling, 30% walls, 20% floor surface.

PART 3 - EXECUTION

3.1 Installation

- .1 Photometry testing to verify readings is to be performed at normal and emergency illumination levels in the presence of the Contract Administrator after luminaires have been cleaned and all finishes in arena are completed and seating installed. Readings are to be based on initial levels provided for all settings. Reports are to be provided to Contract Administrator as a submittal indicating readings taken.
- .2 Testing equipment shall be professional calibre and calibrated prior to testing.

SPORTS AND RECREATIONAL LIGHTING

- .3 If installation does not meet target illumination levels, additional luminaries including installation and distribution (i.e. power circuits and controls) as well as engineering costs are to be provided at no cost to The City.
- .4 Maintenance procedure training to be provided to the operations staff.
- .5 Ensure correct control operation.
- .6 On-site technical assistance and supervision to be provided by manufacturer.
- .7 Defective parts are to be provided free of charge for the first five years of operation of the facility.
- .8 Manufacturer is to provide on-site assistance as required by the Contract Administrator.
- .9 Luminaires are not to be used as temporary construction lighting. Other than for verification and operation testing, luminaires will not be used until after substantial completion unless permission is received from The City or Contract Administrator.
- .10 Luminaires are to be located in accordance with the Manufacturer's drawings. Coordinate exact locations on-site.

3.2 Aiming

- .1 All luminaires must be pre-set in the aimed position at the factory and marked to allow for future field setting. Horizontal and vertical aiming must be stamped or cast into the luminaire body.

END OF SECTION

UNIT EQUIPMENT FOR EMERGENCY LIGHTING

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
- .3 Section 26 05 21 – WIRES AND CABLES UNDER 2000 V.
- .4 Section 26 05 34 – CONDUITS, CONDUIT FASTENERS AND FITTINGS.

1.2 References

- .1 CSA Standard C22.2 No.141 – Emergency Lighting Equipment, latest edition.

1.3 Shop Drawings And Product Data

- .1 Submit Shop Drawings and product data in accordance with Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
- .2 Submit Shop Drawings for equipment and accessories specified in this Section. Include photometric data for all luminaires not named as approved in this specification.
- .3 Data to indicate system components, mounting method, source of power and special attachments.
- .4 Manufacturer/Contractor to ensure runtime capacity of battery unit is sized accordingly to meet the runtimes specified within this section and/or drawings/schedules.

1.4 Warranty

- .1 For batteries, the warranty period shall be extended to 120 months from Total Performance, with a no-charge replacement during the first 5 years and a pro-rata charge on the second 5 years.

PART 2 - PRODUCTS

2.1 Equipment

- .1 Supply voltage: 120 V, ac.
- .2 Output voltage: 24 V dc.
- .3 Operating time: 120 minutes, unless otherwise noted in schedules.
- .4 Battery: 10 year sealed, valve regulated, lead calcium.
- .5 Charger: solid state, multi-rate, voltage/current regulated, inverse temperature compensated, short circuit protected with regulated output of plus or minus 0.01 V for plus or minus 10% input variations. Recharges battery within 24 hours in accordance with CSA.
- .6 Solid state transfer circuit.
- .7 Low voltage disconnect: solid state, modular, operates at 80% battery output voltage.
- .8 Signal lights: solid state, for 'AC Power ON' and 'High Charge'.

UNIT EQUIPMENT FOR EMERGENCY LIGHTING

- .9 Lamp heads: integral on unit and remote as indicated, 345 horizontal and 180 vertical adjustment. Lamp type: LED MR16, wattage to be 6 W unless noted otherwise on drawings or in the "Battery Unit Schedule."
- .10 Directional remote head lamps to have narrow beam spread distribution.
- .11 Recessed remote head lamps to have flood beam spread distribution.
- .12 Cabinet: suitable for direct or shelf mounting to wall and c/w knockouts for conduit. Removable or hinged front panel for easy access to batteries.
- .13 Finish: Baked white enamel.
- .14 Auxiliary equipment:
 - .1 Ammeter.
 - .2 Voltmeter.
 - .3 Test switch.
 - .4 Time delay relay.
 - .5 Battery disconnect device.
 - .6 Ac input and dc output terminal blocks inside cabinet.
 - .7 Bracket.
 - .8 Cord and single twist-lock plug connection for ac.
 - .9 RFI suppressors.

2.2 Wiring Of Remote Heads And Exit Signs

- .1 Conduit: As per Section 26 05 34 – CONDUITS, CONDUIT FASTENERS AND FITTINGS.
- .2 Conductors: As per Section 26 05 21 – WIRES AND CABLES UNDER 2000 V, sized as per manufacturer's recommendation and compliant to the applicable electrical codes.

PART 3 - EXECUTION

3.1 Installation

- .1 Install unit equipment and remote mounted fixtures. Interconnect all heads with central battery pack.
- .2 Direct heads to optimize illumination of egress pathways to minimum building code requirements.
- .3 Connect exit lights to unit equipment.
- .4 Contractor is to include the supply and installation of one additional head or an additional 5% of the total number of heads shown on the drawings, whichever is greater in the bid price. The installation is to include all wiring and conduit required to install the heads. If the heads are not installed during construction then the spare heads are to be turned over to The City at the end of the project.

UNIT EQUIPMENT FOR EMERGENCY LIGHTING

3.2 Testing And Commissioning

- .1 Contractor shall commission and test the entire system and adjust as necessary.
- .2 Trip breaker(s) feeding battery unit(s) to simulate power failure to building. Test the operation of each unit to document the duration of runtime. Testing shall be performed during non-daylight hours.
- .3 Inform Contract Administrator 10 days in advance prior to testing being performed in order for Contract Administrator to make arrangements to witness testing of emergency lighting system.
- .4 Provide Contract Administrator with signed test report by Electrical Subcontractor that each unit successfully operated for the required duration of time.
- .5 Re-test voltage of battery units 24 hours after initial testing to verify rated nominal voltage of unit. If battery unit has not recharged properly, replace unit and re-test as stated above at no additional cost to The City.

3.3 Test Reports

- .1 Submit all test reports as part of the O&M manuals.

END OF SECTION

EMERGENCY LIGHTING - INVERTER

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
- .3 Section 26 05 21 – WIRES AND CABLES UNDER 2000 V.
- .4 Section 26 05 34 – CONDUITS, CONDUIT FASTENERS AND FITTINGS.

1.2 References

- .1 CSA C22.2 No.141 – Emergency lighting equipment, latest edition.
- .2 CSA or cUL listed for Canadian application, UL and ETL listed to UL924 – AC inverter system for emergency power supply, latest edition.
- .3 CSA or cUL listed to CSA C22.2 No.107.1 – Power Conversion Equipment, latest edition; ANSI C62.41; ANSI C62.45 (Cat. A&B), latest edition.
- .4 FCC Rules and Regulations 47 Part 15, Subpart J, Class A - Certified Compliance, latest edition.
- .5 Systems comply with CEC, OESC, OSHA and Life Safety Code, latest edition.
- .6 UL 1778 – Standard for Uninterruptable Power Supply Equipment, latest edition.
- .7 ANSI C62.41 – Recommended Practice on Surge Voltages in Low Voltage Power Circuits, latest edition.
- .8 NEMA PE1 – Uninterruptible power supply, latest edition.
- .9 NFPA 111 – National Fire Protection Agency, latest edition.

1.3 Shop Drawings And Product Data

- .1 Submit Shop Drawings and product data in accordance with Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS
- .2 Submit shop drawings for equipment and accessories specified in this Section. Include photometric data for all luminaires not named as approved in this specification.
- .3 Data to indicate system components, mounting method, source of power and special attachments.
- .4 Manufacturer/Contractor to ensure runtime capacity of battery unit is sized accordingly to meet the runtimes specified within this section and/or Drawings/Schedules.

1.4 Quality Assurance

- .1 The Emergency Lighting Inverter (ELI) module shall be “burned-in” without failure for a minimum of 24 hours.
- .2 A final test procedure for the product shall include a check of performance specifications before and after the twenty-four hour “burn-in.”
- .3 An on-site test procedure shall include a check of controls, functions and indicators after installation of the equipment.

EMERGENCY LIGHTING - INVERTER

1.5 Field Quality Control

- .1 Factory-trained field service personnel shall perform the following inspections and test procedures during the ELI start-up.
- .2 Visual inspection
- .3 Mechanical inspection
- .4 Electrical inspection
- .5 Functional inspection
- .6 After installation of equipment, a signed commissioning report describing on-site testing and functionality shall be sent to the factory to validate warranty.

1.6 Warranty

- .1 The warranty of the equipment shall be twelve (12) months after start-up or eighteen (18) months after shipment.
- .2 For batteries, the warranty period shall be extended to 120 months from Total Performance, with a no-charge replacement during the first 5 years and a pro-rated charge on the second 5 years.
- .3 The battery cell manufacturer's warranty shall be passed through to the end user.

PART 2 - PRODUCTS

2.1 System description

- .1 Provide a complete Emergency Lighting Inverter (ELI) as specified herein to provide continuous, regulated ac power to various emergency lighting fixtures under normal and abnormal conditions, as well as loss of the utility ac power. This system shall incorporate conditioning and power filters on both the input and output sides of the ELI.
- .2 ELI Module Components: The ELI module consists of the following major components:
 - .1 Input ac filter
 - .2 Output ac filter
 - .3 Full galvanic output isolation transformers
 - .4 Inverter
 - .5 Rectifier/Charger
 - .6 Power factor correction (PFC) circuit
 - .7 Dc to dc converter
 - .8 Emergency power off (EPO) interface
 - .9 Input, rectifier, and reserve circuit breakers
 - .10 Internal Maintenance bypass
 - .11 Static bypass switch
 - .12 Microprocessor controlled logic and control panel with alarm indicators and digital metering display

EMERGENCY LIGHTING - INVERTER

- .13 Communications interface:
 - .1 RS-232
 - .2 RS-485
 - .3 Ethernet
 - .4 8 port relay
- .14 Input power walk-in
- .15 Front cable entry
- .16 External battery connection
- .17 Battery Cabinet Component
 - .1 Sealed, maintenance free batteries
 - .2 Battery circuit breaker
- .18 Optional features:
 - .1 Remote terminal strip
- .19 All lugs and terminals to be dual rated for Copper/Aluminum (Cu/Al).
- .3 Definitions
 - .1 ELI Module: The portion of the ELI system that contains the rectifier/charger, inverter, static bypass switch, manual bypass switch, controls, monitoring, isolation transformer and indicators.
 - .2 Rectifier/Charger: The portion of the ELI module, which converts the normal source AC input power to DC power for the inverter input and for charging the battery.
 - .3 Inverter: The portion of the ELI module that converts DC power from either the rectifier/charger or the battery, to regulated and filtered AC power, which is supplied to the critical load.
 - .4 Static Bypass Switch: The portion of the ELI module which automatically transfers the critical loads, without interruption, from the inverter output to the bypass AC power source in the event of an overload or degradation of the inverter's performance.
 - .5 Manual Bypass Switch: The portion of the ELI module, which is used to connect the utility AC power source to the critical loads while maintaining galvanic isolation.
 - .6 Battery: The battery system that provides DC power to the inverter input when the normal AC input power to the ELI module fails or in the event that the rectifier/charger should fail.
 - .7 Critical Loads: Those loads that require regulated continuous AC power and which are connected to the output of the ELI module.

EMERGENCY LIGHTING - INVERTER

2.2 System Operation

- .1 Normal: the inverter shall supply ac power continuously to the critical loads. The inverter output shall be synchronized with the bypass ac power source provided that the bypass ac power source is within the specified frequency range. The PFC circuit shall convert the normal ac input power to dc power for the inverter in conjunction with the charger to maintain the battery charge.
- .2 Loss of normal ac input power: the battery shall supply dc power, via the dc to dc converter, to the inverter so that there is no interruption of ac power to the critical loads whenever the normal ac input power source of the ELI module deviates from the specified tolerances or fails completely. The battery shall continue to supply power to the inverter for the specified protection time.
- .3 Return of normal ac input power source: the PFC circuit shall perform a walk-in start and assume the dc load from the battery when the normal ac input power source returns. The charger shall then simultaneously supply the inverter with dc power and recharge the battery. This shall be an automatic function and shall cause no disturbance to the critical load.
- .4 Transfer to bypass ac power source: if the control circuitry senses an overload, an inverter shutdown signal, a dc bus fault or degradation of the inverter output, then it shall automatically transfer the critical loads from the inverter output to the bypass ac power source without an interruption of power. If the bypass ac power source is above or below normal voltage limits, then the transfer shall be inhibited.
- .5 Transfer back to inverter: the static bypass switch shall be capable of automatically transferring the load back to the inverter after the inverter has returned to normal conditions. Retransfer shall not occur if the two sources are not synchronized. The static bypass control circuit shall have the ability to lock the critical load to either the inverter output or the bypass source (selectable). This lockout condition shall be reset under manual command.
- .6 ELI without battery: if the battery is taken out of service for maintenance, it shall be disconnected from the rectifier/charger and inverter. The ELI shall continue to function and meet the performance criteria specified herein except for the battery reserve time and step load performance.

2.3 Electrical Characteristics

- .1 ELI Module Input
 - .1 Voltage and number of input wires: as shown on electrical single line diagram
 - .2 Voltage range: -20% to +15% without discharging the battery
 - .3 Input frequency: 45 to 65 Hz continuous
 - .4 Reserve frequency: 60 Hz $\pm$ 7% continuous
 - .5 Current walk-in: 20 seconds to full load rating
 - .6 Maximum input current: 150% of nominal full load current
 - .7 Power factor: 0.60 lagging at nominal input voltage, 30% THD at nominal conditions and at full ELI load.
 - .8 Current harmonics: <9% THD, with 12 pulse rectifier and input factor
 - .9 Input transient protection: ANSI C62.41.

EMERGENCY LIGHTING - INVERTER

- .2 ELI Module Output
 - .1 Voltage and number of output wires: as shown on electrical single line diagram
 - .2 Frequency: 60 Hz
 - .3 Power rating: as shown on electrical single line diagram
 - .4 Battery back-up time: 90 minutes unless otherwise noted
 - .5 Voltage regulation: $\pm 2\%$ of nominal for any of the combined effects
 - .1 No load to full load
 - .2 Minimum to maximum output power factor
 - .3 Minimum to maximum ac input voltage
 - .4 Minimum to maximum dc input voltage
 - .5 0 to 40 °C ambient temperature
 - .6 Dynamic regulation:
 - .1 $\pm 3\%$ from nominal for 100% step load
 - .2 $\pm 2\%$ from nominal for 50% step load
 - .3 Recovering to within 1% in less than one cycle
 - .7 Voltage unbalance: $\pm 3\%$ of nominal for 100% unbalanced loads
 - .8 Phase separation:
 - .1 $120^\circ \pm 1\%$ of nominal for 100% balanced loads
 - .2 $120^\circ \pm 2\%$ of nominal for 100% unbalanced loads
 - .9 Voltage distortion
 - .1 $< 2\%$ THD at 100% loads (linear load)
 - .2 $< 3\%$ THD at 100% load (non-linear load)
 - .10 Frequency stability: 60 Hz $\pm 0.01\%$ free running
 - .11 Phase-lock window: 60 Hz, $\pm 4\%$
 - .12 Overload capability:
 - .1 Inverter:
 - .1 $< 110\%$ continuous
 - .2 125% for 15 minutes
 - .3 150% for 10 seconds
 - .2 Static bypass:
 - .1 200% for 30 seconds
 - .2 400% for 1 second
 - .13 Fault clearing capability:
 - .1 Static bypass: 100% for $\frac{1}{2}$ cycle (non-repetitive)
 - .14 Crest factor: 3:1 maximum

EMERGENCY LIGHTING - INVERTER

.3 Battery

- .1 Type: Sealed lead-acid (maintenance-free AGM)
- .2 Number of Cells: 174 Cells
- .3 Voltage range: 295 – 410 VDC
- .4 Float voltage: 396 VDC
- .5 Min. discharge voltage: 295 VDC
- .6 20 year life type battery

.4 Power Factor Correction Circuit

- .1 The PFC circuit shall consist of an input breaker, an input EMI/transient suppressor network, output filter power factor correction circuit and a solid-state rectifier with control circuitry to provide constant voltage/constant current regulation and a current walk-in on start-up. The PFC circuit shall be a full wave high frequency controlled type using SCRs in both the positive and negative legs.
- .2 Over-current/Transient protection: The input of the PFC circuit shall be protected from noise and transients by an input EMI/transient suppressor network. The PFC circuit shall be electronically regulated and current limited to protect the connections to the inverter input and to prevent damage to the charger.
- .3 Control circuitry: The PFC circuit shall be equipped with Digital Signal Processor (DSP) control circuitry to provide constant DC voltage regulation of $\pm 1\%$ for $+15\%$ to -20% ac input voltage change, for 45 to 65 Hz input frequency change, or for 0% to 100% load variations. The control circuitry shall enable continuous PFC circuit operation from an engine generator with output frequency transients of up to 5 Hz.
- .4 Whenever ac power is applied to the PFC circuit, the current limiting control circuitry shall walk-in over a period of at least 20 seconds to allow gradual loading of the normal input ac power source.
- .5 The control circuitry shall automatically turn off the PFC circuit without opening circuit breakers if any of the following conditions occur:
 - .1 High dc voltage
 - .2 Ac over-voltage of 120% of normal ac input
 - .3 Loss of normal ac input
 - .4 Loss of a phase on normal circuit
 - .5 The control circuitry shall be capable of additional PFC circuit features with future DSP control software releases.
- .6 Output filter: The PFC circuit shall be furnished with output filtering to limit output ripple voltage to 0.5% for 0 to 100% load.
- .7 Capacity: The PFC circuit shall have sufficient capacity to supply the inverter at 100%, 0.8 PF load plus recharge the battery bank to 90% of full capacity within 24 hours.

EMERGENCY LIGHTING - INVERTER

.5 Inverter

- .1 The inverter shall utilize fast-switching IGBT transistors, pulse width modulation (PWM) and phase vector synchronization (PVS). It shall consist of a switching bridge, dc input, output filter and control circuitry to provide precise ac voltage regulation, harmonic cancellation//conditioning and superior transient response.
- .2 Control circuitry:
 - .1 The inverter shall be provided with a digital signal processor (DSP) control circuitry to provide constant ac voltage regulation and transient response as specified. The high-speed DSP controls shall sample the output continuously to provide precise voltage control.
 - .2 The high speed DSP control shall sample the inverter output and the ELI module output to determine the phase and amplitude of the output voltage. The results shall be used by the DSP to control the inverter output to ensure a clean output ac voltage sine wave when driving non-linear loads.
 - .3 The circuitry shall provide low voltage initial start-up of the inverter and ramp-up to full voltage.
 - .4 The control circuitry shall automatically synchronize and phase lock the inverter output to the bypass ac power source as long as the bypass source is within the synchronization range. If the bypass ac power source is not within these pre-set limits, then the control circuitry shall break synchronization and lock to an internal crystal oscillator.
 - .5 The control circuitry shall automatically send a signal to the static bypass switch to transfer to the bypass ac source and then turn off the inverter for any of the following conditions:
 - .1 Blown inverter fuse
 - .2 Over-temperature
 - .3 Overloads per specified limits
 - .4 High/low dc voltage
 - .5 Inverter over-voltage or under-voltage condition
 - .6 The control circuitry shall automatically turn off the inverter when the battery reaches the end of discharge. The ELI shall automatically restart and return to normal when input ac power returns.
 - .7 The control circuitry shall be capable of additional inverter features with future DSP control software releases.

.6 Static Bypass Switch

- .1 The static bypass shall consist of two pairs of Silicon Controlled Rectifiers (SCR's) per phase with each pair connected in inverse parallel. The static bypass shall be connected between the bypass (input) AC power source and the output transformer. Static bypass and inverter shall be isolated from one another.
- .2 Inverter Failure: If the inverter is out of normal limits due to under voltage or over voltage, or is shut down for any reason, the static bypass switch shall turn on to provide power to the load from the bypass AC power source without interruption.

EMERGENCY LIGHTING - INVERTER

- .3 Retransfer to Inverter: The static bypass switch shall be capable of automatically retransferring the load back to the inverter after the inverter has returned to normal conditions and stabilized for a pre-set period of time.
- .4 Overload: If an inverter overload is detected, the static bypass switch shall operate as described in 2.5.1 and .2 above. A transfer shall not occur unless the inverter overload ratings and time duration described in paragraph 2.1.2.m) are exceeded.
- .5 Over-current Protection
 - .1 Input over current protection shall be provided internal to the ELI rated at no less than 125 % of ELI rating.
 - .2 The static bypass switch shall be rated to carry 200% of the ELI's rated output current for thirty seconds and 1000% of the ELI's rated output current for one half cycle.
- .6 Transfer Conditions
 - .1 The static bypass switch shall transfer the critical load from the output of the inverter to the bypass AC power source for the following conditions:
 - .1 Inverter voltage less than 95 % of nominal.
 - .2 Inverter voltage greater than 105 % of nominal.
 - .3 Inverter overload period expired.
 - .4 Inverter shutdown for any reason.
 - .2 The static bypass switch shall inhibit transfer to the bypass AC power source for the following conditions:
 - .1 Bypass AC power source voltage less than 80% of nominal line to neutral.
 - .2 Bypass AC power source voltage greater than 120% of nominal line to neutral.
 - .3 Inverter not phase-locked to the bypass AC source.
 - .4 Bypass AC power source frequency deviation greater than 7% of nominal.
- .7 Automatic Retransfer Conditions: The system shall automatically retransfer the load to the inverter provided all of the following conditions are met:
 - .1 The inverter logic and the bypass AC power source are synchronized and in phase.
 - .2 Inverter conditions are normal.
 - .3 The ELI output is not overloaded.
- .8 Transfer Time: Maximum transfer time to switch from inverter to bypass AC power source shall be 100 microseconds.
- .9 Single Input Configuration: The rectifier and internal bypass systems (static bypass and manual bypass switch) shall be connected to the AC power source through a common set of terminals at the ELI input. This single input configuration shall enable the ELI primary and bypass AC power sources to be provided from a single input feeder. This will simplify installation complexity and reduce installation costs.

EMERGENCY LIGHTING - INVERTER

.7 Internal Manual Bypass Switch

- .1 The ELI shall incorporate an internal manual bypass switch. This switch shall provide provisions to allow the input ac power to bypass the electronics and supply the load without interruption of power to the loads. This switch shall not bypass the output isolation transformer or power filters to ensure minimal power problems on manual bypass mode.
- .2 The main CPU shall monitor the manual bypass breaker position. In the event of accidental operation of the breaker without the inverter being shutdown, the CPU will automatically shut down the inverter and trigger an alarm notification. As long as the manual bypass breaker remains in the "on" position inverter operation shall remain inhibited.

.8 Front Panel and User Interface

- .1 The ELI front panel shall include the following LED's and an active mimic diagram of the ELI operation:
 - .1 Eight warning LED's
 - .1 Rect. AC Fail
 - .2 Res AC Fail
 - .3 Fuse/Temp
 - .4 Overload
 - .5 High DC
 - .6 Bat Low
 - .7 Bat Low Shutdown
 - .8 Fault
 - .2 Twenty-four operation LED's
 - .1 Inv On
 - .2 Inv Static Switch
 - .3 Short Circuit
 - .4 Fuse/Temp Shutdown
 - .5 Inv Fail Inverter Shutdown
 - .6 Bypass On Inverter Shutdown
 - .7 High DC Inverter Shutdown
 - .8 Overload Inverter Shutdown
 - .9 70 % Load
 - .10 110 % Load
 - .11 125 % Load
 - .12 150 % Load
 - .13 Res AC Fail
 - .14 Res AC Freq. Fail

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- .15 Bat Low
- .16 Bat Low Shutdown
- .17 Rect. AC Fail
- .18 Rotation Error
- .19 Rect. Shutdown
- .20 Rect. High DC
- .21 Boost Charge
- .22 Battery Test
- .23 Emergency Stop
- .24 Data Line
- .3 The front panel shall include the following buttons for system operation and control of the LCD display:
 - .1 System operation buttons:
 - .1 Inverter On
 - .2 Inverter Off
 - .3 Inverter Control
 - .2 LCD display control buttons:
 - .1 Up
 - .2 Down
 - .3 Enter
- .2 The ELI shall include an audible alarm-warning device. This alarm shall sound whenever any abnormal condition occurs. Any subsequent alarm shall cause reactivation of the status indicator and audible alarm.
- .3 The following parameters shall be measured and displayed by an alphanumeric LCD display on the Front Panel. Each display shall have the nomenclature of the parameter indicated with the associated value. AC voltage and current values shall be measured in true RMS units.
 - .1 Main Menu Display
 - .1 ELI identification
 - .2 Serial number
 - .3 Maximum output rating
 - .4 Input and output voltage configuration
 - .5 Current date and time
 - .2 Select Menu Display
 - .1 Access to further menus

EMERGENCY LIGHTING - INVERTER

- .3 Status Warning Menu Display
 - .1 Current status of ELI operation
 - .2 Warning codes
 - .3 Fault codes
- .4 Real Time Data Menu Display
 - .1 Allow access to further menu options
- .5 Historical Event Menu Display
 - .1 Recorded events, warnings or faults
- .6 Parameter Setting Menu Display
 - .1 Allows control of basic features
- .7 Rectifier Data Display:
 - .1 Input frequency.
 - .2 Rectifier AC voltage - phase to neutral.
- .8 Reserve Data Display
 - .1 Reserve frequency.
 - .2 Reserve AC voltage - phase to neutral.
- .9 Output Data Display
 - .1 Output frequency.
 - .2 Percent load per phase.
 - .3 Output voltage - phase to neutral.
- .10 Other Data Display
 - .1 Internal temperature.
 - .2 Battery voltage.
 - .3 Battery current with flow direction.
- .4 ELI event history shall be available through the alphanumeric display. The event history shall store a minimum of 77 previous status and alarm events with the date and time of each occurrence on an EEPROM. Allowances for a second EEPROM shall be made to allow for the stored recorded events to be increased to 154.
- .9 Communication Interface
 - .1 The ELI shall be equipped with eight (8) Form A (Normally Open) relay alarm contacts for remote signalling:
 - .1 Common (programmable OR gate for any combination of contacts)
 - .2 Battery Low
 - .3 Back-up Mode
 - .4 Manual Bypass Mode
 - .5 Static Bypass Mode
 - .6 Fault Condition
 - .7 Overload Condition
 - .8 Inverter On

EMERGENCY LIGHTING - INVERTER

- .2 The ELI shall be equipped with one Form A (Normally Open) summary alarm contact for remote fire alarm panel connection.
- .3 An input opto-coupled contact shall be included for remote shutdown of the ELI.
- .4 Remote alarm panel interface. Summary includes:
 - .1 Safety shutdown
 - .2 Low battery
 - .3 Bypass activated
 - .4 Output voltage not present
 - .5 Inverter stop activation
- .10 Communication Ports
 - .1 The ELI shall be equipped with:
 - .1 RS-232 port for SNMP (Ethernet Adapter)
 - .2 RS-485 port for computer communications
 - .3 RS-485 port for remote display panel
 - .2 SNMP (Simple Network Management Protocol) Ethernet Adapter shall be included as a standard feature. This adapter will allow for intranet and/or internet communication and monitoring of the ELI system. This adapter shall be password protected and accessible to authorized personnel only.
 - .1 The adapter shall allow the user to monitor the status of the ELI through a web page stored on the adapter from a remote station located on, or have access to the network the adapter is connected.
 - .2 The adapter shall be able to email, page or phone a user programmed number in the event of an emergency.
- .11 Construction
 - .1 Enclosure: The ELI electronics shall be housed in a CSA Type 1 with drip hood, sprinkler proof enclosure. The enclosure shall be primed and painted inside and outside with manufacturer's standard paint. The enclosure shall be a freestanding floor mount design. Enclosure shall incorporate integrated drip shield.
 - .2 Material and workpersonship:
 - .1 Workpersonship shall be first class in every respect.
 - .2 All material shall be new and of best industrial grade.
 - .3 Internal wiring conductors shall be combined into cables or bundles, and shall be tied securely together.
 - .4 All bundled wiring shall be identified by color codes or by wire numbers. Power cables shall be identified at each end.
- .12 Cooling
 - .1 The ELI shall be forced air-cooled. Ventilation shall be from the bottom to the top. The cooling shall be adequate for operation at altitudes up to 2,500 meters.

EMERGENCY LIGHTING - INVERTER

.13 Audible Noise Reduction

- .1 The ELI shall be designed and constructed such that the audible noise is reduced to a typical 38 to 40 decibels, measured on the A scale at 1 meter from the front of the cabinet.

.14 Battery Cabinet

- .1 The ELI shall be designed to operate with any common lead-acid or nickel-cadmium battery type. The installed battery type and rating shall be programmed into the ELI at the factory, and the ELI charger shall select the proper charging regimen based on the actual installed battery type. This will maximize the life of the battery. The ELI shall include a circuit breaker and battery test feature that will automatically test the battery every thirty (30) days. The user shall have the ability to manual test the battery as well.

.15 Output Isolation Transformer

- .1 The output shall be completely isolated from the input on all wires.
- .2 The output neutral and ground wires shall be bonded on the output terminal strip.
- .3 The transformer windings shall be vacuum impregnated to reduce audible noise and increase heat dissipation.
- .4 The transformer shall have a cUL/UL recognized insulation system and shall be so located within the equipment to ensure that the hottest spot shall not exceed the rated insulation temperature and to ensure a low center of gravity.

.16 Optional External Maintenance Bypass Cabinet

- .1 An external maintenance bypass cabinet shall be provided to allow the ELI system to be completely isolated and removed from the electrical system while the load is maintained through the external maintenance bypass. This optional cabinet shall provide make-before-break operation for transfers to and from the external maintenance bypass output. The following components shall be standard: input, ELI and bypass breakers, inter-cabinet wiring and mounting feet. Optional voltage matching transformers, isolation transformers and Kirk-Key interlock are to be offered.
- .2 Output Breakers
 - .1 Allows for loads to be disconnected for load maintenance, without UPS shutdown.

2.4 Acceptable Manufacturers

- .1 BeLuce – Borealis or approved equal.

PART 3 - EXECUTION

3.1 Installation

- .1 The equipment shall be installed in accordance with the manufacturer's recommendations as well as electrical code.
- .2 Install on flat floor only.
- .3 Tie-in general trouble and running alarms into fire alarm panel.

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- .4 The inverter to be tested on site as defined herein. Contractor to oversee all testing and correct any deficiencies noted.

3.2 Testing

- .1 Contractor shall commission and test the entire system and adjust as necessary.
- .2 Trip breaker(s) feeding inverter system to simulate power failure to building. Test the operation of the system to document the duration of runtime. Testing shall be performed during non-daylight hours.
- .3 Inform Contract Administrator 10 days in advance prior to testing being performed in order for Contract Administrator to make arrangements to witness testing of emergency lighting system.
- .4 Provide Contract Administrator with signed test report by Electrical Subcontractor that the inverter system successfully operated for the required duration of time. The Subcontractor is to measure the lighting levels throughout the facility and produce a letter that emergency lighting levels meet the Building Code requirements of 10lux average with minimum readings not less than 1lux on the path of egress.
- .5 Re-test voltage of inverter system battery units 24 hours after initial testing to verify rated nominal voltage of unit. If batteries have not recharged properly, replace unit and re-test as stated above at no additional cost to The City.

3.3 Test Reports

- .1 Submit all test reports as part of the O&M manuals.

3.4 Manufacturer's Field Service

- .1 Service personnel
 - .1 The ELI manufacturer shall employ a nationwide service organization, consisting of factory trained field service personnel dedicated to the start-up, maintenance, and repair of ELI and power equipment.
- .2 Maintenance contracts
 - .1 A full service maintenance contract for both the ELI system and battery system shall be available to the end user. Factory-trained service personnel shall perform all warranty and maintenance.

END OF SECTION

SINGLE PHASE INVERTERS FOR EMERGENCY LIGHTING

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.

1.2 References

- .1 CSA Standard C22.2 No.141 – Emergency Lighting Equipment, latest edition.

1.3 Shop Drawings And Product Data

- .1 Submit Shop Drawings and Product data in accordance with Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
- .2 Submit Shop Drawings for equipment and accessories specified in this section.
- .3 Data to indicate system components, mounting method, source of power and special attachments.
- .4 Ensure runtime capacity of battery is sized accordingly to meet the runtimes and loads specified within this section and/or on the Drawings or Schedules. Indicate runtime on Shop Drawings.
- .5 Include inverter heat rejection, weight, and dimensional data.
- .6 Include inverter single line diagram and wiring diagrams.

1.4 Warranty

- .1 Provide minimum 1 year warranty for inverter system.
- .2 For batteries, provide 120 months warranty period from Total Performance of the Work, with a no-charge replacement during the first 5 years and a pro-rated charge on the second 5 years.

1.5 Testing

- .1 Factory test the inverter(s) prior to shipment.

1.6 Operating and Maintenance

- .1 Include operating and maintenance instructions as part of Project O&M manuals.

PART 2 - PRODUCTS

2.1 Equipment

- .1 Provide single phase inverter system that:
 - .1 Meets the requirements of CSA C22.2 No. 141.
 - .2 Is 120 V in and 120 V out, 277 V in and 277 V out, or 347 V in and 347 V out, as indicated on the Drawings or Schedules.
 - .3 Has power rating as indicated on the Drawings or Schedules.
 - .4 Has number of output breakers as indicated on the Drawings or Schedules.

SINGLE PHASE INVERTERS FOR EMERGENCY LIGHTING

- .5 Includes connections for input and output bonding conductors.
- .6 Is rated for 60 Hz.
- .7 Is fully (100 %) rated for load power factors between 0.9 lagging and 0.9 leading.
- .8 Is suitable for powering LED luminaires at their full lumen rating.
- .9 Has peak overload capacity suitable for accommodating LED luminaire inrush currents.
- .10 Has run time of 30 minutes.
- .11 Has integral valve regulated lead acid (VRLA) battery system that: acts as the source of power in the event of a utility power failure, is maintenance free, and has a 10 year design life.
- .12 Has a pure sine wave output.
- .13 Is capable of powering emergency power luminaires that are normally on, normally off, switched, or dimmed.
- .14 Includes enclosure that is appropriately rated for use in a sprinklered building and has powder coat paint finish.
- .15 Is complete with weekly, monthly, and yearly, non audible auto test feature, as well as manual push button test switch. Indicate malfunctions or auto-test failures. Log and time stamp auto-testing and allow The City to extract data.
- .16 Forces emergency lights to full brightness during a utility power failure.
- .17 Can override 0-10 V dimming systems.
- .18 Is complete with overcurrent protection for the output circuit.
- .19 Is configured for ceiling mount installations. Alternatively, wall, floor, or stand mount installations can be provided, if ceiling mount cannot be achieved.
- .20 Includes a charger; a battery system; an inverter; a control relay; supporting electronics for control, monitoring, and alarms; and supporting protection components.
- .21 Is complete with battery breaker.
- .22 Includes diagnostic / pilot LEDs for AC On and charge.
- .23 Includes charger that is fully automatic and is current limited.
- .24 Has hard wired input/output connections.
- .25 Is rated to operate between 20 and 30 degrees C and only requires front access.
- .26 Is appropriately rated for the available short circuit current shown on the Single Line Diagram.
- .27 Includes battery status indicator and audible signal when battery is low.
- .28 Has 24 hour or less battery recharge time.
- .29 Includes terminal blocks.

SINGLE PHASE INVERTERS FOR EMERGENCY LIGHTING

- .2 Acceptable manufacturers:
 - .1 ABB / Lumacell
 - .2 Stanpro
 - .3 Beluce
 - .4 Acuity / IOTA Engineering
 - .5 Aimlite

PART 3 - EXECUTION

3.1 Installation

- .1 Install inverters in accordance with manufacturer's written installation instructions and all applicable codes and standards.
- .2 Setup and commission inverters to work with lighting control strategy indicated on the Drawings, in the Specifications, or in the Lighting Control Sequence of Operations document.

3.2 Testing And Commissioning

- .1 Commission and test the entire system and adjust as necessary.
- .2 Trip breaker(s) feeding inverter(s) to simulate power failure. Test the operation of each inverter system to document the duration of runtime. Perform testing during non-daylight hours.
- .3 Inform Contract Administrator 10 days in advance of testing being performed in order for Contract Administrator to make arrangements to witness testing of emergency lighting system.
- .4 Provide Contract Administrator with signed test report confirming that each inverter successfully operated for the required duration of time.
- .5 Re-test voltage of inverters 24 hours after initial testing to verify rated nominal voltage of inverter system. If battery has not recharged properly, replace system and re-test as stated above at no additional cost to The City.

END OF SECTION

ELEVATOR SERVICES

PART 1 - GENERAL

1.1 Work Included

- .1 Comply with Elevator Division specifications.
- .2 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .3 Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.

1.2 Reference

- .1 ASME A17.1/CSA-B44 – Safety Code for Elevators and Escalators, latest edition.

1.3 Shop Drawings And Product Data

- .1 Submit Shop Drawings and product data in accordance with Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.

1.4 Description Of System

- .1 Provide elevator machine power supply, wiring, lighting, life safety and receptacle systems for machine room, pits and secondary levels, power, security, music, communication and life safety provisions for cab(s), and conduit and wiring to and for associated control and equipment.

1.5 Warranty

- .1 Provide a warranty in accordance with the requirements of Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Materials

- .1 Individual lockable fusible disconnect switches or panelboards, with rating, number of poles, and configuration as indicated for:
 - .1 Machine power.
 - .2 Lighting for machine room, and pits and secondary levels.
 - .3 Machine room and pit receptacles.
 - .4 Machine room exhaust fan and A/C unit.
 - .5 Group controller power.
 - .6 Power for cab exhaust fan and cab lighting.
 - .7 Intercom – two-way supervised voice communication system.
 - .8 Provide an intercom/two-way voice communication system for the elevators which will allow the following:
 - .9 Two-way voice communication between each elevator and the Central Alarm and Control Facility.
 - .10 Two-way voice communication between each elevator and off site monitoring centre.

ELEVATOR SERVICES

- .11 Electrical Division will be responsible for providing and making operational the entire system except for providing the hoistway wiring between each elevator and its respective machine room and installing the two-way speaker in each cab which will be by Division 14.
- .12 Provide one EVAC speaker in each elevator cab connected to the fire alarm system. Coordinate installation with Division 14. Division 14 will provide wiring from terminal box in machine room to each elevator cab. All other work will be by Electrical Division.

PART 3 - EXECUTION

3.1 Installation

- .1 Interface between work for Electrical Division and Elevator Subcontractor. For all systems, Electrical Subcontractor shall terminate all wiring at the terminals of elevator or escalator controller(s) in the respective machine rooms or pits.
- .2 Coordinate the locations of all equipment with Elevator Subcontractor prior to installation.
- .3 Install disconnect switches or panelboards in the machine rooms as indicated.
- .4 Install 27 mm conduit from nearest communication/telephone room to a 600 mm x 600 mm plywood backboard in each elevator machine room. Install 21 mm conduit system for telephones to each elevator controller from the backboard.
- .5 Install lights, switches and receptacles for machine room, pit and shaft as indicated.
- .6 Provide wiring in 21 mm conduit from each elevator controller to the fire alarm system as described below and as described in the fire alarm specification section to initiate elevator recall. All fire alarm wiring to be as per fire alarm specification section and approved for the installation.
 - .1 For conventional/hard wired fire alarm systems, provide wiring in 21 mm conduit from the auxiliary contact on the detectors located in the elevator shaft, in the elevator lobbies and in the elevator machine room to each of the elevator controllers, as further described in the fire alarm specification section.
 - .2 For addressable fire alarm systems, provide addressable output relays as described in the fire alarm specification section and provide wiring from each respective relay to the respective elevator controller.
- .7 Provide separate 53 mm conduits from each elevator shaft to the CACF or main elevator control panel location. Install control wiring within these conduits. Wiring to be supplied by Elevator Subcontractor.
- .8 If hydraulic elevators utilize battery-pack emergency power lowering feature, provide on the main disconnect switch, a CSA approved, positive action auxiliary interlock switch that prevents "down" operation, when opened, as required by and as approved by the governing body having jurisdiction. Provide wiring from auxiliary switch in 16 mm conduit to the respective elevator controller.
- .9 Provide wiring in conduit from each automatic transfer switch (ATS) in the building to all of the elevator controllers fed from the respective ATS to connect the pre-transfer, post-transfer and inhibit signals. Include for 2 spare wiring pairs in this run of conduit.

ELEVATOR SERVICES

- .10 Provide two 103 mm conduits from each elevator machine/controller room to each of the elevator shafts when the elevator machine/controller room is not adjacent to the elevator shaft.
- .11 Electrical Subcontractor to coordinate all sleeving requirements with Elevator Subcontractor.

END OF SECTION

HAND DRYERS

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.

1.2 Shop Drawings and Product Data

- .1 Submit Shop Drawings and product data in accordance with Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.

1.3 Warranty

- .1 Provide a warranty in accordance with the requirements of Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Description

- .1 The hand dryers shall be surface-mounted, vandal-resistant with a cast iron cover and porcelain enamel finish.
- .2 Acceptable manufacturer and model number for hand dryers is Dyson 'Airblade V', 120V, 60Hz, 1000W.
- .3 The hair dryers shall be surface-mounted, vandal-resistant with a cast iron cover and porcelain enamel finish.
- .4 Acceptable manufacturer and model number for hair dryers is World Dryer 'AirStyle Model B'. 120V, 60 Hz, 1725W.

PART 3 - EXECUTION

3.1 Installation

- .1 Supply, install and provide power connections to the hand dryers as indicated on the electrical plans. Co-ordinate mounting height with architectural plans.
- .2 Install hand dryers in accordance with manufacturer's recommendations.

END OF SECTION

RACEWAYS FOR SECURITY SYSTEM

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.2 Description Of System

- .1 Provide raceways and back boxes only for this security system. A complete security system shall be supplied and installed by others.

PART 2 - PRODUCTS

2.1 Security System

- .1 The security system will be tendered by Division 28, Security Subcontractor. Coordinate with the Contract Administrator, which division supplies and installs the wiring and cables, and which division installs and terminates the devices.

PART 3 - EXECUTION

3.1 Installation

- .1 Install conduits and back boxes only.

END OF SECTION

MULTIPLEX FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
- .3 Section 26 05 34 – CONDUITS, CONDUIT FASTENERS AND FITTINGS.
- .4 Section 26 05 21 – WIRES AND CABLES UNDER 2000 V.

1.2 References

- .1 CAN/ULC-S524, Installation of Fire Alarm Systems, latest edition.
- .2 CAN/ULC-S536, Inspection and Testing of Fire Alarm Systems, latest edition.
- .3 CAN/ULC-S537, Verification of Fire Alarm Systems, latest edition.
- .4 CAN/ULC-S1001, Integrated Systems Testing of Fire Protection and Life Safety Systems, latest edition.
- .5 CAN/ULC-S553, Standard For Installation of Smoke Alarms, latest edition.
- .6 CSA C22.2 No. 124, Mineral-Insulated Cable, latest edition.
- .7 CAN/ULC-S559, Standard for Equipment for Fire Signal Receiving Centres and Systems, latest edition.
- .8 CAN/ULC-S561, Standard for Installation and Services for Fire Signal Receiving Centres and Systems, latest edition.

1.3 System Description

- .1 This section is only applicable to the childcare fire alarm system.
- .2 All equipment and components shall be new, and the manufacturer's current model.
- .3 Spare modules will be provided for future tenant tie ins. Panels will be tied into emergency standby generators, fire pumps, security panels, and auxiliary and ancillary devices.
- .4 Elevator shafts will have a weather proof heat detector located in the pit along with a smoke detector located at the top of the shaft.
- .5 Emergency power feed from generator(s) shall have two supervisory zones each, monitoring Generator Running and Generator General Trouble.
- .6 Emergency power feed from inverter(s) shall have three supervisory zones each, monitoring Inverter Running, Inverter on Bypass and Inverter General Trouble.
- .7 Fully supervised, microprocessor-based, fire alarm system, utilizing digital techniques for data control and digital, and multiplexing techniques for data transmission.
- .8 System to carry out fire alarm and protection functions; including receiving alarm signals; initiating general alarm; supervising components and wiring; actuating annunciators and auxiliary functions; initiating trouble signals and signalling to monitoring agency.
- .9 Zoned, non-coded single stage, as indicated.
- .10 Modular in design to allow for future expansion.

MULTIPLEX FIRE ALARM SYSTEM

- .11 Operation of system shall not require personnel with special computer skills.
- .12 System to include:
 - .1 Central Control Unit in separate enclosure with power supply, stand-by batteries, central processor with microprocessor and logic interface, main system memory, input-output interfaces for alarm receiving, annunciation/display, and program control/signalling.
 - .2 Power supplies.
 - .3 Initiating/input circuits.
 - .4 Indication/output circuits.
 - .5 Auxiliary circuits.
 - .6 Wiring.
 - .7 Manual and automatic initiating devices.
 - .8 Audible and visual signalling devices.
 - .9 End-of-line resistors.
 - .10 Local and remote annunciators.
 - .11 Printer and event log memory chip.
 - .12 Historic event recorder.
 - .13 Isolation modules.
 - .14 Central alarm monitoring.
 - .15 Programmed features.
- .13 Childcare fire alarm system to tie to recreational center fire alarm system to annunciate general alarm.

1.4 Requirements Of Regulatory Agencies

- .1 System components shall be listed by ULC/CSA and comply with applicable provisions of the building code, and meet requirements of local authority having jurisdiction.

1.5 Shop Drawings And Product Data

- .1 Submit Shop Drawings and product data in accordance with Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
- .2 Include:
 - .1 Detail assembly and internal wiring diagrams for control units and auxiliary cabinets.
 - .2 Overall system riser wiring diagram identifying control equipment, initiating zones, signaling circuits; and identifying terminations, terminal numbers, conductors and raceways.
 - .3 Details for devices.
 - .4 Details and performance specifications for control, annunciation and peripherals with item by item cross reference to specification for compliance.

MULTIPLEX FIRE ALARM SYSTEM

- .5 Step-by-step operating sequence, cross referenced to logic flow diagram.
- .6 Submit battery sizing calculations and battery selection.

1.6 Operation And Maintenance Data

- .1 Provide operation and maintenance data for fire alarm system for incorporation into the O&M manual.
- .2 Include:
 - .1 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 with corrections completed and marks removed except review stamps.
 - .4 List of recommended spare parts for system.
 - .5 Detailed sequence of operation or operational matrix.
 - .6 Full fire alarm verification inspection report.
 - .7 USB stick, containing electronic version of fire alarm passive graphic both in PDF and CAD, as part of O&M manual.

1.7 Maintenance Materials

- .1 Include:
 - .1 Spare glass rods for manual pull stations, if applicable.
 - .2 Key for fire alarm panel, remote annunciator, and pull stations.
 - .3 Specialty tool for resetting sprinkler supervisory, if applicable.
 - .4 Spare fuses for control circuits.
 - .5 Beam detector calibrated test filters (if applicable).

1.8 Warranty

- .1 Provide a one year warranty from total performance including all materials, parts, and labour. Be responsible for correcting any deficiencies that are discovered during the one year warranty period, including any that are discovered by The City's first annual inspection and test to CAN/ULC-S536.

1.9 Training

- .1 Provide on-site lectures and demonstration by fire alarm equipment manufacturer to train operational personnel in use and maintenance of fire alarm system.

PART 2 - PRODUCT

2.1 Materials

- .1 Equipment and devices: ULC listed, labelled and supplied by single manufacturer.
- .2 Power supply: to CAN/ULC-S524.

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- .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.
- .10 Signal Transmitting Units and Monitoring: to CAN/ULC-S559 and CAN/ULC-S561.

2.2 System Operation: Single Stage Signals Only

- .1 Actuation of any alarm initiating device to:
 - .1 Cause electronic latch to lock-in alarm state at central control unit and data gathering panel/transponder.
 - .2 Indicate zone of alarm at central control unit and at the remote annunciator.
 - .3 Cause audible signalling devices to sound continuously throughout building and at central control unit.
 - .4 Transmit signal to fire department via central station.
 - .5 Except for air handling systems providing make-up air to public corridors serving suites in Group C major occupancy High Buildings, cause air conditioning and ventilation fans serving more than 1 storey or 1 suite in a storey to shut down.
 - .1 Air handling systems providing make-up air to public corridors serving suites in Group C major occupancy High Buildings shall only shutdown upon activation of the duct smoke detector(s) associated with that specific mechanical unit. On general alarms activated by other initiating devices (i.e. sprinkler, pull station, smoke/heat detector, etc.), the air handling unit shall continue to operate in order to maintain corridor pressurization.
 - .6 Cause supply and/or exhaust fans to function automatically to provide required control of smoke movement per the mechanical smoke control matrix.
 - .7 Cause fire doors and smoke control doors, if normally held open, to close automatically.
- .2 Acknowledging alarm: indicated at central control unit.
- .3 Actuation of supervisory devices to:
 - .1 Cause electronic latch to lock-in supervisory state at central control unit and data gathering panel/transponder.
 - .2 Indicate respective supervisory zone at central control unit and at remote annunciator.
 - .3 Cause audible signal at central control unit to sound.
 - .4 Activate common supervisory sequence.
- .4 Resetting of alarm or supervisory device shall not return system indications/functions back to normal until control unit has been reset.

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- .5 Trouble on system to:
 - .1 Indicate circuit in trouble at central control unit.
 - .2 Activate "system trouble" indication, buzzer and common trouble sequence. Acknowledging trouble condition to silence audible indication; whereas visual indication to remain until trouble is cleared and system is back to normal.
- .6 Trouble on system: suppressed during course of alarm.
- .7 Trouble condition on any circuit in system not to initiate alarm conditions.

2.3 Control Panel

- .1 Central control unit (CCU):
 - .1 Suitable for Data Communication Link style C (DCL-C) unless otherwise noted on the drawings: to CAN/ULC-S524.
 - .2 Features specified are minimum requirements for microprocessor-based system with digital data control and digital multiplexing techniques for data transmission.
 - .3 Minimum capacity of 1000 addressable monitoring and 500 addressable control/signal points. Points may be divided between 2 communication channels in distributed system, each channel operating independently of other. Faults on one communication channel not to affect operation of other channel.
 - .4 System to provide for priority reporting levels, with fire alarm points assigned highest priority, supervisory and monitoring lower priority, and third priority for troubles. Possible to assign control priorities to control points in system to guarantee operation or allow emergency override as required.
 - .5 Integral power supply, battery charger and standby batteries.
 - .6 Basic life safety software: retained in non-volatile Erasable Programmable Read-Only-Memory (EPROM). Extra memory chips: easily field-installed. Random-Access-Memory (RAM) chips in panel to facilitate password-protected field editing of simple software functions (e.g. zone labels, priorities) and changing of system operation software.
 - .7 Circuitry to continuously monitor communications and data processing cycles of microprocessor. Upon failure, audible and visual trouble indication to activate.
 - .8 Communication between CCU and remote DGP's/TPR's to be supervised, DCLA. Should communications fail between CCU and remote units, audible and visual trouble to be indicated at CCU. Data communication to be binary DC, baseband, time-division multiplex, half-duplex. Each data channel: capable of communicating up to distance of 3,000 m.
 - .1 Communication between nodes in networked system to be supervised, DCLA. Should communications fail between any 2 nodes, other nodes on loop to continue to communicate with each other and programmed functions on communicating nodes to continue operating.
 - .9 Support up to 4 RS-232-C I/O ports. CCU output: parallel ASCII with adjustable baud rates to allow interface of any commercially available printer, terminal or PC.

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- .10 Equipped with software routines to provide Event-Initiated-Programs (EIP); change in status of one or more monitor points, may be programmed to operate any or all of system's control points.
- .11 Software and hardware to maintain time of day, day of week, day of month, month and year.
- .12 On-board, 20-column, DC strip printer, thermal head with automatic paper take-up, and silent operation; operational while system is operating on standby power. Expanded font available for selected printing conditions.
- .13 Printer to record activities on system controlled by EIA RS-232-C link from within CCU.
- .14 Software to operate variable sensitivity addressable smoke detectors and annunciate their status and sensitivity settings at control panel.

2.4 Power Supplies

- .1 120V, 60 Hz as primary source of power for system. The circuit shall be labelled at the main power distribution panel as FIRE ALARM. The fire alarm disconnect must be locked, a locked electrical room or panel door does not constitute the lock for the disconnect.
- .2 Voltage regulated, current limited distributed system power.
- .3 Primary power failure or power loss (less than 102 V) will activate common trouble sequence.
- .4 Interface with battery charger and battery to provide uninterruptible transfer of power to standby source during primary power failure or loss.
- .5 Abnormal operating conditions such as a fault in battery charging circuit, short or open in the battery leads, shall activate a common trouble sequence and standby power trouble indicator.
- .6 Standby batteries: 5 year NiCad sealed, maintenance free.
- .7 Continuous supervision of wiring for external initiating and alarm circuits are to be maintained for 24 hrs with capability of maintaining alarm activation for a minimum of 2 hrs, immediately following 24 hrs of supervision.

2.5 Initiating/Input Circuits

- .1 Receiving circuits for alarm initiating devices such as manual pull stations, smoke detectors, heat detectors and water flow switches, wired in DCL-C, as per CAN/ULC-S524, configuration to central control unit or DGP's/transponders.
- .2 Alarm receiving circuits (active and spare) are to be compatible with smoke detectors and open contact devices.
- .3 Actuation of alarm initiating device is to cause system to operate as specified in "System Operation".
- .4 Receiving circuits for supervisory devices are to be wired in DCL-A configuration to central control unit or DGP's/transponders.
- .5 Actuation of supervisory initiating device is to cause the system to operate as specified in "System Operation".

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- .6 Sprinkler devices such as pressure switches and flow switches are to have the tamper switch wired after the switch and before the EOL, to create a trouble condition while still allowing the device to electrically initiate its respective zone.
- .7 Low room temperature devices are to be provided in sprinkler rooms whenever a dry sprinkler system is provided.

2.6 Alarm Output Circuits

- .1 Alarm output circuits are to be connected to signals, wired in class A configuration to the central control unit .
- .2 The signal circuits' operation is to be capable of sounding bells, horns as required. Each signal circuit: rated at 2 A, 24 VDC; fuse-protected from overloading/overcurrent.
- .3 Manual alarm silence, automatic alarm silence and alarm silence inhibit is to be provided by system's common control.
- .4 Separate circuits shall be provided for audible signal devices on each floor area.
- .5 Provide 25% spare capacity in visual signal device circuits to allow for site adjustments of visual signal device candela ratings.

2.7 Auxiliary Circuits

- .1 Auxiliary contacts for control functions.
- .2 Actual status indication (positive feedback) from controlled device.
- .3 Alarm or supervisory trouble on system to cause operation of programmed auxiliary output circuits.
- .4 Upon resetting system, auxiliary contacts are to return to normal or to operate as pre-programmed.
- .5 Fans: stagger-started upon system reset; timing circuit to separate starting of each fan or set of fans connected to auxiliary contact on system. Timing circuit: controlled by CCU.
- .6 Auxiliary circuits: rated at 2 A, 24 V dc or 120 V ac, fuse-protected.

2.8 Wiring

- .1 All fire alarm system wiring must be new.
- .2 Twisted copper conductors: 300 V CSA FAS minimum 105 deg. C with FT4 rating and in mechanical protection i.e. EMT or flex as specified under Section 26 05 34 - CONDUITS, CONDUIT FASTENERS AND FITTINGS.
- .3 To initiating circuits: 18 AWG minimum, and in accordance with manufacturer's requirements.
- .4 To signal circuits: 16 AWG minimum, and in accordance with manufacturer's requirements.
- .5 To control circuits: 14 AWG minimum, and in accordance with manufacturer's requirements.
- .6 All initiating circuits are to be wired in a DCL-C (i.e. Class A) configuration.

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- .7 All output circuits are to be wired in a Class B configuration, unless otherwise shown on drawings.
- .8 All wiring between junction boxes and water flow switch, pressure switch, or supervisory switches will be in liquid tight flexible conduit.
- .9 Where a fire alarm transponder or annunciator located in one fire compartment is connected to a central processing unit or another transponder or annunciator located in a different fire compartment, the data communication link conductors connecting them shall be fire rated for at minimum one (1) hour. Where fire alarm system branch circuits connect transponders and individual fire alarm devices located on another storey, the branch circuits shall be fire rated for at minimum one (1) hour between the transponder and the first fire alarm device located on another storey than the transponder. Provide twisted, shielded pair Mineral-Insulated fire rated cables configured to eliminate interference and cross-talk, except where fire alarm riser diagram clearly illustrates another fire rating approach for particular conductors.

2.9 Manual Alarm Stations

- .1 Addressable manual pull station.
 - .1 Pull lever, break glass rod, semi-flush wall mounted type, single stage, electronics to communicate station's status to addressable module/transponder over 2 wires and to supply power to station. Station address to be set on station in field.

2.10 Automatic Alarm Initiating Devices

- .1 Addressable thermal fire detectors, combination fixed temperature and rate of rise, non-restorable fixed temperature element, self-restoring rate of rise, fixed temperature 57 deg. C., rate of rise 8.3 deg. C. per minute:
 - .1 Electronics to communicate detector's status to addressable module/transponder.
 - .2 Detector address to be programmed on site.
- .2 Addressable Smoke detector: photo electric:
 - .1 Twistlock plug-in type with fixed base.
 - .2 Wire-in base assembly with integral red alarm LED.
 - .3 Auxiliary output contact.
- .3 Addressable Duct type smoke detectors: photo-electric with sampling tubes:
 - .1 Twistlock plug-in type with fixed base.
 - .2 Wire-in base assembly with integral red alarm LED.
 - .3 Auxiliary output contact.
 - .4 Properly sized air sampling tubes.
- .4 Addressable variable-sensitivity smoke detectors:
 - .1 Photo-electric type.
 - .2 Electronics to communicate detector's status to addressable module/transponder.

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- .3 Detector address to be set on detector head in field.
- .4 Sensitivity settings: 3 settings determined and operated by control panel. No shifting in detector sensitivity due to atmospheric conditions (dust, dirt) within certain parameters.
- .5 Ability to annunciate minimum of 2 levels of detector contamination automatically with trouble condition at control panel.
- .6 Auxiliary output contact.
- .5 Water flow switches: lever and pressure type:
 - .1 Shall have a mechanical alarm transmitted delay adjustable from 0-60 seconds. Initial settings shall be 30-45 seconds. Times will be recorded and submitted to Contract Administrator.
 - .2 The tamper switch located within the water flow switch shall be wired as per manufacturer's recommendations such that if the housing is open a latching trouble will be initiated.
- .6 Sprinkler and standpipe valve supervisory switches:
 - .1 The tamper switch located within the supervisory switch shall be wired as per manufacturer's recommendations such that if the housing is open a latching trouble will be initiated.

2.11 Audible Signal Devices

- .1 In sleeping rooms in a building of residential (Group C) or care (Group B, Division 3) occupancy, provide audible signal devices that emit a low frequency signal in the range of 470 Hz to 570 Hz, in accordance with Building Code requirements.
- .2 Horns: 24 V dc, indoor horn type with compression driver, surface mounted.
 - .1 Corrosion, vibration and vermin resistant.
 - .2 Taps: multiple, adjustable with maximum tap output sound level of 100 dB at 3 m.
 - .3 Frequency response: 400 to 4000 Hz.
- .3 Weatherproof Horns: 24 V dc, for use primarily in mechanical equipment areas, both indoor and outdoor. Horn type with compression driver, surface mounted.
 - .1 Corrosion, vibration and vermin resistant.
 - .2 Frequency response: 400 to 4000 Hz.
 - .3 Complete with weatherproof box as recommended by manufacturer.
 - .4 High output 40 mA @ 24 Vdc, Low output 20 mA @ 24 Vdc.

2.12 Visual Alarm Signal Devices

- .1 Visual signal device type: white flashing light, wall mount or ceiling mounted as per drawings.
 - .1 Synchronized at one flash per second.
 - .2 Flash tube enclosure in clear LEXAN.
 - .3 "FIRE" installed red letters.

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- .4 Operating on 20-24 V dc.
- .5 Field adjustable for 15 cd, 30 cd, 75 cd, 95 cd, 110 cd, and 115 cd, unless specified otherwise.
- .2 Fire do not enter signs and their accessories:
 - .1 Compliant with CAN/ULC-S527 "Standard for Control Units for Fire Alarm Systems" and/or CAN/ULC S526 "Standard for Visual Signal Devices for Fire Alarm and Signaling Systems, Including Accessories."
 - .2 Powered by fire alarm system; operating on 24 V dc.
 - .3 Fire alarm signaling device.

2.13 Combination Audible And Visual Signal Devices

- .1 Combination Horn Strobes, complying with the requirements noted above for: Audible Signal Devices and Visual Alarm Signal Devices.

2.14 End-Of-Line Devices

- .1 End-of-line devices to control supervisory current in alarm circuits and signalling 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.

2.15 Remote Annunciators

- .1 LED type, with designation cards to indicate zones.
- .2 Display:
 - .1 Alarms for alarm initiating circuits.
 - .2 Common supervisory alarm for supervisory initiating circuits.
 - .3 Common system trouble.
- .3 Trouble buzzer:
 - .1 Acknowledging trouble at main panel to silence trouble buzzers in system.
- .4 Supervised, with LED test button.
- .5 Interconnected with main fire alarm panel at minimum.

2.16 Remote Printer

- .1 System printer: to give a hard copy record of system events c/w following features:
 - .1 120V ac, 60 Hz.
 - .2 80 columns.
 - .3 160 cps.
 - .4 Utilizes fan fold paper.
 - .5 Connected to RS-232 output at central control panel.

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2.17 Isolation Module

- .1 Provide isolation modules in accordance with CAN-ULC-S524.
 - .1 Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an DCL-C branch. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the DCL segment branch.
 - .2 If a wire-to-wire short occurs, the isolator module shall automatically disconnect the DCL-C segment. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.
 - .3 The isolation module will provide a single LED that flashes to indicate the isolation module is operating and illuminate steadily to indicate that a short circuit condition has been detected and isolated.

2.18 Central Alarm Monitoring

- .1 Provide Signal Transmitting Unit that utilizes internet connection as primary communications method and cellular network as secondary (back-up) communications method.
 - .1 Provide remote antenna for cellular network reception for Signal Transmitting Unit, if location of Signal Transmitting Unit in the building does not facilitate adequate cellular network strength.
- .2 Provide a demarcation point; refer to CAN-ULC-S524 Annex E.
- .3 Provide monitoring of the system including alarm zones, supervisory zones, and trouble signals.

2.19 Programmed Features:

- .1 By-pass feature for signalling devices:
 - .1 Bypassing of audible devices shall be provided through the programmable keys. The use of the feature is intended for personnel with programming access.
- .2 Evacuation feature.
 - .1 Evacuation key will be programmed and accessible for any personnel working on the fire alarm panel.

2.20 Fire Alarm Zone Passive Graphic Display:

- .1 Layout
 - .1 The fire alarm zone passive graphic display shall be completed in the latest version of AutoCAD. The drawing shall indicate all the building floor plans and respective fire alarm zones with the description corresponding to the zone indication at the fire alarm control panel and annunciator.
 - .2 The fire alarm zones indicated for each floor shall be clearly defined with borders to indicate zone separation.
 - .3 The general font style shall be Helvetica upper case. Text size:
 - .1 6 mm in height for building name and 4.5 mm for municipal address and floor plans all coloured green.

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- .2 Main entrance arrow and text shall be Romans forward slant style 3 mm in height coloured cyan.
- .3 Fire alarm zones and equipment notes shall be 3 mm in height coloured red.
- .4 Fire hose cabinets shall be Romans forward slant style 3 mm in height coloured cyan.
- .4 Graphic display colours.
 - .1 Outline of building plan to be black line on white background.
 - .2 All egress corridors shall be clearly defined with Red colour #13 solid hatch pattern.
 - .3 All stairs and elevators shall be indicated using yellow solid hatch pattern.
- .5 Include the following information on the graphic display:
 - .1 A north arrow on the upper left corner of the zone graphic.
 - .2 "You are here" location in Red and properly orientated to the viewer when standing in front of the graphic.
 - .3 A drawing scale graph and drawing file number located in the lower right of the zone graphic.
 - .4 Building name and number at the bottom centre of the graphic display with municipal address indicated on the next line below.
 - .5 The main building entrance and street reference.
 - .6 Location of fire alarm control panel and annunciators, fire department connections, fire pumps, fire hose cabinets and associated standpipe and sprinkler valves.
 - .7 Location of main gas valve, suppression systems, chemical storage vaults, major mechanical equipment and duct smoke detectors indicating zone number.
 - .8 Substation and transformer locations indicating primary and secondary voltages.
- .2 Construction
 - .1 The graphic display shall be:
 - .1 Printed on white heavy weight 40lb. coated bond with colour UV inks, laminated on 1.5 mm styrene board and covered with clear Lexan.
 - .2 Standard passive graphic display size ranges from 8.5"x11" to 23"x35". The final size of the graphic may vary depending on the layout requirements and site conditions.
 - .2 Trim to be No. 4 stainless steel finish.
- .3 Location
 - .1 Install graphic display adjacent to each fire alarm annunciator panel and the fire alarm control panel.

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- .2 Graphic display to be fixed to the building structure or fire alarm control panel enclosure using tamper proof screws at each corner and at the midpoint on all four sides.
- .4 Approval Drawings
 - .1 Submit three full colour print copies of the passive display graphic for review by The City, the Contract Administrator and the local fire department.
 - .2 Include the final approved zone graphic drawing in electronic format with the as-built drawings.

2.21 Ancillary Devices

- .1 Remote relay unit to initiate fan shutdown and door hold open devices.

2.22 STI Steel Web Stoppers, Detector Covers.

2.23 Provide STI 9600 series detector cover for areas where sporting events or similar activities avail. STI Stopper 2 & Weather Proof Stopper 2, Covers For Manual Stations.

- .1 Provide STI Stopper 2 1100 series manual station covers for all vandal resistant locations identified on the electrical and architectural drawings.
- .2 Provide Weather Proof Stopper 2 1200 (flush mount) or 3100 (surface mount) series manual station covers for all weather proof locations and outdoor applications identified on the electrical and architectural drawings.

2.24 Relay Base, For Fire Detectors.

- .1 Provide power along with the relay base detector such that the device that is being controlled with the normally open or normally closed relay base may operate or function. Power requirements and relay condition to be determined on site.

2.25 Manufacturers

- .1 The following are acceptable manufacturers:
 - .1 Mircom.

PART 3 - EXECUTION

3.1 Installation

- .1 Install systems in accordance with CAN/ULC-S524.
- .2 Install central control unit and connect to ac power supply.
- .3 Install manual alarm stations and connect to alarm circuit wiring.
- .4 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. Install duct type detectors complete with sampling tubes. Ensure duct type smoke detectors are installed far enough away from humidifiers to avoid false alarms; coordinate location of duct type smoke detector with Mechanical Subcontractor. If false alarms occur, relocate duct type smoke detector at no cost to The City.

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- .5 Connect alarm circuits to main control panel.
- .6 Install bells, horns and visual signal devices and connect to signalling circuits.
- .7 Connect signalling circuits to main control panel.
- .8 Adjust visual signal device candela ratings upward, where required to meet coverage. Utilize spare visual signal device circuit capacity required in Part 2.
- .9 Install end-of-line devices.
- .10 Install remote annunciator panels and connect to annunciator circuit wiring.
- .11 Install door releasing devices.
- .12 Install remote relay units to control fan shut down.
- .13 Where smoke dampers or combination smoke and fire dampers are shown, terminate damper position monitoring wiring for both fire alarm system and building automation system on damper actuator position end switches. Building automation system wiring to damper location will be provided by Mechanical Division.
- .14 Sprinkler system: wire alarm and supervisory switches and connect to control panel.
 - .1 Sprinkler devices should be wired such that opening of a device will cause a trouble on an alarming device or a supervisory on a supervising device.
 - .2 Where Mechanical/Sprinkler Subcontractor makes revisions to the base design, Electrical Subcontractor shall coordinate any revisions to fire protection system directly with the Mechanical/Sprinkler Subcontractor at no cost to The City and update as-built drawings accordingly.
- .15 Room detection system (where applicable):
 - .1 Install detectors. Make necessary connections between room detection panel and main fire alarm panel.
 - .2 Locate and install audible signals and visual alarms.
 - .3 Locate and install detectors under raised floor. Fasten to steel brackets approximately 300 mm above sub-floor level to clear cables and conduits.
- .16 Connect fire suppression systems to control panel.
- .17 'T-Tapping' is not permitted.
- .18 For audible and visual signal devices in spaces subject to future tenant renovations, install devices in surface mounted boxes and leave 3 m of extra wiring coiled up in the box to allow the devices to be lowered / relocated to suit the tenant fit up ceiling and wall locations.
- .19 Provide necessary raceways, cable and wiring to make interconnections to terminal boxes, annunciator equipment and CCU, as required by equipment manufacturer.
- .20 Ensure that wiring is free of opens, shorts or grounds, before system testing and handing over.
- .21 Identify circuits and other related wiring at central control unit, annunciators, and terminal boxes.

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- .22 Where devices are to be installed in environments where the temperature can drop below 0°C (or below the addressable device temperature rating), an appropriately rated conventional device is to be installed.
 - .1 Provide and install an addressable input module remotely located in a conditioned environment suitable for the device temperature rating.
 - .2 Connect the conventional device(s) to addressable input module(s) as necessary to monitor the status of the conventional device.
- .23 Where shown on Drawings, install "Fire do not enter signs" in accordance with the requirements of CAN/ULC-S524.

3.2 Field Quality Control and Commissioning

- .1 The installing subcontractor is responsible for hiring and coordinating with the manufacturer to perform the following:
 - .1 Testing of system to CAN/ULC-S536 prior to performing verification.
 - .2 Partial verification inspection to CAN/ULC-S537 and reports as required for partial occupancy.
 - .3 Complete an entire building test to CAN/ULC-S536 and provide detailed report. Provide a full verification inspection and test report at the end of the project. Cumulative partial verification reports do not constitute a full verification.
- .2 All fire alarm test and verification reports are to be submitted with a covering letter from the manufacturer clearly stating that there are no deficiencies with the installation prior to releasing the respective area for occupancy.
- .3 Include fire alarm audible signal device sound pressure levels, on a space by space / room by room basis, as part of the fire alarm verification report.
 - .1 Test sound pressure levels when any intervening doors between the device and the rest of the floor area are closed, in accordance with the intent and requirements of the Building Code.

3.3 Life Safety Integration Testing

- .1 The Fire Alarm Subcontractor and fire alarm manufacturer shall participate in the coordination and testing work associated with the Integrated Testing Plan (ITP), as described in more detail in Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS. All work shall be coordinated with the Integrated Testing Coordinator (ITC). The work shall include but not be limited to:
 - .1 Perform functional testing of the integration of all life safety and fire protection systems as a whole to ensure the proper operation and interconnection between the systems.
 - .2 Testing of the integrated life safety systems must be done as a complete installed assembly; individual component testing or partially installed assembly testing is not acceptable.
 - .3 Follow the testing methodology for verifying and documentation of operation as outlined in the ITP and in accordance with CAN/ULC-S1001.

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- .4 Provide fire alarm verification report along with all other documentation requested by the ITC as it relates to the electrical systems in conformance with CAN/ULC-S1001.

3.4 Central Alarm Monitoring

- .1 Locate Signal Transmitting Unit in same room as main fire alarm panel unless shown otherwise on Drawings.
- .2 Provide a data connection from The City's network for internet access for central monitoring.
- .3 Coordinate with The City's Fire Alarm Monitoring Company and install power, conduit and wiring to the Signal Transmitting Unit in compliance with CAN/ULC-S559 and CAN/ULC S561.
- .4 Facilitate conversation between The City and The City's preferred fire alarm central alarm monitoring service to ensure that central monitoring service is provided in time for completion of fire alarm scope and Project occupancy.

END OF SECTION

MULTIPLEX FIRE ALARM AND VOICE COMMUNICATION SYSTEM

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
- .3 Section 26 05 34 – CONDUITS, CONDUIT FASTENERS AND FITTINGS.
- .4 Section 26 05 21 – WIRES AND CABLES UNDER 2000 V.

1.2 References

- .1 CAN/ULC-S524, Installation of Fire Alarm Systems, latest edition.
- .2 CAN/ULC-S536, Inspection and Testing of Fire Alarm Systems, latest edition.
- .3 CAN/ULC-S537, Verification of Fire Alarm Systems, latest edition.
- .4 CAN/ULC-S1001, Integrated Systems Testing of Fire Protection and Life Safety Systems, latest edition.
- .5 CAN/ULC-S553, Standard for Installation of Smoke Alarms, latest edition.
- .6 CSA C22.2 No. 124, Mineral-Insulated Cable, latest edition.
- .7 CAN/ULC-S559, Standard for Equipment for Fire Signal Receiving Centres and Systems, latest edition.
- .8 CAN/ULC-S561, Standard for Installation and Services for Fire Signal Receiving Centres and Systems, latest edition.

1.3 System Description

- .1 This section is only applicable to the recreational center fire alarm system.
- .2 All equipment and components shall be new, and the manufacturer's current model.
- .3 Manual pull stations, speakers and firemen's handsets will be provided at all required exit stairs.
- .4 Speakers will be used throughout the building.
- .5 Panels will be tied into security panels, and auxiliary and ancillary devices.
- .6 Elevator shafts will have a weatherproof heat detector located in the pit along with a smoke detector located at the top of the shaft.
- .7 Emergency power feed from generator(s) or inverter(s) shall have two supervisory zones each, monitoring Generator Running and Generator General Trouble.
- .8 Fully supervised, addressable, microprocessor-based, fire alarm system, utilizing digital techniques for data control and digital, and multiplexing techniques for data transmission.
- .9 System to carry out fire alarm and protection functions; including receiving alarm signals; initiating general and two-stage alarm; supervising components and wiring; actuating annunciators and auxiliary functions; initiating trouble signals and signalling to monitoring agency.

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- .10 Zoned, non-coded two-stage.
- .11 Modular in design to allow for future expansion.
- .12 Operation of system shall not require personnel with special computer skills.
- .13 System to include:
 - .1 Central Control Unit in separate enclosure with power supply, stand-by batteries, central processor with microprocessor and logic interface, main system memory, input-output interfaces for alarm receiving, annunciation/display, and program control/signaling.
 - .2 Power supplies.
 - .3 Initiating/input circuits.
 - .4 Output circuits.
 - .5 Auxiliary circuits.
 - .6 Wiring.
 - .7 Manual and automatic initiating devices.
 - .8 Audible and visual signaling devices.
 - .9 Local and remote annunciators.
 - .10 Printer and event log memory chip.
 - .11 Historic event recorder.
 - .12 Isolation modules.
 - .13 Central alarm monitoring.
 - .14 Programmed features.
- .14 Recreation center fire alarm system to tie to childcare fire alarm system to annunciate general alarm.

1.4 Requirements Of Regulatory Agencies

- .1 System components shall be listed by ULC/CSA and comply with applicable provisions of the building code, and meet requirements of local authority having jurisdiction.

1.5 Shop Drawings And Product Data

- .1 Submit Shop Drawings and product data in accordance with Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
- .2 Include:
 - .1 Detail assembly and internal wiring diagrams for control units and auxiliary cabinets.
 - .2 Overall system riser wiring diagram identifying control equipment initiating zones, signaling circuits; and identifying terminations, terminal numbers, conductors and raceways.
 - .3 Details for devices.

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- .4 Details and performance specifications for control, annunciation and peripherals with item by item cross reference to specification for compliance.
- .5 Step-by-step operating sequence, cross referenced to logic flow diagram.
- .6 Submit battery sizing calculations and battery selection.

1.6 Operation And Maintenance Data

- .1 Provide operation and maintenance data for fire alarm system for incorporation into the O&M manual.
- .2 Include:
 - .1 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 with corrections completed and marks removed except review stamps.
 - .4 List of recommended spare parts for system.
 - .5 Detailed sequence of operation or operational matrix.
 - .6 Full fire alarm verification inspection report.
 - .7 USB stick, containing electronic version of fire alarm passive graphic both in PDF and CAD, as part of O&M manual.

1.7 Maintenance Materials

- .1 Include:
 - .1 Spare glass rods for manual pull stations, if applicable.
 - .2 Key for fire alarm panel, remote annunciator, and pull stations.
 - .3 Specialty tool for resetting sprinkler supervisory, if applicable.
 - .4 Spare fuses for control circuits.
 - .5 Beam detector calibrated test filters (if applicable).

1.8 Warranty

- .1 Provide a one year warranty from total performance including all materials, parts, and labour. Be responsible for correcting any deficiencies that are discovered during the one year warranty period, including any that are discovered by The City's first annual inspection and test to CAN/ULC-S536.

1.9 Training

- .1 Provide on-site lectures and demonstration by fire alarm equipment manufacturer to train operational personnel in use and maintenance of fire alarm system.

PART 2 - PRODUCT

2.1 Materials

- .1 Equipment and devices: ULC listed, labelled and supplied by single manufacturer.

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- .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.
- .10 Speakers: to CAN/ULC-S541.
- .11 Signal Transmitting Units and Monitoring: to CAN/ULC-S559 and CAN/ULC-S561.

2.2 System Operation: Voice Communication - 2 Stage - 3 Channel; Non-High Building; One Way Voice Communication System

- .1 Actuation of any alarm initiating device on first stage to:
 - .1 Cause electronic latch to lock-in alarm state at central control unit and data gathering panel/transponder.
 - .2 Indicate zone of alarm at central control unit and at the remote annunciator.
 - .3 Cause audible signaling devices to sound at 20 strokes per minute in ALERT tone throughout the building.
 - .4 Transmit signal to fire department via central station.
 - .5 Cause air conditioning and ventilation fans serving more than one: storey, suite in a storey, or fire compartment, to shut down.
 - .6 Cause supply and/or exhaust fans to function automatically to provide required control of smoke movement per the mechanical smoke control matrix (if applicable).
 - .7 Cause fire doors and smoke control doors, if normally held open, to close automatically.
- .2 Emergency elevator recall:
 - .1 Actuation of any alarm initiating devices in elevator lobbies, elevator machine room, elevator pit, or top of hoistway to cause elevators to return to primary recall floor, or to alternate recall floor, as required. Elevator recall shall not be activated upon alarms from manual pull stations or on general fire alarm condition.
- .3 Actuation of any alarm initiating device on second stage to:
 - .1 Cause speakers to sound continuously in ALARM evacuation tone throughout building.
- .4 If first stage alert is not acknowledged within 5 minutes, system to automatically go into second stage alarm.

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- .5 Possible to transmit voice message from central control unit to specific zone or group of zones, while maintaining ALERT or ALARM tones to other zones, by means of master microphone and specific zone switches to silence tones in selected zones and allow one-way voice messages over system speakers. Releasing microphone switch and returning zone switches back to original position shall re-activate tones on speakers in zones, unless tones have been silenced. Audio channel available to each speaker circuit to be automatically and dynamically selected by microprocessor. Manual selection and operation of evacuation tones / emergency paging to be provided on a floor by floor basis. The visual signal devices shall not be interrupted while voice messages/instructions are being transmitted.
- .6 Acknowledging alarm: indicated at central control unit.
- .7 Possible to silence signals by "alarm silence" switch at central control unit, after a minimum 20 minute period of operation.
- .8 Subsequent alarm, received after previous alarm has been silenced, to re-activate signals.
- .9 Actuation of any supervisory device to:
 - .1 Cause electronic latch to lock-in supervisory state at central control unit and data gathering panel/transponder.
 - .2 Indicate respective supervisory zone at central control unit and remote annunciator.
 - .3 Cause audible signal at central control unit to sound.
 - .4 Activate common supervisory sequence.
- .10 Resetting alarm or supervisory device not to return system indications/functions back to normal until control unit has been reset.
- .11 Trouble on system to:
 - .1 Indicate circuit in trouble at central control unit.
 - .2 Activate "system trouble" indication, buzzer and common trouble sequence. Acknowledging trouble condition to silence audible indication; visual indication to remain until trouble is cleared and system is back to normal.
- .12 Suppress troubles on system during course of alarm.
- .13 Trouble condition on any circuit in system shall not initiate alarm conditions.

2.3 Control Panel

- .1 Central control unit (CCU):
 - .1 Suitable for Data Communication Link Style C (DCL-C) unless otherwise noted on the drawings: to CAN/ULC-S524.
 - .2 Features specified are minimum requirements for microprocessor-based system with digital data control and digital multiplexing techniques for data transmission.
 - .3 Minimum capacity of 2000 addressable monitoring and 500 addressable control/signal points. Points may be divided between 2 communication channels in distributed system, each channel operating independently of other. Faults on one communication channel not to affect operation of other channel.

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- .4 System to provide for priority reporting levels, with fire alarm points assigned highest priority, supervisory and monitoring lower priority, and third priority for troubles. Possible to assign control priorities to control points in system to guarantee operation or allow emergency override as required.
- .5 Integral power supply, battery charger and standby batteries.
- .6 Circuitry to continuously monitor communications and data processing cycles of microprocessor. Upon failure, audible and visual trouble indication to activate.
- .7 Communication between CCU and remote DGP's/TPR's to be supervised, DCLA. Should communications fail between CCU and remote units, audible and visual trouble to be indicated at CCU. Data communication to be binary DC, baseband, time-division multiplex, half-duplex. Each data channel: capable of communicating up to distance of 3,000 m.
- .8 Communication between nodes in networked system to be supervised, DCLA. Should communications fail between any 2 nodes, other nodes on loop to continue to communicate with each other and programmed functions on communicating nodes to continue operating.
- .9 Support up to 4 RS-232-C I/O ports. CCU output: parallel ASCII with adjustable baud rates to allow interface of any commercially available printer, terminal or PC.
- .10 Equipped with software routines to provide Event-Initiated-Programs (EIP); change in status of one or more monitor points, may be programmed to operate any or all of system's control points.
- .11 Software and hardware to maintain time of day, day of week, day of month, month and year.
- .12 Software to operate variable sensitivity addressable smoke detectors and annunciate their status and sensitivity settings at control panel.
- .2 Two-way voice communication system:
 - .1 Two-way voice communication to each floor or zone via emergency telephone. Master telephone and power supply housed in central control panel, c/w flexible, coiled, self-winding 1.5 m extension cord.
 - .2 Manual selection of telephone circuits on floor by floor basis. Each telephone circuit to have own selection switch at control panel. Incoming call from remote telephone to activate call-in signal and flash circuit status indicator. Lifting master handset and operating circuit selector switch to illuminate circuit status indicator steady, and connect circuit to telephone voice channel, selected by microprocessor at control panel. Subsequent call-ins indicated with flashing indicator at control panel, but not connected until their circuit selector switch is activated.
 - .3 Permit announcements / voice messages to be made from remote telephone to selected zones over system speakers, through phone/paging interface at control panel.

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2.4 Power Supplies

- .1 120V, 60 Hz as primary source of power for system. The circuit shall be labelled at the main power distribution panel as FIRE ALARM. The fire alarm disconnect must be locked, a locked electrical room or panel door does not constitute the lock for the disconnect, and painted red.
- .2 Voltage regulated, current limited distributed system power.
- .3 Primary power failure or power loss (less than 102 V) will activate common trouble sequence.
- .4 Interface with battery charger and battery to provide uninterruptible transfer of power to standby source during primary power failure or loss.
- .5 Abnormal operating conditions such as a fault in battery charging circuit, short or open in the battery leads, shall activate common trouble sequence and standby power trouble indicator.
- .6 Standby batteries: 5 years NiCad sealed, maintenance free.
- .7 Continuous supervision of wiring for external initiating and alarm circuits are to be maintained for 24 hrs with capability of maintaining alarm activation for a minimum of 2 hrs, immediately following 24 hrs of supervision.

2.5 Initiating/Input Circuits

- .1 Receiving circuits for alarm initiating devices such as manual pull stations, smoke detectors, heat detectors and water flow switches, wired in DCLC with isolation modules, as per CAN/ULC-S524, configuration to central control unit or DGP's/transponders.
- .2 Alarm receiving circuits (active and spare) are to be compatible with smoke detectors and open contact devices.
- .3 Actuation of alarm initiating device is to cause system to operate as specified in "System Operation".
- .4 Receiving circuits for supervisory, N/O devices are to be wired in DCLA configuration to central control unit or DGP's/transponders.
- .5 Actuation of supervisory initiating device is to cause the system to operate as specified in "System Operation".
- .6 Sprinkler devices such as pressure switches and flow switches are to have the tamper switch wired after the switch and before the EOL, to create a trouble condition while still allowing the device to electrically initiate its respective zone.
- .7 Low room temperature devices are to be provided in sprinkler rooms whenever a dry sprinkler system is provided.

2.6 Alarm Output Circuits

- .1 Alarm output circuit are to be connected to signals, wired in class A configuration to the central control unit or DGP's/transponders.
- .2 The signal circuits' operation is to be capable of sounding bells, horns as required. Each signal circuit: rated at 3 A, 24 VDC; self-protected from overloading/overcurrent.
- .3 Manual alarm silence, automatic alarm silence and alarm silence inhibit is to be provided by system's common control.

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- .4 Speaker circuits operation: follow system programming; capable of reproducing tones and voice fed by audio channels.
- .5 Audio channel available to each speaker circuit to be automatically and dynamically selected by system's microprocessor.
- .6 Manual selection and operation of alarm tones to be provided on floor by floor basis.
- .7 Manual selection for emergency paging to be provided on floor by floor basis.
- .8 Proprietary evacuation control switch to be provided to bypass automatic system programming, once manual control of the system has been assumed by authorized personnel.
- .9 Separate circuits shall be provided for audible signal devices on each floor area.
- .10 Audible signal devices within dwelling units or suites of residential occupancy shall be wired on separate signal circuits from those not within suites of residential occupancy or dwelling units.
- .11 Provide a manual signal silence switch within dwelling units or suites of residential occupancy. The switch will silence the local annunciation until the next announcement or new alarm.
- .12 Provide 25% spare capacity in visual signal device circuits to allow for site adjustments of visual signal device candela ratings.

2.7 Auxiliary Circuits

- .1 Auxiliary contacts for control functions.
- .2 Actual status indication (positive feedback) from controlled device.
- .3 Alarm or supervisory trouble on system to cause operation of programmed auxiliary output circuits.
- .4 Five sets of separate contacts for elevator fire alarm recall, for each elevator or bank of elevators sharing a common shaft and common fire detectors:
 - .1 Elevator recall to primary floor, from elevator lobby smoke detectors on all floors except primary recall floor.
 - .2 Elevator top of shaft detection signal to elevator controller.
 - .3 Elevator pit detection signal to elevator controller.
 - .4 Elevator machine room detector signal to elevator controller.
 - .5 Elevator recall to alternate floor, from elevator lobby smoke detector(s) at primary recall floor.
- .5 Upon resetting system, auxiliary contacts are to return to normal or to operate as pre-programmed.
- .6 Fans: stagger-started upon system reset; timing circuit to separate starting of each fan or set of fans connected to auxiliary contact on system. Timing circuit: controlled by CCU.
- .7 Auxiliary circuits: rated at 2 A, 24 V dc or 120 V ac, fuse-protected.

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2.8 Amplifiers

- .1 Modular in construction, solid state in design, with power output of 70 V RMS, for constant voltage distribution to speaker circuits.
- .2 Continuously supervised for proper operation. Loss of power, open or short circuit on input or output of amplifier, or total amplifier failure, to activate trouble sequence at central control unit with visual indication.
- .3 Integral power supply, powered through system power supply, housed in central control unit and supported by standby batteries in case of power failure.
- .4 Riser amplifiers: housed in central control unit, with outputs connected to voice communication risers.
- .5 Standby amplifiers: sized to meet requirements of largest amplifier, with automatic transfer to be on a priority basis.
- .6 Amplifiers shall have 25% spare capacity for future expansion.

2.9 Wiring

- .1 All fire alarm system wiring must be new.
- .2 Twisted copper conductors: 300 V CSA FAS minimum 105 deg. C with FT4 rating and in mechanical protection i.e. EMT or flex as specified under Section 26 05 34 - CONDUITS, CONDUIT FASTENERS AND FITTINGS. To initiating circuits: 18 AWG minimum, and in accordance with manufacturer's requirements.
- .3 To signal circuits: 16 AWG minimum, and in accordance with manufacturer's requirements.
- .4 To control circuits: 14 AWG minimum, and in accordance with manufacturer's requirements.
- .5 To speaker circuits: twisted, shielded pairs, and in accordance with the manufacturer's requirements.
- .6 To telephone circuits: twisted, shielded pairs, and in accordance with the manufacturer's requirements.
- .7 All initiating circuits are to be wired in a DCL-C (i.e. Class A) configuration.
- .8 All output circuits are to be wired in a Class B configuration, unless otherwise shown on the Drawings or unless otherwise indicated below.
- .9 All wiring between junction boxes and water flow switch, pressure switch, or supervisory switches will be in liquid tight flexible conduit.
- .10 Where a fire alarm transponder or annunciator located in one fire compartment is connected to a central processing unit or another transponder or annunciator located in a different fire compartment, the data communication link conductors connecting them shall be fire rated for at minimum one (1) hour. Where fire alarm system branch circuits connect transponders and individual fire alarm devices located on another storey, the branch circuits shall be fire rated for at minimum one (1) hour between the transponder and the first fire alarm device located on another storey than the transponder. Provide twisted, shielded pair Mineral-Insulated fire rated cables configured to eliminate interference and cross-talk, except where fire alarm riser diagram clearly illustrates another fire rating approach for particular conductors.

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2.10 Manual Alarm Stations

- .1 Addressable manual pull station.
 - .1 Pull lever, break glass rod, semi-flush wall mounted type, 2 stage, electronics to communicate station's status to addressable module/transponder over 2 wires and to supply power to station. Station address to be set on station in field.

2.11 Automatic Alarm Initiating Devices

- .1 Addressable thermal fire detectors, combination fixed temperature and rate of rise, non-restorable fixed temperature element, self-restoring rate of rise, fixed temperature 57 deg. C., rate of rise 8.3 deg. C. per minute:
 - .1 Electronics to communicate detector's status to addressable module/transponder.
 - .2 Detector address to be programmed on site.
- .2 Smoke detector: photo electric:
 - .1 Twistlock plug-in type with fixed base.
 - .2 Wire-in base assembly with integral red alarm LED.
 - .3 Auxiliary output contact.
- .3 Duct type smoke detectors: photo-electric with sampling tubes:
 - .1 Twistlock plug-in type with fixed base.
 - .2 Wire-in base assembly with integral red alarm LED.
 - .3 Auxiliary output contact.
 - .4 Properly sized air sampling tubes.
- .4 Beam type detectors: long range and short range:
 - .1 Complete with transmitter and receiver.
 - .2 Short range operating distance of 9-30 meters.
 - .3 Long range operating distance of 30-100 meters.
 - .4 Operating temperatures shall be of -5 to 55 deg. C.
 - .5 The beam detector shall feature alignment LEDs on both the receiver and the transmitter and automatic gain control.
 - .6 Beam detector calibrated test filters, if applicable.
- .5 Addressable variable-sensitivity smoke detectors:
 - .1 Photo-electric type.
 - .2 Electronics to communicate detector's status to addressable module/transponder.
 - .3 Detector address to be set on detector head in field.
 - .4 Sensitivity settings: 3 settings, determined and operated by control panel. No shifting in detector sensitivity due to atmospheric conditions (dust, dirt) within certain parameters.

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- .5 Ability to annunciate minimum of 2 levels of detector contamination automatically with trouble condition at control panel.
- .6 Auxiliary output contact.
- .6 Water flow switches: lever and pressure type:
 - .1 Shall have a mechanical alarm transmitted delay adjustable from 0-60 seconds. Initial settings shall be 30-45 seconds. Times will be recorded and submitted to Contract Administrator.
 - .2 The tamper switch located within the water flow switch shall be wired as per manufacturer's recommendations such that if the housing is open a latching trouble will be initiated.
- .7 Sprinkler and standpipe valve supervisory switches:
 - .1 The tamper switch located within the supervisory switch shall be wired as per manufacturer's recommendations such that if the housing is open a latching trouble will be initiated.

2.12 Audible Signal Devices

- .1 In sleeping rooms in a building of residential (Group C) or care (Group B, Division 3) occupancy, provide audible signal devices that emit a low frequency signal in the range of 470 Hz to 570 Hz, in accordance with Building Code requirements.
- .2 Speakers: Cone type: Recessed, 200 mm, round, ceiling mounted or surface mounted in box for unfinished areas.
 - .1 Fire retardant, moisture proof.
 - .2 Multiple taps adjustable from 0.25 to 2 W. Set at 0.5 watt tap and modify up if required to achieve audibility.
 - .3 Frequency response: 400 to 4000 Hz.
 - .4 Output sound level: 87 dB at 3 m with 1 W tap.
- .3 Horns: weatherproof mounting, 24 V dc, for use primarily in mechanical equipment areas, both indoor and outdoor. Horn type with compression driver, surface mounted.
 - .1 Corrosion, vibration and vermin resistant.
 - .2 Designed to broadcast high quality emergency voice communications as well as alert and alarm tone signals.
 - .3 Multiple taps adjustable from 2, to 15 watt tap with maximum tap output sound level of 100 dB at 3 m.
 - .4 Frequency response: 400 to 4000 Hz.
 - .5 Available in 25 or 70 Vrms.

2.13 Visual Alarm Signal Devices

- .1 Visual signal device type: white flashing light, wall mount or ceiling mounted as per drawings.
 - .1 Synchronized at one flash per second.
 - .2 Flash tube enclosure in clear LEXAN.

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- .3 "FIRE" installed red letters.
- .4 Operating on 20-24 V dc.
- .5 Field adjustable for 15 cd, 30 cd, 75 cd, 110 cd, and 115 cd, unless specified otherwise.
- .6 Designed for surface mounting on ceiling or walls as indicated.
- .2 Fire do not enter signs and their accessories:
 - .1 Compliant with CAN/ULC-S527 "Standard for Control Units for Fire Alarm Systems" and/or CAN/ULC S526 "Standard for Visual Signal Devices for Fire Alarm and Signaling Systems, Including Accessories."
 - .2 Powered by fire alarm system; operating on 24 V dc.
 - .3 Fire alarm signaling device.

2.14 Combination Audible And Visual Signal Devices

- .1 Combination Speaker Strobes, complying with the requirements noted above for: Audible Signal Devices and Visual Alarm Signal Devices.
- .2 Combination Horn Strobes, complying with the requirements noted above for: Audible Signal Devices and Visual Alarm Signal Devices.

2.15 End-Of-Line Devices

- .1 End-of-line devices to control supervisory current in alarm circuits and signalling 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.

2.16 Remote Annunciators

- .1 LED type, with designation cards to indicate zones.
- .2 Display:
 - .1 Alarms for alarm initiating circuits.
 - .2 Common supervisory alarm for supervisory initiating circuits.
 - .3 Common system trouble.
- .3 Trouble buzzer:
 - .1 Acknowledging trouble at main panel to silence trouble buzzers in system.
- .4 Supervised, with LED test button.
- .5 Interconnected with main fire alarm panel at minimum.

2.17 Remote Printer

- .1 System printer: to give a hard copy record of system events c/w following features:
 - .1 120 V ac, 60 Hz.
 - .2 80 columns.
 - .3 160 cps.

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- .4 Utilizes fan fold paper.
- .5 Connected to RS-232 output at central control panel.

2.18 Isolation Module

- .1 Provide isolation modules in accordance with CAN-ULC-S524.
 - .1 Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an DCL-C branch. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the DCL segment branch.
 - .2 If a wire-to-wire short occurs, the isolator module shall automatically disconnect the DCL-C segment. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.
 - .3 The isolation module will provide a single LED that flashes to indicate the isolation module is operating and illuminate steadily to indicate that a short circuit condition has been detected and isolated.

2.19 Central Alarm Monitoring

- .1 Provide Signal Transmitting Unit that utilizes internet connection as primary communications method and cellular network as secondary (back-up) communications method.
 - .1 Provide remote antenna for cellular network reception for Signal Transmitting Unit, if location of Signal Transmitting Unit in the building does not facilitate adequate cellular network strength.
- .2 Provide a demarcation point; refer to CAN-ULC-S524 Annex E.
- .3 Provide monitoring of the system including alarm zones, supervisory zones, and trouble signals.

2.20 Programmed Features:

- .1 By-pass feature for signalling devices:
 - .1 Bypassing of audible devices shall be provided through the programmable keys. The use of the feature is intended for personnel with programming access.
- .2 Evacuation feature.
 - .1 Evacuation key will be programmed and accessible for any personnel working on the fire Alarm Panel.

2.21 Fire Alarm Zone Passive Graphic Display

- .1 Layout
 - .1 The fire alarm zone passive graphic display shall be completed in the latest version of AutoCAD. The drawing shall indicate all the building floor plans and respective fire alarm zones with the description corresponding to the zone indication at the fire alarm control panel and annunciator.
 - .2 The fire alarm zones indicated for each floor shall be clearly defined with borders to indicate zone separation.

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- .3 The general font style shall be Helvetica upper case. Text size:
 - .1 6 mm in height for building name and 4.5 mm for municipal address and floor plans all coloured green.
 - .2 Main entrance arrow and text shall be Romans forward slant style 3 mm in height coloured cyan.
 - .3 Fire alarm zones and equipment notes shall be 3 mm in height coloured red.
 - .4 Fire hose cabinets shall be Romans forward slant style 3 mm in height coloured cyan.
- .4 Graphic display colours.
 - .1 Outline of building plan to be black line on white background.
 - .2 All egress corridors shall be clearly defined with Red colour #13 solid hatch pattern.
 - .3 All stairs and elevators shall be indicated using yellow solid hatch pattern.
- .5 Include the following information on the graphic display:
 - .1 A north arrow on the upper left corner of the zone graphic.
 - .2 "You are here" location in Red and properly orientated to the viewer when standing in front of the graphic.
 - .3 A drawing scale graph and drawing file number located in the lower right of the zone graphic.
 - .4 Building name and number at the bottom centre of the graphic display with municipal address indicated on the next line below.
 - .5 The main building entrance and street reference.
 - .6 Location of fire alarm control panel and annunciators, fire department connections, fire pumps, fire hose cabinets and associated standpipe and sprinkler valves.
 - .7 Location of main gas valve, suppression systems, chemical storage vaults, major mechanical equipment and duct smoke detectors indicating zone number.
 - .8 Substation and transformer locations indicating primary and secondary voltages.
- .2 Construction
 - .1 The graphic display shall be:
 - .1 Printed on white heavy weight 40lb. coated bond with colour UV inks, laminated on 1.5 mm styrene board and covered with clear Lexan.
 - .2 Standard passive graphic display size ranges from 8.5"x11" to 23"x35". The final size of the graphic may vary depending on the layout requirements and site conditions.
 - .2 Trim to be No. 4 stainless steel finish.

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.3 Location

- .1 Install graphic display adjacent to each fire alarm annunciator panel and the fire alarm control panel.
- .2 Graphic display to be fixed to the building structure or fire alarm control panel enclosure using tamper proof screws at each corner and at the midpoint on all four sides.

.4 Approval Drawings

- .1 Submit three full colour print copies of the passive display graphic for review by The City, the Contract Administrator and the local fire department.
- .2 Include the final approved zone graphic drawing in electronic format with the as-built drawings.

2.22 Ancillary Devices

- .1 Remote relay unit to initiate fan shutdown and door hold open devices.

2.23 STI Steel Web Stoppers, Detector Covers

- .1 Provide STI 9600 series detector cover for areas where sporting events or similar activities avail.

2.24 STI Stopper 2 & Weather Proof Stopper 2, Covers For Manual Stations

- .1 Provide STI Stopper 2 1100 series manual station covers for all vandal resistant locations identified on the electrical and architectural drawings.
- .2 Provide Weather Proof Stopper 2 1200 (flush mount) or 3100 (surface mount) series manual station covers for all weather proof locations and outdoor applications identified on the electrical and architectural drawings.

2.25 Relay Base, For Fire Detectors

- .1 Provide power along with the relay base detector such that the device that is being controlled with the normally open or normally closed relay base may operate or function. Power requirements and relay condition to be determined on site.

2.26 Manufacturers

- .1 The following are acceptable manufacturers:
 - .1 Chubb Edwards.
 - .2 Johnson Controls Simplex.
 - .3 Mircom.
 - .4 Siemens.
 - .5 Notifier.
 - .6 Johnson Controls Autocall.

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PART 3 - EXECUTION

3.1 Installation

- .1 Install systems in accordance with CAN/ULC-S524.
- .2 Install central control unit and connect to ac power supply.
- .3 Install manual alarm stations and connect to alarm circuit wiring.
- .4 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. Install duct type detectors complete with sampling tubes. Ensure duct type smoke detectors are installed far enough away from humidifiers to avoid false alarms; coordinate location of duct type smoke detector with Mechanical Subcontractor. If false alarms occur, relocate duct type smoke detector at no cost to The City.
- .5 Connect alarm circuits to main control panel.
- .6 Install bells, horns and visual signal devices and connect to signalling circuits.
- .7 Connect signalling circuits to main control panel.
- .8 Adjust visual signal device candela ratings upward, where required to meet coverage. Utilize spare visual signal device circuit capacity required in Part 2.
- .9 Install remote annunciator panels and connect to annunciator circuit wiring.
- .10 Install door releasing devices.
- .11 Install remote relay units to control fan shut down.
- .12 Where smoke dampers or combination smoke and fire dampers are shown, terminate damper position monitoring wiring for both fire alarm system and building automation system on damper actuator position end switches. Building automation system wiring to damper location will be provided by Mechanical Division.
- .13 Sprinkler system: wire alarm and supervisory switches and connect to control panel.
 - .1 Sprinkler devices should be wired such that opening of a device will cause a trouble on an alarming device or a supervisory on a supervising device.
 - .2 Where Mechanical/Sprinkler Subcontractor makes revisions to the base design, Electrical Subcontractor shall coordinate any revisions to fire protection system directly with the Mechanical/Sprinkler Subcontractor at no cost to The City and update as-built drawings accordingly.
- .14 Room detection system (where applicable):
 - .1 Install detectors. Make necessary connections between room detection panel and main fire alarm panel.
 - .2 Locate and install audible signals and visual alarms.
 - .3 Locate and install detectors under raised floor. Fasten to steel brackets approximately 300 mm above sub-floor level to clear cables and conduits.
- .15 Connect fire suppression systems to control panel.
- .16 'T-Tapping' is not permitted.

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- .17 For audible and visual signal devices in spaces subject to future tenant renovations, install devices in surface mounted boxes and leave 3 m of extra wiring coiled up in the box to allow the devices to be lowered / relocated to suit the tenant fit up ceiling and wall locations.
- .18 Provide necessary raceways, cable and wiring to make interconnections to terminal boxes, annunciator equipment and CCU, as required by equipment manufacturer.
- .19 Ensure that wiring is free of opens, shorts or grounds, before system testing and handing over.
- .20 Identify circuits and other related wiring at central control unit, annunciators, and terminal boxes.
- .21 Install speakers and connect to speaker circuits.
- .22 Where devices are to be installed in environments where the temperature can drop below 0°C (or below the addressable device temperature rating), an appropriately rated conventional device is to be installed.
 - .1 Provide and install an addressable input module remotely located in a conditioned environment suitable for the device temperature rating.
 - .2 Connect the conventional device(s) to addressable input module(s) as necessary to monitor the status of the conventional device.
- .23 Where shown on Drawings, install "Fire do not enter signs" in accordance with the requirements of CAN/ULC-S524.

3.2 Field Quality Control and Commissioning

- .1 The installing Subcontractor is responsible for hiring and coordinating with the manufacturer to perform the following:
 - .1 Testing of system to CAN/ULC-S536 prior to performing verification.
 - .2 Partial verification inspection to CAN/ULC-S537 and reports as required for partial occupancy.
 - .3 Complete an entire building test to CAN/ULC-S536 and provide detailed report. Provide a full verification inspection and test report at the end of the project. Cumulative partial verification reports do not constitute a full verification.
- .2 All fire alarm test and verification reports are to be submitted with a covering letter from the manufacturer clearly stating that there are no deficiencies with the installation prior to releasing the respective area for occupancy.
- .3 Include fire alarm audible signal device sound pressure levels, on a space by space / room by room basis, as part of the fire alarm verification report.
 - .1 Test sound pressure levels when any intervening doors between the device and the rest of the floor area are closed, in accordance with the intent and requirements of the Building Code.

MULTIPLEX FIRE ALARM AND VOICE COMMUNICATION SYSTEM

3.3 Life Safety Integration Testing

- .1 The fire alarm subcontractor and fire alarm manufacturer shall participate in the coordination and testing work associated with the Integrated Testing Plan (ITP), as described in more detail in Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS. All work shall be coordinated with the Integrated Testing Coordinator (ITC). The work shall include but not be limited to:
 - .1 Perform functional testing of the integration of all life safety and fire protection systems as a whole to ensure the proper operation and interconnection between the systems.
 - .2 Testing of the integrated life safety systems must be done as a complete installed assembly; individual component testing or partially installed assembly testing is not acceptable.
 - .3 Follow the testing methodology for verifying and documentation of operation as outlined in the ITP and in accordance with CAN/ULC-S1001.
 - .4 Provide fire alarm verification report along with all other documentation requested by the ITC as it relates to the electrical systems in conformance with CAN/ULC-S1001.

3.4 Central Alarm Monitoring

- .1 Locate Signal Transmitting Unit in same room as main fire alarm panel or in CACF room, unless shown otherwise on Drawings.
- .2 Provide a data connection from The City's network for internet access for central monitoring.
- .3 Coordinate with The City's Fire Alarm Monitoring Company and install power, conduit and wiring to the Signal Transmitting Unit in compliance with CAN/ULC-S559 and CAN/ULC S561.
- .4 Facilitate conversation between The City and The City's preferred fire alarm central alarm monitoring service to ensure that central monitoring service is provided in time for completion of fire alarm scope and Project occupancy.

END OF SECTION

EXCAVATION AND BACKFILL FOR ELECTRICAL WORK

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
- .3 Section 31 00 00 – EXCAVATION/EARTHWORKS.

1.2 Scope

- .1 This Section governs requirements for all excavating and backfilling Work required for the installation of buried power and communication services and backfill.
- .2 Assume that material to be excavated is earth. When rock is encountered during construction, payment will be made on unit price basis to the extent of net difference in cost between dry earth excavation and solid rock excavation, all as indicated in Contract Documents.

1.3 Shop Drawings And Product Data

- .1 Submit Shop Drawings and product data in accordance with Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
- .2 Provide Shop Drawings indicating proposed method of bedding and backfilling.

1.4 Warranty

- .1 Provide a warranty in accordance with the requirements of Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Soils

- .1 To the requirements for Granular “A”, “B” (Type 1), “M” and “Select Subgrade Material”.
- .2 Requirements for Pea Gravel: Granular, well-graded clean rounded pea gravel or stone with not more the 2% material that will pass 75 um (No. 200) sieve, maximum 6 mm (1/4 in.), containing no other deleterious material, and subject to testing that specified density can be achieved without compaction.
- .3 Requirements for Sand Fill: Uniform quality and unwashed river sand or any clean sand containing less than 5% organic materials, clay or silt (passing 125 um sieve) is acceptable. It can contain a limited amount of small stones or rocks as it comes from the pit. Sharp, clean, coarse sand, water washed, free from clay, salts and organic matter, and in accordance with CSA A179 – Mortar and Grout for Unit Masonry, for masonry sand is also acceptable.

EXCAVATION AND BACKFILL FOR ELECTRICAL WORK

PART 3 - EXECUTION

3.1 Installation

- .1 All excavation and backfilling for all services shall be in accordance with Site Work Division.
- .2 Protection:
 - .1 Provide protection to existing structures and services. Be responsible for rectifying any damage to existing structures and services resulting from this operation.
- .3 Excavation in Soil:
 - .1 Excavation carried below the correct inverts shall be backfilled with 2000 psi (13.5 mPa) concrete to the underside of the pipe lines, unless otherwise directed in writing.
- .4 Excavation in rock:
 - .1 All excavation in rock is included under separate Section, (the Site Work Division Section 31 00 00 – EXCAVATION/EARTHWORKS) and is taken to a minimum of 150 mm below the correct pipe invert. This Division shall use a bedding material to the correct trench invert.
- .5 Backfilling
 - .1 Backfill with sand from the bottom of the trench or excavation up to a point 300 mm above the top of service line or appurtenance.
 - .2 Backfill duct trenches with sand to a depth 300 mm above the ducts. The sand shall be thoroughly tamped around and over the pipes in 150 mm layers.
 - .3 Backfill the remainder of trench or excavation up to top of subgrade or bottom of floor slabs on-grade.

END OF SECTION

CONCRETE ENCASED DUCT BANKS AND MAINTENANCE CHAMBERS

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.

1.2 References

- .1 Canadian Standards Association (CSA)
 - .1 CAN/CSA-A3000, Cementitious materials compendium, latest edition.
 - .2 CSA-A23.1, Concrete Materials and Methods of Concrete Construction, latest edition.
 - .3 CSA G30.18, Carbon Steel Bars for Concrete Reinforcement, latest edition.
- .2 American Society for Testing and Materials (ASTM)
 - .1 ASTM D 1056, Specification for Flexible Cellular Materials - Sponge or Expanded Rubber, latest edition.
 - .2 ASTM A1064, Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete, latest edition.

1.3 Shop Drawings And Product Data

- .1 Submit Shop Drawings and product data in accordance with Section 26 05 04 – SUBMITTALS/SHOP DRAWINGS.
- .2 Submit Shop Drawings for precast maintenance chambers.
- .3 Submit Shop Drawings for ground rod details for cable rack grounding.

1.4 Warranty

- .1 Provide a warranty in accordance with the requirements of Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

PART 2 - PRODUCTS

2.1 PVC Ducts

- .1 PVC ducts, Type EB1, encased in reinforced concrete.

2.2 PVC Duct Fittings

- .1 Rigid PVC opaque solvent welded type couplings, bell end fittings, plugs, caps, adaptors as required to make complete installation.
- .2 Expansion joints.
- .3 Rigid PVC 5 degree angle couplings.

CONCRETE ENCASED DUCT BANKS AND MAINTENANCE CHAMBERS

2.3 Precast Concrete Maintenance Chambers

- .1 Precast concrete maintenance chambers and auxiliary sections shall be fabricated in steel forms.
- .2 Aggregates: to CSA-A23.1.
- .3 Cement: to CAN/CSA-A3000, Type 30.
- .4 Steel welded wire fabric mesh reinforcing: to ASTM A1064.
- .5 Pulling inserts and bolts for racks integrally cast in concrete.
- .6 Neoprene gasket seals between maintenance chamber sections: to ASTM D 1056.
- .7 Precast concrete maintenance chambers to come complete with a well in the bottom of the maintenance chamber with a breakout section in the bottom to allow for natural drainage. Well to be used for sump pump where one is identified on the drawings.
- .8 Precast concrete maintenance chambers to come complete with concrete knockout duct sections in each wall of the duct bank. Provide a minimum of 18 duct knockouts on each face of the maintenance chamber. Provide additional knockouts as required to suit the Contract documents. Rebar is only to encircle all the duct knockouts and no rebar is to be run between duct knockouts.

2.4 Drainage

- .1 Provide floor drain fittings in maintenance chamber consisting of floor drain, back water valve, trap and pipe connection to drainage system.
- .2 Provide a storm sewer connection: cast iron service saddle consisting of oil resistant gasket, stainless steel clamp and oil resistant O-ring.
- .3 Provide a sump pit with dimensions of 300 x 300 x 125 mm.

2.5 Maintenance Chamber Necks

- .1 Shall be constructed of concrete brick and mortar.

2.6 Maintenance Chamber Frames And Covers

- .1 Provide cast iron maintenance chamber frames and covers.
- .2 Provide bolted on covers to prevent unauthorized entry.

2.7 Grounding

- .1 Ground rods: Provide ground rod detail, as indicated for cable rack grounding.

2.8 Cable Racks

- .1 Hot dipped galvanized cable racks and supports.
- .2 Cable racks to be a minimum of 300 mm deep with a universal clamping means to secure the cable to the cable rack.
- .3 Provide all required hardware and supports to allow for the installation of the cable racks.

CONCRETE ENCASED DUCT BANKS AND MAINTENANCE CHAMBERS

2.9 Cable Pulling Equipment

- .1 Pulling iron: galvanized steel rods, size and shape as indicated.
- .2 Pull rope: 6 mm stranded polypropylene, tensile strength 5 kN, continuous throughout each duct run with 3 m spare rope at each end.

2.10 Marker Tape

- .1 Use of red plastic marker tape with black letters "DANGER – HIGH VOLTAGE" identifying the underground electrical installation.

PART 3 - EXECUTION

3.1 Installation General

- .1 Install underground duct banks and maintenance chambers including formwork.
- .2 Build duct bank and maintenance chambers on undisturbed soil or on well compacted granular fill not less than 150 mm thick, compacted to 95 % of maximum proctor dry density.
- .3 Open trench completely between connected maintenance chambers before ducts are laid and ensure that no obstructions will necessitate change in grade of ducts.
- .4 Prior to laying ducts, construct "mud slab" not less than 75 mm thick.
- .5 Install ducts at elevations and with slope as indicated and minimum slope of 1 to 400.
- .6 Install base spacers at maximum intervals of 1.5 m leveled to grades indicated for bottom layer of ducts.
- .7 Lay PVC ducts with configuration and reinforcing as indicated with preformed interlocking, rigid plastic intermediate spacers to maintain spacing between ducts at not less than 40 mm horizontally and vertically. Stagger joints in adjacent layers at least 150 mm and make joints watertight. Encase duct bank with 75 mm thick concrete cover. Use galvanized steel conduit for sections extending above finished grade level.
- .8 Make transpositions, offsets and changes in direction using angle sections.
- .9 Use bell ends at duct terminations in maintenance chambers or buildings.
- .10 Use conduit to duct adapters when connecting to conduits.
- .11 Terminate duct runs with duct coupling set flush with end of concrete envelope when dead ending duct bank for future extension.
- .12 Cut, ream and taper end of ducts in field in accordance with manufacturer's recommendations, so that duct ends are fully equal to factory-made ends.
- .13 Allow concrete to attain 50 % of its specified strength before backfilling.
- .14 Use anchors, ties and trench jacks as required to secure ducts and prevent moving during placing of concrete. Tie ducts to spacers with twine or other non-metallic material. Remove weights or wood braces before concrete has set and fill voids.
- .15 Clean ducts before laying. Cap ends of ducts during construction and after installation to prevent entrance of foreign materials.

CONCRETE ENCASED DUCT BANKS AND MAINTENANCE CHAMBERS

- .16 Install a minimum of four 3 m lengths of 15 mm reinforcing rods, one in each corner of duct bank when connecting duct to maintenance chambers or buildings. Wire rods to 15 mm dowels at maintenance chamber or building and support from duct spacers. Protect existing cables and equipment when breaking into existing maintenance chambers. Place concrete down sides of duct bank filling space under and around ducts. Rod concrete with flat bar between vertical rows filling voids.
- .17 Prior to installation of any wire or cable in the ducts, pull through each duct a flexible mandrel not less than 300 mm long and size for the internal diameter of duct, followed by stiff bristle brush to remove sand, earth and other foreign matter. Avoid disturbing or damaging ducts where concrete has not set completely. Provide photo and video evidence of compliance with this clause and send to Contract Administrator for review within 24 hours of Work occurring.
- .18 Install a polypropylene pull string in each duct. Secure the pull string at each end of the duct.
- .19 Install red "DANGER – HIGH VOLTAGE" warning tape across the entire width of the ductbank in the soil half way between the duct bank and grade.
- .20 Mark location of duct runs under hard surfaced areas not terminating in maintenance chamber with railway spike driven flush in edge of pavement, directly over run.
- .21 Where markers are removed to permit installation of additional duct, reinstall existing markers.
- .22 Provide As-Built Drawings showing locations of markers.

3.2 Maintenance Chambers

- .1 Install precast maintenance chambers.
- .2 Provide 115 mm deep window to facilitate cable bends in wall at each duct connection. Terminate ducts in bell-end fitting flush with window face. Provide four 10 mm steel dowels at each duct run connection to anchor duct run. On runs of 16 ducts and over, support concrete duct encasement on a 700 mm wide by 75 mm thick concrete pier poured against maintenance chamber wall between slab and bottom of duct run, provide dowels for anchoring.
- .3 Alternately connect large duct runs by leaving square opening in wall, later pouring duct run and wall opening in one pour, and install 10 mm x 3 m reinforcing rods in duct run at maintenance chamber connection.
- .4 Build up concrete maintenance chamber neck to bring cover flush with finished grade in paved areas and 40 mm above grade in unpaved areas.
- .5 Install maintenance chamber frames and covers for each chamber. Set frames in concrete grout onto chamber neck.
- .6 Drain floor towards sump with 1 to 48 slope minimum and install drainage fittings as indicated.
- .7 Provide two levels of cable racks around the entire perimeter of each maintenance chamber. Provide anchor bolts and pulling irons on all four sides of the maintenance chamber.
- .8 Grout frames of maintenance chambers. Cement grout to consist of two parts sand and one part cement and sufficient water to form a plastic like slurry.

CONCRETE ENCASED DUCT BANKS AND MAINTENANCE CHAMBERS

- .9 Ensure filling of voids in joint being sealed. Plaster with cement grout the walls, ceiling and neck.
- .10 Spray paint an "X" on ceiling of maintenance chamber above floor drain or sump pit.

3.3 Reviews

- .1 Review of duct and duct clean out will be witnessed by the Contract Administrator prior to placement of concrete.

END OF SECTION

RECREATION CENTRE LIGHTING CONTROL SEQUENCE OF OPERATIONS

ATTACHMENT A

**RECREATION CENTRE
LIGHTING CONTROL SEQUENCE OF OPERATIONS**

END OF SECTION

LIGHTING SEQUENCE OF OPERATION

Smith + Andersen

Project Name: South Winnipeg Recreational Center

Project Number: 22522.002.E.001

Date: 26-Sep-25

SWRC - REC

Space Type	Room Name	Sequence:
Interior		
Lobby/Corridor/Vestibule	Lobby (R101), Entry vestibule (R100), East-West corridor L1 (R170), CC Connection (R171), North-South corridor L1 (R130), Family Space (R131), East-West corridor L2 (R200), North-South corridor L2 (R230)	Sequence: ON: Lights automatically turn on at 6:00 AM. ADJUST: The Staff to have the ability to manually override dimming at Reception. (Confirm switch/control location) The lights continually adjust (dim) where daylight sensors are shown, between off and a maximum level predetermined by the available daylight within the space. (Where Applicable) During operating hours if there are no occupants within the space the lights will dim to 50% of full lighting power. Upon the detection of occupants the lights are to go 100% full lighting power. OFF: After Hours Mode will begin at 11:00 PM. 30 minutes prior to the lights turning off at the scheduled time, the lights will flash 3 times. If no override scene is selected within 10 minutes, the lights in the space turn off. After Hours Mode will end at 06:00 AM. **Emergency lights are also controlled. Provide UL-924 listed relay to control emergency lighting. **Emergency lights remain on during after hours. **Lights come to full brightness when fire alarm system is in "alarm" mode.
Gymnasium/Fitness Centre (Playing Area)	Triple GYM (R180), Running Track (R210), Fitness Centre (R207)	Sequence: ON: Lights automatically turn on to 25% at 6:00 AM. ADJUST: Occupant can manually override all lighting zone(s) at the master controller located in the Gym near the west entrance. (Confirm Lighting Control Switch location, Switch can be located in a less public accessible area if required) Lighting zone(s) in the room shall have the following preset scenes: Scene 1: 0% Scene 2: 25% Scene 3: 50% Scene 4: 75% Scene 5: 100% Scene 6: Clerestory Scene 7: Spare Scene 8: Spare The lights continually adjust (dimmed) where daylight sensors are shown, between off and a maximum level predetermined by the available daylight within the space. (Where Applicable) OFF: All lights switch off after business hours. After Hours Mode will begin at 11:00 PM. After Hours Mode will end at 6:00 AM. **Emergency lights are also controlled. Provide UL-924 listed relay to control emergency lighting.

LIGHTING SEQUENCE OF OPERATION

Smith + Andersen

Project Name: South Winnipeg Recreational Center

Project Number: 22522.002.E.001

Date: 26-Sep-25

SWRC - REC

Space Type	Room Name	Sequence:
Conference, Meeting, Multi-Purpose Room	Reception/Control Desk (R102), Recreation Staff RM (R106), AdminEntry&Storage (R108), MPR Team RM (R155), Loading/Waste Management (R162), Staff Entrance (R164), Food Concession (R132), MPR Servery (R134), GYM Storage (R181, R183, R184, R185), Movement Studio (R201), Wellness RM (R203), Fitness RM Maintenance Shop (R208), Running Track Storage (R211)	Sequence: ON: User enters the space and the all the light fixtures are turned on to 50% power via occupancy sensor. ADJUST: The user manually selects different pre-defined scenes through the use of the preset scene control on the wall. User(s) can manually dim or turn off the lihghts via low voltage wall switch(es). Lighting zone(s) in the multipurpose rooms shall have the following preset scenes: Scene 1: 50% Scene 2: 100% OFF: 15 minutes after the room has been vacated, the lights will automatically turn off. **Emergency lights are also controlled. Provide UL-924 listed relay to control emergency lighting. **Lights come to full brightness when fire alarm system is in "alarm" mode.
Office	Cash office (R103), Staff office (R109, R110, R111, R112b), L MPR 2 (R135), L MPR 1 (R137), MPR Living RM L2 (R231), MPR Classroom RM L2 (R233), MPR Craft RM L2 (R235),	Sequence: ON: User enters the space and the all the light fixtures are turned on to 50% power via occupancy sensor. ADJUST: The user can manually increase the light output using the switch/dimmer/keypad on the wall. The lights continually adjust (dimmed) where daylight sensors are shown, between off and a maximum level predetermined by the available daylight within the space. (Where Applicable) OFF: 15 minutes after the room has been vacated, the lights will automatically turn off. ** (Where Applicable) Emergency lights are also controlled. Provide UL-924 listed relay to control emergency lighting. **Lights come to full brightness when fire alarm system is in "alarm" mode.
Washrooms	Public Washroom L1 (R122), UTR L1, Women's Change RM (R151), Universal Change RM (R152), Men's Change RM (R153), Women's Washroom L2 (R221), Men's Washroom L2 (R223), UTR L2	Sequence: ON: User enters the space and the lights automatically turn on via occupancy sensor. OFF: 15 minutes after the room has been vacated, the lights will automatically turn off. ** (Where Applicable) Emergency lights are also controlled. Provide UL-924 listed relay to control emergency lighting. **Lights come to full brightness when fire alarm system is in "alarm" mode.
Storage Rooms	Laundry (R107), Custodial Closet (R204), Food Storage (R133), L MPR 2 Storage (R136), L MPR 1 Storage (R139), Movement Studio Storage (R202), MPR Storage L2 (R234, R236)	Sequence: ON: User enters the space and the lights automatically turn on to 50% of full lighting power via occupancy sensor. ADJUST: The user can manually increase the light output to 100% of full lighting power using the switch on the wall. OFF: 15 minutes after the room has been vacated, the lights will automatically turn off. ** (where Applicable) Emergency lights are also controlled. Provide UL-924 Listed relay to control emergency lighting
Stairs	Stair A, Stair B, Stair C, Stair D	Emergency lights remain on at all times.

LIGHTING SEQUENCE OF OPERATION

Smith + Andersen

Project Name: South Winnipeg Recreational Center

Project Number: 22522.002.E.001

Date: 26-Sep-25

SWRC - REC

Space Type	Room Name	Sequence:
Service Room	Electrical RM (R105, R163, R140, R205), IT/Server RM (R105), Mechanical RM (R240, R206)	Sequence: ON: User manually turns on lights. OFF: User manually turns off lights. ** Provide UL-924 Listed relay to control emergency lighting. Emergency lighting to come to full brightness in event of power loss. Regardless if lights in room are on. Use local normal circuit for sensing. **Lights come to full brightness when fire alarm system is in "alarm" mode.

Exterior

Exterior		Sequence: ON: Lights automatically turn on when it gets dark outside (astronomical time clock, pre-set hours). ADJUST: Manual override switch to turn lights on/off is located at Reception. (Confirm override switch location) OFF: Lights automatically turn off when it gets bright (astronomical time clock, pre-set hours). *Exterior Entrance Lights to be controlled as a separate zone, LZ-01.
Main Parking - Exterior		Sequence: ON: Lights automatically turn on when it gets dark outside (astronomical time clock, pre-set hours). ADJUST: Manual override switch to turn lights on/off is located at Reception. (Confirm override switch location) OFF: Lights automatically turn off when it gets bright (astronomical time clock, pre-set hours). *Main Parking Lot Lights to be controlled as a separate zone, LZ-01.

NOTES:

- 1) After-hour scheduling times to be confirmed by Owner during commissioning.
 - 2) Lighting control system to come complete with required accessories and devices. Contractor to review luminaire schedule and ensure compatibility between drivers and lighting control system.
 - 3) Follow manufacturer recommendations for wiring and installation.
- 1 - Buttons are to provide override on/off switching of listed circuits/ relays. Read in conjunction with relay schedules
2 - Emergency lighting circuits are to fail-safe on during loss of normal power.

CHILDCARE LIGHTING CONTROL SEQUENCE OF OPERATIONS

ATTACHMENT B

**CHILDCARE
LIGHTING CONTROL SEQUENCE OF OPERATIONS**

END OF SECTION

LIGHTING SEQUENCE OF OPERATION

Smith + Andersen



Project Name: South Winnipeg Recreational Center

Project Number: 22522.002.E.001

Date: 17-Sep-25

SWRC - CC

Space Type	Room Name	Sequence:
Interior		
Lobby/Corridor/Vestibule	CC South Vestibule (C100) CC Vestibule (C115) CC Entry (C101b) Corridor (C101,C110, C140) Pre-School East Vestibule (C143)	Sequence: ON: Lights automatically turn on at 6:00 AM. ADJUST: The Staff to have the ability to manually override dimming at Admin Office. (Confirm switch/control location) The lights continually adjust (dim) where daylight sensors are shown, between off and a maximum level predetermined by the available daylight within the space. (Where Applicable) During operating hours if there are no occupants within the space the lights will dim to 50% of full lighting power. Upon the detection of occupants the lights are to go 100% full lighting power. OFF: After Hours Mode will begin at 11:00 PM. 30 minutes prior to the lights turning off at the scheduled time, the lights will flash 3 times. If no override scene is selected within 10 minutes, the lights in the space turn off. After Hours Mode will end at 06:00 AM. **Emergency lights are also controlled. Provide UL-924 listed relay to control emergency lighting. **Emergency lights remain on during after hours. **Lights come to full brightness when fire alarm system is in "alarm" mode.
Childcare - Classroom	Infant RM # 1-6 (C121 ... C126) Pre-School RM Play/Nap # 1-8 (C131 ... C138)	Sequence: ON: User enters the space and the all the light fixtures are turned on to 50% power via occupancy sensor. ADJUST: The user can manually increase the light output using the switch/dimmer/keypad on the wall. The lights continually adjust (dimmed) where daylight sensors are shown, between off and a maximum level predetermined by the available daylight within the space. (Where Applicable) OFF: 15 minutes after the room has been vacated, the lights will automatically turn off. ** (Where Applicable) Emergency lights are also controlled. Provide UL-924 listed relay to control emergency lighting. **Lights come to full brightness when fire alarm system is in "alarm" mode. **Lights in playing area to be controlled as a separate zone, LZ-01. **Lights in napping area to be controlled as a separate zone, LZ-02.
Childcare - Washroom/change room	Infant Change W/C # 1-6 (C121b ... C126b) Pre-School Change W/C # 1-8 (C131b ... C138b)	Sequence: ON: User enters the space and the lights automatically turn on via occupancy sensor. OFF: 15 minutes after the room has been vacated, the lights will automatically turn off. ** (Where Applicable) Emergency lights are also controlled. Provide UL-924 listed relay to control emergency lighting. **Lights come to full brightness when fire alarm system is in "alarm" mode.
Childcare - Infant RM Vestibule	Infant RM Vestibule # 1-3 (C129 ... C127)	Sequence: ON: User enters the space and the lights automatically turn on via occupancy sensor. OFF: 15 minutes after the room has been vacated, the lights will automatically turn off. ** (Where Applicable) Emergency lights are also controlled. Provide UL-924 listed relay to control emergency lighting. **Lights come to full brightness when fire alarm system is in "alarm" mode.

LIGHTING SEQUENCE OF OPERATION

Smith + Andersen



Project Name: South Winnipeg Recreational Center

Project Number: 22522.002.E.001

Date: 17-Sep-25

SWRC - CC

Space Type	Room Name	Sequence:
Office/Staff room	Admin Office (C120) Director's Office (C103) Staff RM (C120) Kitchen CC (C116)	Sequence: ON: User enters the space and the all the light fixtures are turned on to 50% power via occupancy sensor. ADJUST: The user can manually increase the light output using the switch/dimmer/keypad on the wall. The lights continually adjust (dimmed) where daylight sensors are shown, between off and a maximum level predetermined by the available daylight within the space. (Where Applicable) OFF: 15 minutes after the room has been vacated, the lights will automatically turn off. ** (Where Applicable) Emergency lights are also controlled. Provide UL-924 listed relay to control emergency lighting. **Lights come to full brightness when fire alarm system is in "alarm" mode.
Washrooms	Staff W/C 1 (C109) Limited Mobility W/C (C109b) UTR (C107)	Sequence: ON: User enters the space and the lights automatically turn on via occupancy sensor. OFF: 15 minutes after the room has been vacated, the lights will automatically turn off. ** (Where Applicable) Emergency lights are also controlled. Provide UL-924 listed relay to control emergency lighting. **Lights come to full brightness when fire alarm system is in "alarm" mode.
Kitchen/Garbage&Water Meter	Staff RM (C120) Kitchen CC (C116) Garbage/Water Meter RM (C114)	Sequence: ON: User enters the space and the lights automatically turn on to 50% of full lighting power via occupancy sensor. ADJUST: The user can manually increase the light output to 100% of full lighting power using the switch on the wall. OFF: 15 minutes after the room has been vacated, the lights will automatically turn off. ** (where Applicable) Emergency lights are also controlled. Provide UL-924 Listed relay to control emergency lighting
Storage Rooms/Laundry	Custodial (C106) Laundry 1 (C105) Storage (C108) Kitchen Storage (C117) Laundry 2 (C141) General Storage RM (C144) Pre-School Storage (C142)	Sequence: ON: User enters the space and the lights automatically turn on to 100% of full lighting power via occupancy sensor. OFF: - AUTO: 15 minutes after the room has been vacated, the lights will automatically turn off. - MANUALLY: User manually turns off lights using the switch on the wall. ** (where Applicable) Emergency lights are also controlled. Provide UL-924 Listed relay to control emergency lighting
Service Room	Electrical RM (C113) Mechanical RM (C111) IT Closet (C112) General Storage RM (C104) Crawl Space	Sequence: ON: User manually turns on lights. OFF: User manually turns off lights. ** Provide UL-924 Listed relay to control emergency lighting. Emergency lighting to come to full brightness in event of power loss. Regardless if lights in room are on. Use local normal circuit for sensing. **Lights come to full brightness when fire alarm system is in "alarm" mode.

Exterior

LIGHTING SEQUENCE OF OPERATION

Smith + Andersen

**Project Name:** South Winnipeg Recreational Center**Project Number:** 22522.002.E.001**Date:** 17-Sep-25**SWRC - CC**

Space Type	Room Name	Sequence:
Exterior Canopy/ Entrance		Sequence: ON: Lights automatically turn on when it gets dark outside (astronomical time clock, pre-set hours). ADJUST: Manual override switch to turn lights on/off is located at Admin Office. (Confirm override switch location) OFF: Lights automatically turn off when it gets bright (astronomical time clock, pre-set hours). *Exterior Canopy Lights to be controlled as a separate zone, LZ-01. *Exterior Entrance Lights to be controlled as a separate zone, LZ-02.

NOTES:

- 1) After-hour scheduling times to be confirmed by Owner during commissioning.
 - 2) Lighting control system to come complete with required accessories and devices. Contractor to review luminaire schedule and ensure compatibility between drivers and lighting control system.
 - 3) Follow manufacturer recommendations for wiring and installation.
- 1 - Buttons are to provide override on/off switching of listed circuits/ relays. Read in conjunction with relay schedules
- 2 - Emergency lighting circuits are to fail-safe on during loss of normal power.

GENERAL INSTRUCTIONS FOR TELECOMMUNICATIONS SECTIONS

PART 1 - GENERAL

1.1 Overview

- .1 Conform to the requirements of Divisions 0 and 1, which apply to and form part of all sections of the work.
- .2 In the event of a conflict between Divisions 0 or Division 1 sections and information contained in Sections 27 00 05.10 - GENERAL INSTRUCTIONS FOR TELECOMMUNICATIONS SECTIONS, 27 00 05.60 – ADMINISTRATIVE REQUIREMENTS, and 27 00 05.70 – PROJECT SPECIFIC REQUIREMENTS of this document, the more stringent, onerous, and/or costly requirement shall apply.
- .3 Read and comply with all sections of this document.
- .4 Provide all labour, materials, tools, and equipment required for the complete scope of the Work specified in all sections of the Contract Documents.

1.2 Sections Affected

- .1 These instructions apply to and form a part of all Telecommunications Sections.

1.3 INTENT

- .1 The Specifications are an integral part of the accompanying Drawings. Any item or subject omitted from one or the other, but which is either mentioned or reasonably implied, shall be considered as properly and sufficiently specified.
- .2 Be completely responsible for the acceptable condition and operation of all systems, equipment, and components forming part of the installation or directly associated with it. Promptly replace defective material, equipment, and repair related damages. The replacement of equipment and repair to damages shall be coordinated with other trades completed in a timely fashion so as not to affect the complete construction of the Telecommunications Systems and/or work by others.

1.4 Work Included for Recreation Center

- .1 Provide a new Telecommunications Structured Cabling system for the area included in the scope of this Contract. The Structured Cabling Systems shall be as follows:
 - .1 Horizontal Structured Cabling System consisting of 4-pair Copper Cabling for voice and data applications.
 - .2 Intra-building Backbone Structured Cabling System consisting of Multi-pair Copper Cabling.
 - .3 Intra-building Backbone Structured Cabling system consisting of Fibre Optic Cabling.
- .2 All horizontal cabling shall be serviced from the nearest logical Telecommunications Room, either existing or new as shown on floor plans.

GENERAL INSTRUCTIONS FOR TELECOMMUNICATIONS SECTIONS

- .3 The Telecommunications Structured Cabling system is based on a physical star wiring topology (unless otherwise specified) that is designed in accordance with and supported by a manufacturer backed certification and warranty as specified herein. This cabling infrastructure solution shall encompass, and not be limited to, all telecommunication outlets, cable, cable terminating hardware, equipment cabinets/racks, and selected connectivity devices.
- .4 Provide CMP (FT6) rated components of the Telecommunications Cabling System that is to be located within spaces deemed a Return Air Plenum. CMR (FT4) rated components may be used in spaces upon approval by all Authorities Having Jurisdiction (AHJ) and/or the Contract Administrator. For this project, all components shall have a CMP (FT6) rating unless otherwise specified in this document. All CMP (FT6) rated products must be CSA/ULC.
- .5 While every attempt has been made to ensure all information is correct at the time of publication, the products specified are available and that any part numbers identified are correct, it is the responsibility of the Telecommunications Subcontractor to verify all part numbers and to report any errors and/or omissions in the Drawings and/or Specification during the procurement process.
- .6 Dimensions shown on Drawings are approximate. Verify dimensions by reference to Shop Drawings and field measurements.
- .7 Quantities or lengths indicated in any of the Contract Documents are approximate only and shall not be held to gauge or limit the Work.
- .8 Include all labour, materials, plant, transportation, storage costs, training, equipment, insurance, temporary protection, permits, inspections, bonding, taxes, and all necessary and related items required to provide complete and operational systems shown and described.

1.5 Work Included for Child Care Center

- .1 Provide a new Telecommunications Structured Cabling system for the area included in the scope of this Contract. The Structured Cabling Systems shall be as follows:
 - .1 ROUGH-IN ONLY for Horizontal Structured Cabling System consisting of 4-pair Copper Cabling for voice and data applications.
 - .2 ROUGH-IN ONLY for Intra-building Backbone Structured Cabling System consisting of Multi-pair Copper Cabling.
 - .3 ROUGH-IN ONLY for Intra-building Backbone Structured Cabling system consisting of Fibre Optic Cabling.
- .2 All horizontal cabling shall be serviced from the nearest logical Telecommunications Room, either existing or new as shown on floor plans.
- .3 The Telecommunications Structured Cabling system is based on a physical star wiring topology (unless otherwise specified) that is designed in accordance with and supported by a manufacturer backed certification and warranty as specified herein. This cabling infrastructure solution shall encompass, and not be limited to, all telecommunication outlets, cable, cable terminating hardware, equipment cabinets/racks, and selected connectivity devices.

GENERAL INSTRUCTIONS FOR TELECOMMUNICATIONS SECTIONS

- .4 While every attempt has been made to ensure all information is correct at the time of publication, the products specified are available and that any part numbers identified are correct, it is the responsibility of the Telecommunications Subcontractor to verify all part numbers and to report any errors and/or omissions in the Drawings and/or Specification during the procurement process.
- .5 Dimensions shown on Drawings are approximate. Verify dimensions by reference to Shop Drawings and field measurements.
- .6 Quantities or lengths indicated in any of the Contract Documents are approximate only and shall not be held to gauge or limit the Work.
- .7 Include all labour, materials, plant, transportation, storage costs, training, equipment, insurance, temporary protection, permits, inspections, bonding, taxes, and all necessary and related items required to provide complete and operational systems shown and described.

1.6 Bidder Inquiries

- .1 Bidders who find discrepancies or omissions in this RFQ, or who have any doubt as to the technical meaning or intent of any part of this RFQ, shall direct their questions or other inquiries in writing to the Contract Administrator as defined in Section 27 00 05.20 – DEFINITIONS AND ABBREVIATIONS
- .2 In fairness to all bidders, all questions will be answered and distributed to all. Oral questions will not be answered. No questions will be answered within 48 hours of the closing date / hour of the bid. Refer to Division 0 for question period close time and date.

1.7 Tender Forms and Submission Of Tenders

- .1 Submit all information called for on the Telecommunications Tender and Supplementary Tender Forms. Tenders not completed in full may, at the discretion of The City, be rejected.
- .2 Show separate, identified, alternate and unit prices for optional components or items called for as additions to or deductions from the Tender amount.
- .3 The City reserves the right to accept or reject any substitution without question.
- .4 Include incidental fees and other fees for items required to successfully install the Structured Cabling Solution that may or may not be indicated in this document. Meet all requirements of this document and all telecommunications (and related) standards, municipal, local, Provincial and Federal building, safety, fire and electrical codes.

1.8 Holdback

- .1 The value for testing and documentation (cable test results and as-builts), for payment purposes, shall be set at 10% of the base Contract or \$5,000; whichever is greater. This amount will be withheld from the Telecommunications Subcontractor until testing and correction of deficiencies is 100% complete.

1.9 Schedule

- .1 By submitting a response to this document and associated Drawings, the Telecommunications Subcontractor agrees to meet and adhere to all project milestones as indicated in the project schedule(s).

GENERAL INSTRUCTIONS FOR TELECOMMUNICATIONS SECTIONS

- .2 Acknowledge that project schedule(s) are subject to change. Verify all project milestones with the Contractor Administrator and/or Contractor.

1.10 Labour

- .1 Comply with all job-site requirements for the duration of the project.
- .2 Do not assign or sub-contract any Work without the prior written consent of the Contract Administrator. In the event of Subcontractor approval, submit a complete list of sub-contractors during the procurement process.
- .3 Use only workers who are fully trained, qualified, and experienced on the installation, termination, and testing of the Structured Cabling Solution.
- .4 Third party certification will not be permitted unless the certifying Subcontractor performs the termination and testing for all cabling. If third party certification is necessary, the Telecommunications Subcontractor shall obtain the consent of the Contract Administrator prior to submitting a bid response.
- .5 Make any changes or alterations required by an authorized inspector of the authority having jurisdiction.
- .6 Obtain consent from the Contract Administrator before changing the Project Manager and/or Site Supervisor during the Project.

1.11 Access and Protection

- .1 Access to the Site shall be limited to location and time of day. Refer to Section 27 00 05.70 – PROJECT SPECIFIC REQUIREMENTS and conform to requirements.
- .2 Refer to the security and protection requirements in the General Conditions and conform to all requirements.

1.12 Drawings, Changes and Installation

- .1 The Drawings are intended to show the general character and scope of the Work and not the exact details of the Work. Complete the Work with all accessories required for a complete and operative installation.
- .2 The location, arrangement, and connection of equipment and material as shown on the Drawings represent a close approximation to the intent and requirements of the Contract. The Contract Administrator reserves the right to make reasonable changes required to accommodate conditions arising during the progress of the Work, at no extra cost to The City.
- .3 Certain details indicated on the Drawings are general in nature and specific labelled detail references to each occurrence of use is not indicated, however, such details shall be applicable to every occurrence on the Drawings.
- .4 The location and size of existing services shown on the Drawings are based on the best available information. Verify the actual location of existing services in the field before Work is commenced.
- .5 Make changes and modifications necessary to ensure co-ordination and to avoid interference and/or conflicts with other trades, or to accommodate existing conditions, at no extra cost to The City.

GENERAL INSTRUCTIONS FOR TELECOMMUNICATIONS SECTIONS

- .6 Leave areas clear where space is indicated as reserved for future equipment, and equipment for other trades. Adequate space and provisions shall be left for removal of components and servicing of equipment, with minimum inconvenience to the operation of systems.
- .7 Where equipment is shown to be 'roughed in only', obtain accurate information from the Contract Administrator before proceeding with the Work.
- .8 Location of outlets, luminaires, diffusers, grilles, registers, thermostats, sprinklers, and all other equipment shown on Drawings (if shown) is diagrammatic.
- .9 Remedy any Work not installed in correct location (at the sole discretion of the Contract Administrator). The Telecommunications Subcontractor is responsible to mark-out their Work and fully co-ordinate with all other trades. Review the Work with Contract Administrator prior to rough in.

1.13 Approved Equal

- .1 Wherever the term "approved equal", "approved equivalent", or another variation is used herein, it is to be understood that reference to the specified trade name, brand name, manufacturer's name, model number, and catalog number has been made solely to indicate the minimum standard of quality required in material, workmanship, and service. Any proposed alternate shall be submitted for review and acceptance before procurement and installation. The review and acceptance shall be at the sole discretion of The City and the Contract Administrator.

1.14 Conflicting Requirements

- .1 In the case of conflict or discrepancy in the requirements indicated in the Contract documents the more stringent, onerous, and/or costly requirement shall apply.

1.15 Equipment and Materials Minimum Requirements

- .1 Materials and equipment provided under this Division shall be new and free from defects.
- .2 All equipment and material for which there is a listing service shall bear a ULC and/or CSA label.
- .3 Equipment shall meet all applicable FCC/CRTC Regulations.
- .4 Materials shall have a flame spread in accordance with local Authorities Having Jurisdiction, and in accordance with the Specifications of this project.

1.16 Document Format

- .1 This document has been constructed based on a 3-part specification for Division 27. The first part 'General' describes general information pertaining to the section. The second part 'Product' describes the products that shall be provided for the project. The third part 'Execution' details the requirements for the installation of the specified products. Reference sections 1 and 3 for the relevant General information and Execution requirements of products that are listed in section 2.

GENERAL INSTRUCTIONS FOR TELECOMMUNICATIONS SECTIONS

1.17 Statement of Prices

- .1 Submit a statement of their estimated prices for the various portions of the Work including both labour and materials to form a basis of progress payments. The total price of all portions of the Work shall equal the total price of the Work covered under the Telecommunications Division.

1.18 Valuation of Changes

- .1 Further to Contract requirements, the method to be used in determining the value of a change to the Work, by either Change Order or Change Directive, shall be:
 - .1 Estimate and acceptance in a lump sum, unless the Contract Administrator otherwise determines that the method shall be unit prices set out in the Contract.
- .2 Provide the Contract Administrator with a detailed cost analysis of the contemplated change indicating:
 - .1 Quantity of each material.
 - .2 Unit cost of each material.
 - .3 Time involved.
 - .4 Sub-trade quotations including a complete analysis of costs.
 - .5 Mark-ups, if applicable.
 - .6 Value of GST or HST, as applicable.
 - .7 Proposed change in Contract Time.
- .3 The detailed cost breakdown is to list material and labour separately for each item on the proposed change. The breakdown for contemplated change is to follow the format of the attached document.
- .4 The following shall not be included in the cost of the Work but are covered by the hourly rate:
 - .1 The Contractor's payroll, administrative, head office and site office expenses, including stationary, postage and other office supplies.
 - .2 The costs of the Telecommunications Subcontractor's Project Manager, clerical and administrative personnel, and executive personnel.
 - .3 Use of temporary offices, sheds, small / hand tools, storage, site office consumables, etc., including but not limited to the cost of telephone, light, power, water and heat used therein.
 - .4 Transportation and overnight room expenses for out-of-town labour, if local labour is unavailable.
 - .5 Insurance premiums, all government payroll burdens, variable labour factors and union or association funds.
 - .6 Licenses and permits, except when these are special for a particular item of Work.
 - .7 Printing charges for Proposed Changes, Change Orders and Drawings for the Contractor's and Subcontractors use in the Work. Contract Administrator will provide one PDF copy of change notice documentation.

GENERAL INSTRUCTIONS FOR TELECOMMUNICATIONS SECTIONS

- .8 The cost of preparing As-Built drawings, layout drawings, working drawings and Shop Drawings. This includes any and all AutoCAD / BIM (or other methods) costs related to interference drawings or other associated drawings that may be required as part of the changes.
- .9 The cost of cleanup and disposal of waste material.
- .10 Parking, travel, coffee breaks, rest periods, warranties, safety training, WHMIS and health and safety committee, and non-productive time.
- .11 Rentals, additional bonding, project financing.
- .5 The Contractor shall not be entitled to any additional compensation arising out of changes to the Work other than the amounts determined and agreed to under the City of Winnipeg Tender Contract No 63-2025B..
- .6 Inform the Surety Company or Companies who have issued any bonds for this Contract, and any Insurers who have insured any part of the Work or operations or who have an interest in this Contract, of all changes in the Contract. Pay all costs of any changes in bonds or insurances required to maintain bonds or insurances in conformance with the requirements of the Contract Documents. Provide The City immediately with any revised bonds or insurances.
- .7 Charge special equipment rental rates at cost. Submit the invoice for special equipment rental with the cost of the Work.
- .8 The maximum percentage fee for mark-ups shall be as stated in the Division 0/1 specifications or the Contract Supplementary Conditions.
- .9 All changes, change notices, revisions to Contract, site instructions, change directives or any additional costs or deletes to the stipulated lump sum Contract price are subject to review and scrutiny by a qualified third party or individual.
- .10 Labour Rate:
 - .1 For the duration of the Contract, extra Work hourly labour units are to be based on the latest edition of the National Electrical Contractors Association (NECA) labour unit's column 1 (one). No additional factors will be accepted.
 - .2 The hourly labour rate for all changes will be based on a Journeyperson rate as listed on the Supplementary Bid Form. The City and/or Contract Administrator reserve the right to renegotiate the labour rate. The hourly labour rate will be inclusive of overhead, mark-up, and profit. The labour rate will be inclusive of all labour burden charges as stated in this 'Valuation of Changes' section above.
 - .3 The following labour burdens are not part of the hourly labour cost and are covered under overhead and mark-up or under the NECA labour unit rates: safety measures and regulations, drawings and specifications study, layout, measuring and marking the installation locations, material unloading jobsite storage and delivery to the installation area, inspection, uncrating and shipping support removal, tool-acquisition and return to storage, clean-up of excess material.
 - .4 Submit a detailed labour cost breakdown showing a breakdown of all adders to the base wage rate comprising the proposed hourly rate. The City and the Contract Administrator reserve the right to negotiate the hourly labour rate with the Contractor.

GENERAL INSTRUCTIONS FOR TELECOMMUNICATIONS SECTIONS

- .11 When pricing additional work for Proposed Changes, the Telecommunications Subcontractor shall only price new materials that are required for the Proposed Change. Where existing materials and / or infrastructure (i.e. roughed-in cables) can be re-used for the Proposed Change, the Telecommunications Subcontractor shall utilize these items in the valuation of the Change at no extra cost.
- .12 Where a Proposed Change includes both credits and extras, overhead and permitted mark-ups apply to the net extra or credits, if any, of the entire change.
- .13 When pricing Proposed Changes containing both additions and credits, and where no work and / or materials have been installed on site, the Electrical Subcontractor shall only price the net new materials and net new labour that are required for the Proposed Change. Per unit labour and material costs shall be equal for credits and additions.

GENERAL INSTRUCTIONS FOR TELECOMMUNICATIONS SECTIONS

PROPOSED CHANGE ORDER

Company Name:	CCN #
Address:	Date:
City, Prov.:	Project Name:
Postal Code:	Project Number:
	Quote Number:
Telephone:	Change Order #:
Fax:	
E-Mail address:	
Owner Address:	

Work Description

We reserve the right to correct this quote for errors and omissions.
This quote covers direct costs only.
This price is good for acceptance within 30 days from the date of receipt.

Itemized Breakdown

<u>Description</u>	<u>Qty.</u>	<u>Net Price U</u>	<u>Total Mat(\$)</u>	<u>Labor U</u>	<u>Total Hours</u>
4-Pair Category Cable		\$X.XX C		\$X.XX C	
Termination Module		\$X.XX C		\$X.XX C	
Patch Cord		\$X.XX C		\$X.XX C	
Modular Patch Panel		\$X.XX C		\$X.XX C	
Labelling		\$X.XX C		\$X.XX C	
Testing		\$X.XX C		\$X.XX C	
TOTALS					

Summary

<u>Description</u>	<u>Total Hours</u>
General Materials	\$Y.YY
Material Total	
JOURNEYPerson (xx Hrs. @ \$xx.00)	
Subtotal	
MARK-UP	
Overhead/Mark-up (@ 5.000 %)	
Profit (@ 5.000%)	
Total Mark-up	
Final Amount (TNIP)	

GENERAL INSTRUCTIONS FOR TELECOMMUNICATIONS SECTIONS

PART 2 - PRODUCTS

2.1 Not Used.

PART 3 - EXECUTION

3.1 Cyber Security

- .1 Coordinate with The City's Information Technology representatives, obtain a copy of The City's cyber security policy and provide all applicable cyber security configurations.

3.2 Definitions

- .1 Cyber Assets: Systems (including hardware, software, and data) and Telecommunication networks (including hardware, software, and data).
- .2 Critical Cyber Assets: Those cyber assets that perform critical system functions. The loss or compromise of these cyber assets would adversely affect the operational reliability of the system.
- .3 Cyber Attack: The use of electronic means to interrupt, manipulate, destroy, or gain unauthorized access to a computer system, network, or device.
- .4 Cybercrime: to be any crime where cyber – the internet and information technologies, such as software, firmware, computers, tablets, personal digital assistants or mobile devices – has a substantial role in the commission of a criminal offence.
- .5 Cyber Hygiene: is a reference to the practices and steps that users of computers and other devices take to maintain system health and improve online security. These practices are often part of a routine to ensure the safety of identity and other details that could be stolen or corrupted.
- .6 Cyber Incident: Any unauthorized attempt, whether successful or not, to gain access to, modify, destroy, delete, or render unavailable any computer network or system resource.
- .7 Cyber Security: refers to the body of technologies, processes and practices designed to protect networks, devices, programs, and data from attack, damage, or unauthorized access.
- .8 Cyber Threat or Cyber Security Threat: is a malicious act that seeks to damage data, steal data, or disrupt digital life in general. Cyber threats include computer viruses, data breaches, Denial of Service (DDoS/DoS) attacks and other attack vectors.
- .9 Cyber Threat Actors: is a broad term for any states, groups, or individuals who, with malicious intent, aim to take advantage of vulnerabilities, low cyber-Security awareness, and technological developments to gain unauthorized access to information systems in order to access or otherwise affect victims' data, devices, systems and networks.
- .10 IP Multicast: is a technique for one-to-many and many-to-many real-time communication over an IP Infrastructure network.
- .11 Endpoint: is a remote computing device that communicates back and forth with a network to which it is connected. Such as a server, desktop, or laptop.
- .12 Network Certificates: are also known as a Digital Certificates, which are an electronic "password" that allows a person, organization to exchange data securely over the internet using the public key infrastructure (PKI). Digital Certificates are also known as a public key certificate or identity certificate. There are 3 Main types of certificates:

GENERAL INSTRUCTIONS FOR TELECOMMUNICATIONS SECTIONS

- .1 Secure Socket Layer Certificate (SSL) Digi-SSL
- .2 Software Signing (Code Signing Certificate) Digi-Code
- .3 Client Certificate (Digital ID) Digi-ID
- .13 Social Engineering: are exploitation methods that target human vulnerabilities, such as carelessness and trust.
- .14 Technical Vulnerabilities: are weaknesses or flaws in the design, implementation, operation, or management of an information technology system, device, or service.

3.3 Cyber Security Measures

- .1 The following multi-layered Cyber Security measures shall be implemented at minimum to limit and or reduce The City's potential risk from a cyber threat event, such as a Cyber Security data breach or Cyber Security attack.
- .2 Password Management
 - .1 Employ password management best practices such as:
 - .1 Do not use default passwords.
 - .2 Use strong and unique passwords for all applications. Where there is no password policy inherent in the software use a minimum of 8 characters; use a mixture of uppercase and lowercase letters, numbers, and include at least one special character (! @ # ?]).
 - .3 Reset passwords at regular intervals.
 - .4 Configure two-factor authentication for all accounts where possible in the system software.
 - .5 Do not use System Admin logins for simple tasks. Create separate user accounts with rights levels appropriate for the job function. These user accounts can be defined and created in many ways such as role based, individual logins or assigned roles.
 - .6 Use different passwords for every account.
 - .7 Enforce secure password policies within the business environment.
 - .8 Have interface lock after a predefined # of failed login attempts for a pre-determined time interval.
 - .3 Port and Interface Management
 - .1 Employ Port Management techniques such as:
 - .1 Restrict access on network switch ports to assigned devices addresses.
 - .2 Be sure to lock down all open, unused and unsecure ports on the networking devices such as switches, routers, and firewalls.
 - .3 Shut off all unused communication services and hardware interfaces.
 - .4 The use of 3rd party port security monitoring such as Solarwinds should be investigated and is highly recommended.
- .4 Physical and Virtual Networks

GENERAL INSTRUCTIONS FOR TELECOMMUNICATIONS SECTIONS

- .1 Where a dedicated LAN has not been provided a dedicated VLAN for the Security System including Video Surveillance, Access Control, Intrusion Detection, Duress Alarm, etc. is required.
- .5 Encryption
 - .1 Minimum TLS 1.2 should be used and where available use of TLS 1.3 for all network attached equipment.
- .6 Network Certificates
 - .1 Make sure Network Certificates are up to date and not expired for all equipment and systems.
- .7 Firmware & Software Update Management
 - .1 Be sure to have the latest stable Firmware / Software version on all devices/ equipment/ as well as implement a Firmware/Software Update management process and procedure.
- .8 Manufacturer's System Hardening Guides
 - .1 Be sure to have the Manufacturers System hardening guides provided for the equipment being installed and implement as many recommendations/features as practical to do so.
- .9 External Memory
 - .1 Restrict the use of external memory. The use of devices such as external USB Thumb drives should be restricted or not used at all unless expressly allowed by The City's Information Technology representatives.
- .10 Log Off
 - .1 Enable auto-logoff timer. Be sure to have the local Workstation being used to access the equipment has an auto-logoff timer set with a reasonable timer in the case that the employee leaves it unattended for any amount of time.
- .11 Anti-Virus Software
 - .1 Enable and configure anti-virus software on PC endpoints in accordance with The City's Information Technology requirements, unless it is to be installed and configured by The City.
- .12 Filtering Techniques
 - .1 There are many types of filtering techniques and filters that can be applied and should be investigated for specific project requirements. Some of these filtering techniques are:
 - .1 Web Filtering: A Web filter adds another layer to your anti-phishing defences by blocking the web-based component of phishing and malware attacks.
 - .2 Multicast Message Filtering: Filters the packets sent to multicast groups they are not subscribed to.
 - .3 Content Filtering: is the use of a program to screen and or exclude access to web pages or email deemed objectionable. A content filter will then block access to this content
- .13 Back up Regularly

GENERAL INSTRUCTIONS FOR TELECOMMUNICATIONS SECTIONS

- .1 Provide backup schedule in the closeout submittals and configure system for automatic backups wherever possible. Regularly back up important files either manually or through a scheduled backup procedure. This helps to protect against many types of data loss, especially if a Cyber Threat Actor gains access.

3.4 IT Devices and Systems

- .1 The above listed Cyber security measures can be applied in part or in full to a wide range of Information Technology (IT) Devices. A list of some of these device types are:
 - .1 Firewalls
 - .2 Routers
 - .3 Network switches (Core and Edge Devices)
 - .4 Servers and databases
 - .5 Workstation computers
 - .6 Network connected system devices and controllers
 - .7 Wireless Access Points and wireless controllers
 - .8 Mobile phones and tablets
 - .9 Any IT System or endpoint connected to the network can have some form of Cyber security measure applied to it.

3.5 OT Devices and Systems

- .1 These Cyber security measures can also be applied in part or in full to a wide range of Operational Technology (OT) Network devices.
 - .1 Industrial Control Systems such as:
 - .1 (PLC's) Programmable Logic Controllers are an industrial digital computer which has been ruggedized and adapted for the control of manufacturing processes, such as assembly lines, or robotic devices.
 - .2 (SCADA) Supervisory Control and Data Acquisition is a control system architecture comprising of computers, networked data communications and graphical user interfaces (GUI) for high level process supervisory management.
 - .3 (DCS) Distributed Control System is a computerized control system for a process or plant usually with many control loops, in which autonomous controllers are distributed throughout the system.
 - .4 (CNC) Computer numerical Control is the automated control of machining tools (Drills, boring tools, lathes) and 3D printers by means of a computer.
 - .2 BMS/BAS (Building Management and Building Automation Systems)
 - .3 HVAC equipment
 - .4 Lighting controls for both internal and external applications
 - .5 Energy monitoring and metering equipment
 - .6 Transportation and parking systems
 - .7 Scientific equipment
 - .8 Any other OT System or endpoint that can be connected to the network

GENERAL INSTRUCTIONS FOR TELECOMMUNICATIONS SECTIONS

.2 Report Cybercrime

- .1 When performing any work on a network connected system advise the The City and or their representatives of any indication of a Cyber Incident of a criminal nature.

.3 Cyber Security Report Letter

- .1 When implementing any and or all of the Cyber Security Measures mentioned in this Specification, be sure to include a report letter in the closeout documents to The City stating which Cyber Security measures have been implemented.

3.6 Site Examination

- .1 Prior to submitting their tender response, perform a site survey (when available) to familiarise their workers with the site and all conditions of the site affected by the proposed Work. No claims for extra payment will be considered because of failure to fulfil this condition.

END OF SECTION

DEFINITIONS AND ABBREVIATIONS

PART 1 - GENERAL

1.1 Definitions

.1 Generally, the following definitions are used in this Division:

Addendum	- Normative document used to provide additional requirements and recommendations to a published document (e.g., standards, contracts). When published, an addendum effectively becomes part of the document that it supports.
Basic Link	- The Basic Link configuration consists of a maximum of 90 meters (295 ft) of uninterrupted solid-copper twisted-pair cable with a termination connection on each end.
Bonding	- The permanent joining of metallic parts to form an electrically conductive path that will ensure electrical continuity and the capacity to conduct safely any current likely to be imposed.
Bonding Conductor (BC)	- A conductor used specifically for the purpose of bonding.
Building Entrance Facility	- The room or space inside a building where telecommunications cables enter and leave the building.
Category	- A rating that defines the performance of cabling components and systems. Describes mechanical properties and transmission characteristics of balanced twisted-pair cabling and provides a numbered designation.
Channel	- Complete end to end connection including patch cords, cable and termination device(s).
Cut Over	- The live date(s) when The City will occupy the space as indicated by date and/or phasing.
Demolish	- Detach existing items and legally dispose of them off site.
Drawings	- Details, diagrams, layouts, schedules, and other information in a design drawing package accompanying this specification.
Grounded Conductor	- A system or circuit conductor that is intentionally grounded.
Grounding System	- A system of hardware and wiring that provides an electrical path from a specified location to an earth ground point.
Modular Copper Patch Panel	- A patch panel that allows each RJ-45 female jack (or port) to be removed individually.

DEFINITIONS AND ABBREVIATIONS

Owner	-	Person or company that will own the system and components.
Permanent Link	-	The Permanent Link is a Basic Link that has been tested to the applicable cabling performance for the relevant standard.
Project	-	Supply and installation of a complete Structured Cabling Solution to support Voice, Data and/or Video applications as described in this document.
Provide	-	Supply, install, test, configure, and document.
Shop Drawings	-	Contractor provided construction drawings to facilitate compliance with the plans and specifications.
Telecommunications Subcontractor	-	The successful bidder to this Specification responsible for the supply and installation of the Structured Cabling Solution as detailed in this document and associated Drawings.
Contractor Administrator (Telecommunications Engineer's Representative)	-	Muhieddine Salhab Smith + Andersen 1100 - 100 Sheppard Avenue East, Toronto, ON - M2N 6N5
Telecommunications Outlet	-	A fixed connecting device where the horizontal cable terminates that provides the interface to the work area cabling and is typically found on the floor, wall, ceiling or on furniture.
Work Area	-	Work area (WA) components extend from the telecommunications outlet/connector end of the horizontal cabling system to the WA equipment.
Workstation	-	Systems Furniture Workstation, Office, Meeting Room, Boardroom, Classroom, etc. Any Voice or Data cable originating in a Telecom, LAN, Computer Room or Consolidation Point that is not terminated on a patch panel / IDC Block at the other end.

1.2 Abbreviations

.1 Generally, the following abbreviations are used in this Division:

A	-	Ampere
ac	-	Alternating current
ACR	-	Attenuation to Cross-Talk Ratio
ADC	-	Analog to Digital Converter
ADSL	-	Asymmetric Digital Subscriber Line

DEFINITIONS AND ABBREVIATIONS

A/E	- Architect or Engineer
AFF	- Above Finished Floor
AHJ	- Authority Having Jurisdiction
ALPETH	- Aluminum Polyethylene
AME	- Architectural, Mechanical, Electrical
AN	- Access Node
ANSI	- American National Standards Institute
AP	- Access Point
ARPAP	- Resin-coated Aluminum, Polyethylene Aluminum, Polyethylene
ASCII	- American Standard Code for Information Interchange
ASP	- Aluminum Steel Polyethylene
ASTM	- American Society for Testing and Materials
ATD	- Asynchronous Time Division
ATDM	- Asynchronous Time Division Multiplexing
ATM	- Asynchronous Transfer Mode
Attn	- Attenuation
AV	- Audiovisual
AWG	- American Wire Gauge
BAS	- Building Automation System
BC	- Bonding Conductor
BCD	- Backbone Conduit
BCT	- Bonding Conductor for Telecommunications
BEF	- Building Entrance Facility
BER	- Bit Error Rate
BERT	- Bit Error Rate Test
BFOC	- Bayonet Fibre Optic Connector
BIC	- Building Industry Consultant
BICSI®	- Building Industry Consulting Service International
bit	- Binary Digit
BOM	- Bill Of Material
b/s	- Bit per Second
BWA	- Broadband Wireless Access
CA	- Cable
CACSP	- Coated Aluminum Coated Steel Polyethylene

DEFINITIONS AND ABBREVIATIONS

CAD	- Computer Aided Design
CATV	- Community Antenna Television (Cable Television)
CCIA	- Computer Communications Industry Association
CCTV	- Closed Circuit Television
CD	- Compact Disc
CEC	- Canadian Electrical Code
CEF	- Cable Entrance Facility
CENELEC	- European Committee for Electrotechnical Standardization
cm	- Centimetre
CMP	- Communications Plenum
CMR	- Communications Riser
coax	- Coaxial Cable
CO-OSP	- Customer-Owned Outside Equipment
CP	- Consolidation Point
CPU	- Central Processing Unit
CPVC	- Chlorinated Polyvinyl Chloride
CRTC	- Canadian Radio-television Telecommunications Commission
CSA	- Canadian Standards Institute
CSC	- Construction Specifications Canada
CSI	- Construction Specifications Institute
CT	- Cable Tray
Cu	- Copper
dB	- Decibel
dB/km	- Decibel per Kilometre
dBm	- Decibel milliwatt
dBmV	- Decibel millivolt
demarc	- Demarcation Point
D-ring	- Distribution Ring
DID	- Direct Inward Dialing
DSL	- Digital Subscriber Line
EF	- Entrance Facility
EIA	- Electronics Industry Alliance
ELFEXT	- Equal Level Far-End Crosstalk
e-mail	- Electronic Mail

DEFINITIONS AND ABBREVIATIONS

EMI	- Electromagnetic Interference
EMI/RFI	- Electromagnetic Interference / Radio Frequency Interference
ER	- Equipment Room
ESD	- Electrostatic Discharge
ETL	- Edison Testing Laboratories
e/w	- Equipped With
FC	- Fibre Connector
FCC	- Federal Communications Commission
FDDI	- Fibre Distributed Data Interface
FEP	- Fluorinated Ethylene Propylene
FEXT	- Far-End Crosstalk
FOTP	- Fibre Optic Test Procedure
ft	- Foot / Feet
ft ²	- Square Foot / Feet
FTTD	- Fibre To The Desk
FT 1 / FT 3	- Fractional T 1 / Fractional T 3
G	- Giga
Gb	- Gigabit
GB	- Gigabyte
Gb/s	- Gigabit per Second
GHz	- Gigahertz
GWB	- Gypsum Wall Board
HC	Horizontal Cross-connect
Hz	- Hertz
I	- Current
IC	- Intermediate Closet
IC	- Intermediate Cross-connect
ID	- Identification
ID	- Inside Diameter
IDC	- Insulation Displacement Connection
IDC	- Insulation Displacement Connector
IDC	- Insulation Displacement Contact
IDF	- Intermediate Distribution Frame
IEEE®	- Institute of Electrical and Electronics Engineers, Inc. ®

DEFINITIONS AND ABBREVIATIONS

IG	- Isolated Ground
in	- Inch
in2	- Square Inch
I/O	- Input / Output (Device)
ICEA	- Insulated Cable Engineers Association
IEC	- International Electrotechnical Commission
IOR	- Index Of Refraction
ISDN	- Integrated Services Digital Network
ISO	- International Organization for Standardization
IT	- Information Technology
kb	- Kilobit
kB	- Kilobyte
kg	- Kilogram
Km	- Kilometre
kV	- Kilovolt
kVA	- Kilovoltampere
kW	- Kilowatt
kWh	- Kilowatt hour
LAN	- Local Area Network
laser	- Light Amplification by Stimulated Emission of Radiation
lb	- Pound
LED	- Light Emitting Diode
LEN	- Local Exchange Node
LSZH	- Low Smoke Zero Halogen
m	- Metre
m2	- Square Metre
mA	- Milliampere
MAC	- Move, Add, or Change
MAN	- Metropolitan Area Network
Mb	- Megabit
MB	- Megabyte
Mb/s	- Megabit per Second
MB/s	- Megabyte per Second
MC	- Main Cross-connect

DEFINITIONS AND ABBREVIATIONS

MDF	- Main Distribution Frame
MGB	- Main Grounding Busbar
MHz	- Megahertz
mi	- Mile
MIMS	- Mineral Insulated Metal Sheathed
min	- Minute
mm	- Millimetre
MM	- Multimode
MMF	- Multimode Fibre
MPP	- Modular Patch Panel
ms	- Millisecond
MSDS	- Material Safety Data Sheet
MUTO	- Multi-user Telecommunications Outlet
MUTOA	- Multi-user Telecommunications Outlet Assembly
mW	- Milliwatt
MW	- Megawatt
NBCC	- National Building Code of Canada
NESC	- National Electrical Safety Code
NEXT	- Near-end Crosstalk
NIC	- Network Interface Card
NIR	- Near-end crosstalk-to-Insertion loss Ratio
NRCC	- National Research Council of Canada
OD	- Outside Diameter
ODBC	- Open Database Connectivity
OEM	- Original Equipment Manufacturer
OF	- Optical Fibre
OSP	- Outside Plant
PBX	- Private Branch Exchange
PDU	- Power Distribution Unit
PSACR	- Power Sum Attenuation to Crosstalk Ratio
PSELFEXT	- Power Sum Equal Level Far-End Crosstalk
PSNEXT	- Power Sum Near-End Crosstalk
PVC	- Polyvinyl Chloride
QA	- Quality Assurance

DEFINITIONS AND ABBREVIATIONS

QC	- Quality Control
QoS	- Quality of Service
RCDD®	- Registered Communications Distribution Designer
RF	- Radio Frequency
RFI	- Radio Frequency Interference
RFQ	Request for Quote
RJ	- Registered Jack
rms	- Root Mean Square
RU	- Rack Unit (1.75")
RX	- Receive
RX	- Receiver
SAN	- Storage Access Network
SC	- Single Fibre Coupling Optical Fibre Connector
SCC	- Standards Council of Canada
SCS	- Structured Cabling System
ScTP	- Screened Twisted Pair
SFTP	- Screened Foiled Twisted Pair
SI	- International System of Units (Le Système International d'Unités)
SLA	- Service level Agreement
SM	- Singlemode
SMF	- Singlemode Fibre
SNMP	- Simple Network Management Protocol
SNR	- Signal-to-Noise Ratio
STALPETH	- Steel Aluminum Polyethylene
STP	- Shielded Twisted Pair
STP-A	- Shielded Twisted Pair A
T 1	- Trunk Level 1
TBB	- Telecommunications Bonding Backbone
TBBIBC	- Telecommunications Bonding Backbone Interconnecting Bonding Conductor
TC	- Telecommunications Closet
TDD	- Telecommunications Device for the Deaf
TGB	- Telecommunications Grounding Busbar
TGR	- Telecommunications Grounding Rod
TIA	- Telecommunications Industry Association

DEFINITIONS AND ABBREVIATIONS

TMGB	- Telecommunications Main Grounding Busbar
TN	- Telecommunications Node
TP	- Twisted Pair
TR	- Telecommunications Room
TS	- Technical Standard
TSB	- Telecommunications Systems Bulletin (formerly Technical Systems Bulletin)
TTY	- Teletypewriter / Text Telephone
TV	- Television
TX	- Transmit
TX	- Transmitter
UD	- Underfloor Duct
UL®	- Underwriters Laboratories Inc.®
ULC	- Underwriters Laboratories of Canada
UPC	- Universal Product Code
UPS	- Uninterruptible Power Supply
UTP	- Unshielded Twisted Pair
V	- Volt
VA	- Volt-Ampere
VCSEL	- Vertical Cavity Surface Emitting Laser
VLAN	- Virtual Local Area Network
VoIP	- Voice over Internet Protocol
VPN	- Virtual Private Network
W	- Watt
WAN	- Wide Area Network
WAP	- Wireless Application Protocol
WiFi	- Wireless Fidelity
Wi-Fi	- Wireless Fidelity
WLAN	- Wireless Local Area Network
WMAN	- Wireless Metropolitan Area Network
WWAN	- Wireless Wide Area Network
X	- Cross-connect
XLPE	- Cross-linked Polyethylene
XPE-PVC	- Expanded Polyethylene Polyvinyl Chloride

DEFINITIONS AND ABBREVIATIONS

PART 2 - PRODUCTS

2.1 Not Used

PART 3 - EXECUTION

3.1 Not Used

END OF SECTION

CODES, STANDARDS AND REGULATIONS

PART 1 - GENERAL

.1 Code, Standard and Regulation Compliances

- .1 The Telecommunications Subcontractor shall adhere to all Codes, Standards, Regulations and documents listed throughout this document.
- .2 All products installed must meet or exceed all Local, Provincial and Federal Building, Fire, Health, Safety and Electrical Codes.
- .3 The non-plenum/plenum cable shall be ETL or ULC Listed and CSA Certified as type CMR/CMP, in accordance with the Binational Standard for Telecommunications Cable, UL444/C22.2 No. 214-17.
- .4 The equipment, material and installation shall conform to the latest version of the applicable Codes, Standards and Regulations of Authorities Having Jurisdiction as indicated in Table 1. In the case of conflict or discrepancy the more stringent code, standard or regulation shall apply.
- .5 Table 1: Applicable Codes, Standards and Regulations

STANDARD	TITLE
ANSI/ICEA	
S-80-576	Communication Cables.
S-83-596	Optical Fibre Premises Distribution Cable, latest version
S-87-640	Optical Fibre Outside Plant Communications Cable, latest version
S-104-696	Standard for Indoor-Outdoor Optical Cable, latest version
Z136.2	American Standards for the Safe Operation of Optical Fibre Communication Systems Utilizing Laser Diode and LED Sources.
ANSI/TIA	
455	Standard Test Procedures for Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices and Other Fiber Optic Components – latest version
472CAAA-93	Detail Specification for All-Dielectric (Construction 1) Optical Fibre Communications Cable for Indoor Plenum Use, Containing Class Ia, 62.5 mm Core Diameter/125 Cladding Diameter Optical Fibre(s).
472DAAA-93	Detail Specification for All-Dielectric Optical Fibre Communications Cable for Outside Plant Use, Containing Class Ia, 62.5 mm Core Diameter/125 mm Cladding Diameter/250 mm Coating Diameter Optical Fibre(s).

CODES, STANDARDS AND REGULATIONS

492AAAA-09	Detail Specification for 62.5-mm Core Diameter/125-mm Cladding Diameter Class Ia Multimode, Graded-Index Optical Waveguide Fibres.
492AAAB-09	Detail Specification for 50.0-mm Core Diameter/125-mm Cladding Diameter Class Ia Multimode, Graded-Index Optical Waveguide Fibres.
492CAAA-98	Detail Specification for Class IVa Dispersion-Unshifted Singlemode Optical Waveguide Fibres Used In Communications Systems.
526-14	Optical Power Loss Measurement of Installed Multimode Fibre Cable Plant; Modification of IEC 61280-4-1 edition 2, Fibre-Optic Communications Subsystem Test Procedures – Part 4-1: Installed Cable Plant-Multimode Attenuation Measurement
568.0	Generic Telecommunications Cabling for Customer Premises, latest version.
568.1	Commercial Building Telecommunications Infrastructure Standard, latest version.
568.2	Balanced Twisted Pair Telecommunications Cabling and Component Standard, latest version.
568.3	Optical Fibre Cabling Components Standard, latest version.
568.4	Broadband Coaxial Cabling and Components Standard, latest version.
568.5	Balanced Single Twisted Pair Telecommunications Cabling and Component Standard, latest version.
569	Commercial Building Standard for Telecommunications Pathways and Spaces including all addenda, latest version
598	Optical Fibre Cable Colour Coding, latest version
570	Residential Telecommunications Infrastructure Standard, latest version.
604-5	FOCIS 5 Fiber Optic Connector Intermateability Standard- Type MPO, latest version.
606	Administration Standard for Telecommunications Infrastructure, latest version.
607	Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises, latest version.

CODES, STANDARDS AND REGULATIONS

758	Customer Owned Outside Plant Telecommunications Cabling Standard, latest version.
862	Structured cabling infrastructure Standard for Intelligent Building Systems, latest version.
942	Telecommunications Infrastructure Standard for Data Centers
1005	Telecommunications Infrastructure Standard for Industrial Premises
CSA	
C22.1	Canadian Electrical Code Part I: Safety Standards for Electrical Installations, latest version.
C22.2 No. 41	Grounding & Bonding Equipment
C22.2 No. 182.4-M90	Plugs, Receptacles, and Connectors for Communication Systems, latest version.
C22.2 No. 214-17	Communications Cables.
CAN/CSA-C22.2 No. 0-10	General Requirements, Canadian Electrical Code, Part II (latest version)
OTHER	
CAN/ULC-S115	Standard Method of Fire Tests of Firestop Systems, latest version.
CAN/ULC S101	Standard Method of Fire Endurance Tests of Building Construction and Materials, latest version.
CAN/ULC S102	Standard Method of Testing for Surface Burning Characteristics of Building Materials and Assemblies, latest version.
CENELEC EN 50173	Information Technology – Generic Cabling Systems Part 1: General Requirements, latest version
CLC	Canada Labour Code, Part II Occupational Health and Safety, and Provincial and Local Health and Safety regulations
ICEA S-90-661	Category 3, and 5e Individually Unshielded Twisted Pair Indoor Cables (with or without an overall shield) for use in General Purpose and LAN Communication Wiring Systems, latest version.
IEC 60603-7	Connectors for electronic equipment - Part 7: Detail specification for 8-way, unshielded, free and fixed connectors, latest version.

CODES, STANDARDS AND REGULATIONS

ISO/IEC IS 11801-1	Information Technology - Generic Cabling for Customer Premises – Part 1: General Requirements, latest version.
NEMA WC 63.1	Performance Standard for Twisted Pair Premise Voice and Data Communications Cable, latest version.
RoHS	Restriction of Hazardous Substances Directive 2011/65/EU, latest version

- .6 Comply with all Local, Provincial and Federal codes for fire and electrical, as well as all local laws, where applicable and with requirements of the Canadian Standards Association (CSA) when mandatory. Make any changes or alterations required by the authorised inspector of the Authority Having Jurisdiction, at no extra charge to The City.
- .2 General Installation Requirements
 - .1 Provide all scaffolding, rigging, hoisting and services necessary for erection and delivery of equipment, apparatus and installation of systems cabling solution furnished into premises. Remove these items from premises when no longer required.
- .3 Metric Conversions
 - .1 Particular care shall be taken with imperial versus S.I. metric conversions. This applies to all services including, equipment, material, and site services in both new and existing installations.
- .4 Cutting, Patching and Repairing
 - .1 Perform all cutting, patching, repairing, and making good related to the Telecommunications Cabling Work including any penetrations through walls or floors.
 - .2 Allow for all costs associated with cutting, patching, repair, and making good related to the Telecommunications Work including any penetrations through walls or floors.
 - .3 Paint all visible Telecommunications conduit to match existing.
 - .4 Coordinate the colour and location of all conduits, devices, and their housing with Contract Administrator and architectural drawings on-site before installation.

PART 2 - PRODUCTS

2.1 Not Used

PART 3 - EXECUTION

3.1 Code, Standard and Regulation Compliances

- .1 Install and terminate all cables and components in accordance with CSA, the latest edition of ANSI/TIA-568 and its Amendments as well as UL/ULC Guidelines. Maintain the integrity of the pair twists, bend radius and ensuring proper distance is kept from fluorescent light fixtures, electrical cables or any other source of EMI.

CODES, STANDARDS AND REGULATIONS

- .2 Comb and bundle all cables in a neat and organised manner. The Contract Administrator will determine neatness of the installation. Cables that have not been properly combed and dressed shall be re-dressed at the Telecommunications Subcontractor's expense. Coordinate with the Contract Administrator prior to re-dressing cables.
- .3 The maximum horizontal run length for 4-pair cabling shall not exceed 90-metres. If the 90-metre constraint cannot be met, notify the Contract Administrator of any cables that exceed 90-metres, prior to installation.

END OF SECTION

CONTRACT DOCUMENTS

PART 1 - GENERAL

1.1 Contract Documents

- .1 Read and complete the Telecommunications Tender forms.
- .2 All Contract Documents, including all General Conditions, Division 1 Specification Sections (if present) and Instructions to Bidders apply to this section and all other Specification sections.

1.2 Work Included

- .1 Drawings List
 - .1 Refer to the drawing list in the Telecommunications Drawings for a list of drawings that shall be used for preparation of bids and construction.

PART 2 - PRODUCTS

2.1 Not USED

PART 3 - EXECUTION

3.1 Coordination

- .1 Carefully examine Work and Drawings of all related trades and thoroughly plan the Work to avoid conflict or interference with other services. Report defects that would adversely affect Work. Do not commence installation until defects have been corrected. Beginning the Work constitutes acceptance of conditions as satisfactory.
- .2 Co-ordinate the Work of this Contract such that items will properly interface with the Work of other trades. Prepare installation drawings of critical locations and submit to the Contract Administrator for review.

END OF SECTION

ADMINISTRATIVE REQUIREMENTS

PART 1 - GENERAL

1.1 Project Closeout Submittals

- .1 Project closeout submittals shall include:
 - .1 Table of contents
 - .2 As-built drawings
 - .3 Cable Test Results
 - .4 Connectivity Database
 - .5 Warranty Letters
 - .6 Manufacturer Certification
 - .7 Cyber Security Report Letter
 - .8 Seismic Restraint Letter
 - .9 Fibre Optic Safety Letter

1.2 Work Included

- .1 Closeout Submittal – As-built Drawings
 - .1 Prepare drawing(s) to clearly mark all changes and deviations during the construction process, including the pathway of the cables from the Telecom Room(s) to the Workstations or between Telecom Rooms. Drawing(s) shall be kept up-to-date during construction and in addition to field measurements shall include field instructions and all other changes. Include all additional cables installed during the project in the as-built drawings.
 - .2 The Contract Administrator has the right to review the status of the as-built drawing(s) from time to time during the construction process. On completion of the project, submit to the Contract Administrator a soft copy of as-built drawings indicating all such changes and deviations for review within five (5) business days of the completion of the project.
 - .3 Request (in writing) from the Contract Administrator a soft copy of the Drawings for use by the Telecommunications Subcontractor in preparation for as-built Drawings. Update the soft copy drawing(s) with correct as-built information (i.e. cable numbers, outlet locations, rack/backboard elevations, etc.) in digital format using the most current version of the Drawings native format (e.g.: AutoCAD or Revit).
 - .4 All changes to drawing(s) shall follow conventional Engineering Draft Standards. All outlet locations shall be identified with proper designation.
 - .5 If the Telecommunications Subcontractor cannot comply with this requirement, Smith + Andersen will transfer all hand drawn as-builts to the Drawing's native format (AutoCAD or Revit) at a cost to the Telecommunications Subcontractor. The cost for this service shall be based on per diem rates at time of completion.
 - .6 Print / plot two sets of as-built Drawings at no extra cost. Final as-built print(s)/plot(s) must not contain markings or corrections by hand (i.e. marker, pen, pencil, etc.) and shall be delivered to The City.

ADMINISTRATIVE REQUIREMENTS

- .7 The project will remain incomplete and a holdback will be retained until satisfactory as-built drawing(s) are provided.
- .2 Closeout Submittal – Cable Test Results
 - .1 Produce a test report based on the cable schedules. The report shall indicate for each cable, when it was tested successfully and the signature of the technician that performed the test.
 - .2 An authorized person certified with the Manufacturer for the Telecommunications Subcontractor must sign the entire report. Supply one (1) soft copy in the tester's native format, along with the appropriate software to read the test results.
 - .3 The project will remain incomplete and a holdback will be retained until satisfactory cable test results are provided.
 - .4 Provide testing and commissioning documentation for all items and their related components to the Contract Administrator prior to the completion of the project or at the Contract Administrator request. Include maintenance manuals and operating instructions for The City's staff use.
- .3 Closeout Submittal – Warranty
 - .1 Provide a minimum of a 2-year unconditional parts and labour Warranty for all equipment and labour provisioned under this Contract, from the date of substantial performance of the Contract, for each Telecommunications cabling system.
 - .2 Response time for Warranty items shall be 24 hours. Repair deficient Cabling Solution components outside regular working hours. Bidders shall include a statement of Warranty terms and conditions with their Contract documents.
- .4 Closeout Submittal – Manufacturer Certification
 - .1 Arrange for a minimum of 25-year Manufacturer's Warranty and System Performance Guarantee, from the date of substantial performance of the Contract, for each Telecommunications cabling system.
 - .2 Provide a manufacturer Warranty that the Structured Cabling Solution is installed and fully operating in accordance with this and the manufacturer Specifications.
 - .3 Upon request and at no additional cost to The City, the Telecommunications Subcontractor must provide a manufacturer's technical representative to conduct an on-site visit to ensure complete technical compliance.
 - .4 All documentation including the certificate must be in English and French, and shall be submitted to the Contract Administrator for signed acceptance prior to their production.

ADMINISTRATIVE REQUIREMENTS

.5 Closeout Submittal – Connectivity Database

- .1 The Telecommunications Subcontractor shall prepare separate Data and Voice Connectivity Databases in Microsoft Excel spreadsheet format that includes the following:
- .2 Data and/or Voice (VoIP) - For data connectivity, this shall include but must not be limited to workstation identification or number, horizontal Data cable number, active equipment port and copper and/or fibre backbone cable/strand.
- .3 Voice (Centrex) - For voice connectivity, this shall include but must not be limited to workstation identification or number, horizontal Voice cable number, backbone pair, service provider demarcation pair(s), DID and LEN.
- .4 Voice (PBX) - For voice connectivity, this shall include but must not be limited to workstation identification or number, horizontal Voice cable number, backbone pair and Telephone Switch/Node TN.
- .5 The Telecommunications Subcontractor shall only be required to provide this information when the Telecommunications Subcontractor is responsible for the installation of patching/cross-connect of the data and/or voice systems.
- .6 One electronic copy shall be supplied to the Contract Administrator.

.6 Closeout Submittal – Cyber Security Letter

- .1 Prepare a letter confirming The City's cyber security policy was reviewed, and all applicable cyber security configurations are implemented. Where The City does not have a cyber security policy, state in the letter what measures have been taken to protect The City from Cyber Incidents.

.7 Closeout Submittal – Seismic Restraint Letter

- .1 Prepare a letter confirming the installation adheres to all seismic restraint requirements. The letter must be signed and sealed by the Professional Engineer responsible for the design of the seismic for restraint system.
- .2 Refer to section 27 05 48 SEISMIC PROTECTION for requirements.

.8 Closeout Submittal – Fibre Optic Safety Letter

- .1 Prepare a letter confirming safety labels have been provided at all required locations, and that they will meet performance requirements.
- .2 Refer to section 27 05 53 – IDENTIFICATION FOR COMMUNICATIONS SYSTEMS for location and maintenance requirements.

.9 Project Submittal – Shop Drawings

- .1 Shop Drawings shall indicate clearly the materials and/or equipment actually being supplied, all details of construction, accurate dimensions, capacity, operating characteristics and performance. Each Shop Drawing shall give the identifying number of the specific assembly for which it was prepared.
- .2 Prepare specifically for this project each Shop Drawing for non-catalogue items. Clearly mark Shop Drawings and brochures for catalogue items to show what is being supplied.
- .3 Stamp and sign each Shop Drawing or catalogue sheet shall to indicate the drawing has been checked by the Telecommunications Subcontractor for

ADMINISTRATIVE REQUIREMENTS

conformance with all requirements of the Drawings and Specifications, that they have co-ordinated this equipment with other equipment to which it is attached and/or connected and that they have verified all dimensions to ensure the proper installation of equipment within the available space and without interference with the work of other trades. Ensure that co-ordination is complete before submitting Shop Drawings for review.

- .4 Installation of any equipment shall not start until after final review of Shop Drawings by the Contract Administrator has been obtained.
 - .5 When requested, supplement Shop Drawings by data explaining the theory of operation. The Contract Administrator may also request that this information be added to the maintenance and operating manual.
 - .6 Provide space for Shop Drawing review stamps for the Telecommunications Subcontractor and Contract Administrator. This space shall be clear of all technical information and shall not be on the back of any sheets.
 - .7 One original Shop Drawing will be returned. All copies required for the trades, suppliers or other Consultants will be printed by the Telecommunications Subcontractor.
- .10 Project Submittal – Permits, License Reviews and Fees
- .1 Where materials are specified which require special review and approval of CSA and/or local Authorities Having Jurisdiction, obtain such approval for the particular installation with the co-operation of the material supplier. Obtain and pay for permits and reviews required for Work performed.
 - .2 Submit required Documents and Shop Drawings to authorities having jurisdiction in order to obtain approval for the Work. Copies of Drawings and Specifications may be used for this purpose. Prepare any additional information, details and Drawings these authorities may require.
- .11 Project Submittal – Substitutions and Alternate Products
- .1 This document specifies the use of a complete end-to-end Structured Cabling Solution as manufactured, warranted and certified by a single manufacturer. Alternate materials (from the overall cabling solution) will not be accepted unless specifically noted.
 - .2 Where supply of the materials may compromise the schedule, submit a request to use alternate product to the Contract Administrator. Depending on the circumstance, the Contract Administrator may provide written authorisation to substitute the Product. Obtain written authorization before providing alternates.
 - .3 Where a separate price is requested in this document, prepare quotation(s) to install/provide products and/or systems as outlined. Submit the separate price quotation with the bid response. Instructions and products requested under separate price sections shall not be considered substitutions or alternate products.

ADMINISTRATIVE REQUIREMENTS

- .4 The Contract Administrator's decision regarding the acceptance or rejection of the proposed substitution is final. Substitutions may be accepted if the delivery of the component or item is such that it will not jeopardise the construction schedule. Otherwise, the substitution may not be approved.
- .5 In order to be assessed, proposed substitutions must include the following:
 - .1 Description of proposed substitution,
 - .2 Respective cost of items originally specified and the proposed solution,
 - .3 Compliance with the applicable Building Codes and the requirements of Authorities Having Jurisdiction,
 - .4 Compliance with the applicable Telecommunications standards,
 - .5 Affect concerning compatibility with and interface with adjacent building materials and components,
 - .6 Compliance with the intent of the Contract Documents, and
 - .7 Reason(s) for the request.
- .6 Substitution submissions do not relieve the Telecommunications Subcontractor from the obligation of preparing and submitting a Contract documents that is in complete compliance with this specification document and associated Drawings. Any substitution submissions must be clearly outlined in addition to the original specified equipment as detailed in this document and associated Drawings as a separate or alternate price format.
- .12 Project Submittal – Scheduling
 - .1 Within one week of award of the Contract, submit a formal project schedule to the Contract Administrator showing start and finish dates of major tasks as denoted by system such as: demolition, backbone cabling, horizontal cabling, rack and cabinet installation, material order and delivery to site and testing.
 - .2 Submit updated schedules as periodically requested by Contract Administrator.
- .13 Project Submittal – Review and Testing Requirements
 - .1 Develop and submit a test plan indicating the process and types of tests to be performed. The plan must indicate the testing process for each cable.
 - .2 The Contract Administrator must approve the testing procedure prior to testing commencing and may request to be present during the initial testing.
 - .3 Invite the Contract Administrator to witness field testing a minimum of five (5) business days before testing commences.
 - .4 Upon completion of the testing the Contract Administrator may request a random test of up to 10% of the links. The Telecommunications Subcontractor shall test these randomly selected links and the results shall be stored in accordance with this document. The results obtained shall be compared to the original test data. A penalty of \$50.00 shall be deducted from the Contract amount for each cable that fails to pass the random test. If more than 2% of the sample results differ in terms of the pass/fail determination, repeat 100% testing under the supervision of the Contract Administrator. The cost of the labour required for the testing as well as the cost for the supervision by the part of Contract Administrator shall be borne by the Telecommunications Subcontractor.

ADMINISTRATIVE REQUIREMENTS

- .14 Keep the site and surrounding area clean, safe and free from debris at all times. Remove all debris from the site on a daily basis. The costs for cleaning are the responsibility of the Telecommunications Subcontractor.
- .15 Upon completion of the Work and before acceptance and final payment will be made, clean and remove from the site, all surplus and discarded materials, temporary structures and debris of every kind. Surplus and waste materials removed from the site shall be disposed of in accordance with applicable laws and regulations.
- .16 Before acceptance by the Contract Administrator, all the equipment and cabling must be cleaned and tested.

PART 2 - PRODUCTS

2.1 Not Used.

PART 3 - EXECUTION

3.1 Not USED.

END OF SECTION

PROJECT SPECIFIC REQUIREMENTS

PART 1 - GENERAL

1.1 Work Included

.1 Cable Installation

- .1 The Telecommunications Subcontractor may assume at their own risk that the entire cable installation will be done during regular hours, except:

- .1 Where noted otherwise in this specification.
- .2 As outlined in the project front end documents.

.2 Floor/Ceiling Tiles

- .1 Remove and re-install all floor/ceiling tiles in areas affected by the Work. This shall be done on a daily basis for all areas that are occupied during the construction period. Otherwise, remove and re-install the tiles after the Work is complete.
- .2 Any damage to ceiling tiles during the installation of any Work described in this document is the responsibility of the Telecommunications Subcontractor. Damages include chipping, breaking and/or soiling. Final decisions on the trade responsible for any damage to ceiling tiles shall be made by The City and/or the Contract Administrator.
- .3 The Telecommunications Subcontractor shall be responsible for storage and protection of floor/ceiling tiles when they have been removed from the floor/ceiling grid.

.3 Cut Over Planning and Management

- .1 Include for a total of 16 hours cut over support, to be used at the discretion of The City/Contract Administrator. The technician shall be available to provide services to The City as required. This may involve additional testing or Move, Add, Change (MAC) activity. Any additional materials used shall be addressed separately.
- .2 Schedule installers such that the cut over schedule is maintained. Any shift work or overtime premiums that are required to complete the project on schedule shall be included in the Telecommunications Subcontractor's Contract Price.

.4 Safety of Persons and Property

- .1 Comply with all laws, ordinances, rules, regulations, and policies of The City and lawful orders of any public Authority Having Jurisdiction for safety of persons or property or to protect them from damage, injury or loss.
- .2 Moderate public pedestrian traffic should be expected around all Work locations. Ladders scaffold, installation materials, and all other hazardous conditions shall be fully protected at all times. Warning cones, signs, barricades and warning tapes shall be used to warn and protect persons and property at all times in public corridors.
- .3 Work shall not interfere with legal fire exits. Corridors, areas of egress, fire protection stand pipes, hydrants and exit stairs shall be maintained at all times.
- .4 Maintain at all times free access to fire lanes and emergency and utility control facilities such as fire alarm boxes, utility vaults, manholes and junction boxes.

PROJECT SPECIFIC REQUIREMENTS

- .5 No open flames/smoking shall be permitted without prior written approval of The City.
- .6 Set up and remove all signage and safety measures to ensure that other trades and non-trade personnel are safe from work of the Telecommunications Subcontractor.
- .5 Access to Site
 - .1 Coordinate site access with the Project Manager and/or The City as determined during the initial project meeting.
- .6 Identification
 - .1 All Telecommunications Subcontractor personnel shall be clearly identified by either uniform or company ID. The Telecommunications Subcontractor may also be required to wear City provided ID for required card access locations or identification. All City ID(s) must be returned daily or at the end of the project as determined by The City.
- .7 Emergency Facilities
 - .1 The Telecommunications Subcontractor shall maintain at all times free access to fire lanes and emergency and utility control facilities such as fire alarm boxes, utility vaults, manholes and junction boxes.
- .8 Product Delivery Requirements
 - .1 Be responsible for complete delivery, handling, and installation of all materials used in the performance of the Work.
 - .2 Arrange for the delivery of The City furnished equipment/materials related to the Specifications or Drawings and related items, including unloading of supplier's truck, elevator scheduling, storage, and placement on as indicated on Contract Drawings.
- .9 Product and Tools Storage Requirements
 - .1 Be responsible for storage and handling of all materials used in the performance of the Work.
 - .2 Job boxes may be allowed to be stored on the site during construction. The tools and the job box shall be the responsibility of the Telecommunications Subcontractor. The City and their representative shall be in no way responsible or liable for any tools of the Telecommunications Subcontractor.
- .10 Confined Spaces
 - .1 Where Work is performed in a confined space, comply with all code related and The City specific safety requirements.
- .11 Coordination with Occupants
 - .1 Be responsible for co-ordinating all Work with The City/tenant of the floor space for their daily work.

PROJECT SPECIFIC REQUIREMENTS

.12 Project Meetings

- .1 Attend site meetings when requested by the Contract Administrator and/or the Project Manager. Regular meetings may occur once per week at the Contract Administrator's and/or the Project Manager's discretion.
- .2 Attend scheduled project meetings throughout the duration of the project to review the status of current and planned activities, schedule and conduct other business associated with the project.

.13 Progress Reports

- .1 Prepare and issue a status report at the scheduled project meeting including status of: progress, project completion for phases, material ordering and delays.

PART 2 - PRODUCTS

2.1 Not Used

PART 3 - EXECUTION

3.1 Product Delivery Requirements

- .1 Unload materials from delivery trucks in such a manner as to protect the materials from damage. In particular, reels of cable shall not be unloaded by dropping them off the vehicle.

3.2 Protecting Installed Systems and Construction

- .1 The Telecommunications Subcontractor shall be responsible for the assembly of above equipment/materials and protection of the above equipment and related items until project cut over. Any damage to equipment shall be the liability of the Telecommunications Subcontractor. All damage shall be repaired, or at The City's request, the equipment shall be replaced at no extra charge to The City.

END OF SECTION

FIRE STOPPING AND WATER PROOFING

PART 1 - GENERAL

1.1 Work Included

.1 Fire Stopping

- .1 Provide seals in all Fire Rated Separations and Firewalls to form tight barriers to retard the passage of flame and smoke.
- .2 The installed seals shall provide and maintain the fire resistance rating of the adjacent floor, wall or other fire separation assembly in accordance with Fire Code and Building Code requirements.
- .3 Establish/re-establish the integrity of all fire-rated structures and assemblies that they have created or disturbed, or that were created by others for use by the Telecommunications Subcontractor.
- .4 Provide Fire Stop pillows for existing cable tray penetrations through firewalls.
- .5 For the purposes of this specification, the only acceptable Fire Stop Systems shall be those that have been tested to the CAN/ULC S115 Standard.
- .6 Provide non-permanent CSA approved Fire Stop systems that are dielectric, water resistant, non-hardening, permanently pliable/re-enterable putty along with the appropriate damming or backer materials (where required).
- .7 All fire stopping shall maintain a minimum one-hour rating and shall meet applicable Federal, Provincial and Local building codes.
- .8 All Fire Stop Systems shall be listed and tested by an SCC and accredited Third Party Testing Agency in accordance with the Standards.
- .9 Fire resistance ratings of installed Fire Stop Systems shall not be less than the fire resistance rating of the surrounding Fire Separation or Firewall.
- .10 All Smoke Seals selected for use shall comply with Fire Code, Building Code, and Building Standards.
- .11 All Fire Stop Materials and Smoke Seals shall have elastomeric characteristics to allow for building settling and seismic movement. All Fire Stop Materials and Smoke Seals shall be free of asbestos.

.2 Water Proofing

- .1 Seal all foundation penetrating conduits and service entrance conduits and sleeves to eliminate the intrusion of moisture and gases into the building. This requirement also includes spare conduits.
- .2 Seal or reseal all service entrance conduits through building upon cable placement. Plug spare conduits with expandable plugs.

.3 Quality Assurance

- .1 Provide fire stopping systems that comply with the following requirements following:
 - .1 Fire stopping tests are performed by a qualified, testing and inspection agency. A qualified testing and inspection agency is UL, or another agency performing testing and follow-up inspection services for fire stop system acceptable to authorities having jurisdiction.

FIRE STOPPING AND WATER PROOFING

- .2 Fire stopping products bear the classification marking of qualified testing and inspection agency.
- .2 Provide the Work of this Section using competent installers, experienced in the application of the materials and systems being used, approved and trained by the material or system manufacturer.
- .3 Fire Stop Systems shall conform to the fire (F), hose (H) and temperature (T) ratings of Codes.
- .4 Fire Stop Materials and Smoke Seal materials shall have a flame spread rating of 25 or less, National Fire Protection Association (NFPA Class "A").
- .5 For the purposes of this specification the only acceptable Fire Stop Systems are those that have been tested to the CAN/ULC S115 Standard.
- .4 Performance
 - .1 Fire rated pathway devices shall be the preferred product and shall be installed in all locations where frequent cable moves, add-ons and changes will occur.
 - .2 Where non-mechanical products are utilized, provide products that upon curing do no re-emulsify, dissolve, leach, breakdown or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture characteristic during or after construction.
 - .3 Where it is not practical to use a mechanical device, openings within floors and walls designed to accommodate telecommunications and data cabling shall be provided with re-enterable products that do not cure or dry.
 - .4 Seal openings for cable trays using re-enterable fire stopping pillows.
- .5 Project Conditions
 - .1 Do not install fire stopping products when ambient or substrate temperatures are outside limitations recommended by manufacturer
 - .2 Do not install fire stopping products when substrates are wet due to rain, frost, condensation, or other causes.
 - .3 Maintain minimum temperature before, during, and for a minimum 3 days after installation of materials.
 - .4 Do not use materials that contain flammable solvents.
 - .5 Coordinate construction of openings and penetrating items to ensure that through-penetration fire stop systems are installed according to specified requirements.
 - .6 Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration fire stop systems.
 - .7 Schedule installation of fire stopping after completion of penetrating item installation but prior to covering or concealing of openings.

FIRE STOPPING AND WATER PROOFING

PART 2 - PRODUCTS

2.1 General

- .1 Use only fire stopping products that have been tested for specific fire resistance rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire rating involved for each separate instance.

2.2 Manufacturers

- .1 Products manufactured by Hilti Corporation (or approved equivalent) are acceptable.
- .2 Obtain fire stop systems for each type of penetration and construction condition indicated only from a single manufacturer.

2.3 Materials

- .1 Firestop Sealants: The following products are acceptable.
 - .1 Hilti FS-ONE MAX high performance Intumescent Firestop Sealant
 - .2 Hilti CP 601S Elastomeric Firestop Sealant.
 - .3 Hilti CP 606 Flexible Firestop Sealant
 - .4 Hilti CP 604 Self-Leveling Firestop Sealant
 - .5 Or equivalent
- .2 Cast-In Firestop Device: A one-step cast-in firestop device for a variety of pipe materials and diameters. The following product is acceptable.
 - .1 Hilti CP 680-M Cast-in Firestop Device or equivalent.
- .3 Firestop Putty: An intumescent, non-hardening, firestop putty for cable and pipe penetrations. The following product is acceptable:
 - .1 Hilti CP 618 Firestop Putty Stick or equivalent.
- .4 Firestop Plug: Ready-to-use intumescent and reusable plug for small openings. The following product is acceptable:
 - .1 Hilti CFS-PL Firestop Plug or equivalent.
- .5 Fire Rated Cable Pathways: Re-penetrable cable management device:
 - .1 Hilti CP 653 Speed Sleeve or equivalent.

PART 3 - EXECUTION

3.1 Fire Stopping

- .1 Before beginning installation, verify that substrate conditions previously installed under other sections are acceptable for installation of fire stopping in accordance with manufacturer's installation instructions and technical information.
- .2 Examine sizes and conditions of voids to be filled to establish correct thickness and installation of Fire Stop Materials.
- .3 Surfaces shall be free of dirt, grease, oil, scale, laitance, rust, release agents, water repellents, and any other substances that may inhibit optimum adhesion.

FIRE STOPPING AND WATER PROOFING

- .4 Prepare surfaces in contact with Fire Stop Systems and Smoke Seals to manufacturer's instructions. Mask where necessary to avoid spillage and over coating onto adjoining surfaces; remove stains on adjacent surfaces.
- .5 Install/replace sound barrier/fire stopping materials as soon as cables have been pulled through the opening.
- .6 In all Fire Stop Systems that require mineral wool or ceramic fibre backer or filler materials, these materials shall be dry and free of other contaminants before, during and after installation of sealant Fire Stop Materials. Alkaline water contamination of the backer or filler materials may cause corrosion of metallic penetrating items.
- .7 Apply Fire Stop Systems and Smoke Seals in strict accordance with manufacturer's instructions to prevent the passage of fire and smoke, and where required and / or specifically designated, the passage of fluids.
- .8 Provide temporary forming and packing as required. Tool or trowel all exposed surfaces to smooth, neat and tidy finish.
- .9 Fire Stop and smoke seal gaps and holes in all Fire Separation and Firewall construction through which cables pass as a result of Work in this document.
- .10 In Combustible Construction (membrane GWB type) where the framing members are wood or where paper faced insulation is incorporated within the separation, a Fire and Temperature rise "FT" rating is required equal to that of the rating of the Fire Separation. Include openings which have been formed and sleeved.

3.2 Water Proofing

- .1 Conduits with cables in them shall be permanently sealed by firmly packing the void around the cable with oakum and capping with a hydraulic cement or waterproof duct seal.

3.3 Exposed Service Penetrations in Ceiling of Underground Parking Areas

- .1 Where the bottom of a Fire Stop System is exposed, seal bottom side of the assembly with a fire rated elastomeric Fire Stop sealant.

3.4 Clean Up

- .1 Remove excess materials and debris and clean adjacent surfaces immediately after application to satisfaction of the Contract Administrator. Remove and or correct staining and discolouring of adjacent surfaces as directed.

END OF SECTION

GROUNDING AND BONDING FOR TELECOMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 Work Included

- .1 Applicable Codes & Standards
- .2 Provide grounding & bonding in accordance with good industry practices and in accordance with the following Codes and Standards:
 - .1 ANSI/TIA-607 – Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises, latest version,
 - .2 ANSI/TIA-942-B – Telecommunications Infrastructure Standard for Data Centers,
 - .3 CSA Standard C22.2 No.41 latest version – Grounding & Bonding Equipment,
 - .4 Local Codes & Bylaws, and
 - .5 BICSI requirements.
- .3 Refer to Electrical Specifications for Electrical Codes and Building Codes.

PART 2 - PRODUCTS

2.1 Approved manufacturers

- .1 All components of the Grounding & Bonding Infrastructure shall be by Panduit Canada or equivalent.
- .2 Typical part numbers are as follows;
 - .1 Rack Grounding Strips: Part# RGS134-1Y
 - .2 Rack Jumper Kits: Part# ACG24K
 - .3 Thread forming screws shall be used: Part # RGTS-CY or RGTSM6-C, and
 - .4 Bonding screws: Part# RGTBS-C or RGTBSM6-C.
- .3 A Green Jacketed #6 AWG Stranded Copper Conductor shall be used to ground the Telecommunications grounding system to all;
 - .1 Telecommunications Cabinets,
 - .2 Telecommunications Racks,
 - .3 Telecommunications Metallic Pathways including cable tray, conduit, etc,
 - .4 Metallic sheath of all Backbone Cables (use appropriate manufacturer's bond clamp), and
 - .5 All Telecommunications enclosures including consolidation point enclosures, building entrance protection panels, etc.

2.2 Cable Bonding

- .1 Bond all backbone cables containing armouring or a metallic sheath using bonding clamps.

GROUNDING AND BONDING FOR TELECOMMUNICATIONS SYSTEMS

- .2 Approved Products:
 - .1 Commscope 12A1 CLAMP 700025513,
 - .2 Belden X9905753, or
 - .3 Equivalent.

2.3 Grounding Lug Kits

- .1 All Building Entrance Terminal frames must be grounded to the busbar provided by Division 26 using Grounding Lug Kits. One Grounding Lug Kit must be used per Building Entrance Terminal frame.
- .2 Approved Products:
 - .1 TE Connectivity 556438-1, or
 - .2 Equivalent.

PART 3 - EXECUTION

3.1 Installation

- .1 Determine if the grounding conductor shall be placed near the bottom or top of the Telecommunications cabinets, racks, or enclosures. Do not proceed to install the conductor(s) until direction has been given. Ensure that complete metal-to-metal contact is made when grounding to painted or powder coated metal surfaces.
- .2 Coordinate the installation of a properly sized Copper Grounding Busbar and associated hardware in the Telecommunications Room with the Electrical Subcontractor. The Busbar shall be permanently connected to the building ground system by the Electrical Subcontractor.
- .3 Grounding & Bonding Infrastructures installed by the Subcontractor shall not interfere with the existing grounding practices within the customer premises.
- .4 Provide one (1) rack grounding strip c/w #6 AWG green grounding wire connection back to grounding Busbar for each Telecommunications rack or cabinet as depicted on room layouts.
- .5 Provide one (1) rack jumper kit for each piece of network equipment as depicted on rack elevation drawings.
- .6 Use thread forming screws, bonding screws & any other hardware necessary to complete the ground system.

3.2 Cable Bonding

- .1 All backbone cables containing armouring or a metallic sheath shall be grounded using a bonding clamp. All bond clamps must attach the cable shield and be connected to the grounding Busbar using minimum #6 AWG green grounding wire.
- .2 Ensure that the teeth of the bond clamp penetrate the cable sheath of all shielded cables.

END OF SECTION

PATHWAYS FOR TELECOMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 Work Included

- .1 Supply and install cabling as detailed in the Contract Documents. Use pathways installed by the Electrical Subcontractor to distribute the cables throughout the facility. Where the cables leave the pathways and extend to the termination point they shall use cable support hangers.
- .2 Do not use any mechanical or electrical fittings to support the Telecommunications cabling.
- .3 Independently support the cables above all ceiling tiles in such a manner that the cables do not interfere with the removal of the ceiling tiles. Maintain a minimum of 75 mm 3"(in) of clear vertical space above the ceiling tiles shall .
- .4 Obtain the Contract Administrator approval for all deviations from the Contract documents and Drawings in relation to cable routing, outlet and equipment locations.

1.2 Indoor Cable Distribution

- .1 Utilise all indicated and available cable pathways such as conduits, Telecommunications cable tray, ducts, surface raceways installed by the Electrical Subcontractor, and furniture system channels except where otherwise noted.
- .2 Inside buildings minimize any possibilities of interference by maintaining the following minimum clearances from electrical and heat sources when routing cables.

Item	Minimum Separation Distances		
	(<2kVA)	(2-5kVA)	(>5kVA)
Unshielded power lines or electrical equipment in proximity to open or non-metallic pathway.	127 mm (5"(in))	305 mm (12"(in))	610 mm (24"(in))
Unshielded power lines or electrical equipment in proximity to a grounded metal conduit pathway.	64 mm (2.5"(in))	152 mm (6"(in))	305 mm (12"(in))
Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to a grounded metal conduit pathway.	---	76 mm (3"(in))	152 mm (6"(in))
Motors	1.2 m (4'-0")		
Transformers	1.2 m (4'-0")		
Fluorescent Luminaires	300 mm (12")		
Pipes (gas, oil, water, etc.)	120 mm (5")		
HVAC (equipment, ducts, etc.)	150 mm (6")		

PART 2 - PRODUCTS

2.1 Non-Continuous Cable Support

- .1 Supply and install cable support for the distribution of horizontal and backbone cables where conduit or cable tray has not been provided.

PATHWAYS FOR TELECOMMUNICATIONS SYSTEMS

- .2 Use non-continuous cable supports up to the maximum density of cables permitted, as specified by the manufacturer.
- .3 Provide adequate supports to suit the quantity of cables in runs used for distribution.
- .4 Include any other miscellaneous hardware (angled hanger bracket, hammer/screw on clamps) required to support horizontal and backbone cabling.
- .5 Approved Manufacturers:
 - .1 Erico,
 - .2 Panduit, or
 - .3 An equivalent and sized as per manufacturer recommendations.
- .6 Approved Products
 - .1 Panduit J-Pro, J-Mod, or equivalent cable supports shall be used where ceiling space rating dictates.

Description	Panduit Part#	J-Mod
Wall Mount	JP2W-L20	Equivalent
Ceiling Mount	JP2CMB-L20 SPEC	Equivalent
Drop Wire and Threaded Rod Clip	JP2DW-L20	Equivalent
Screw-On Beam Clamps	JP2SBC50-L20 or JP2SBC50RB-L20	Equivalent
Hammer On Beam Clamps	JP2HBC25RB-L20 or JP2HBC50RB-L20 or JP2HBC75RB-L20	Equivalent
Purlin Clips	JP2ZP-L20 or JP2CP-L20	Equivalent
Under Floor Pedestal Support Clamp	JP2UF100-L20	Equivalent

2.2 Velcro Straps

- .1 Provide only Velcro straps for bundling of cable. Under no circumstance shall plastic tie-wraps be used.
- .2 Acceptable Manufacturers
 - .1 Panduit: HLS/HLM-15R0 (Black), or
 - .2 Approved equivalent
- .3 If plastic tie-wraps are used the Telecommunications Subcontractor shall remove and replace all affected cables at their own expense.

2.3 Spiral Wrap

- .1 Size Spiral Wrap according to quantity of cables being fed into the system furniture. Spiral Wrap colour shall match system furniture manufacturer's power feed.
- .2 Approved Manufacturers:
 - .1 Panduit part number: T50F-CX, or

PATHWAYS FOR TELECOMMUNICATIONS SYSTEMS

- .2 Approved equivalent.

2.4 Inner Duct

- .1 For plenum rated spaces, supply and install plenum rated Inner duct. Carlon part numbers are listed below.
- .2 Acceptable manufacturer:
- | .1 | Size | Plenum | Riser |
|----|------|--------------------------|--------------------------|
| | 1" | Carlon Part# CF4X1C XXX | Carlon Part# DF4X1C XXX |
| | 2" | Carlon Part # CJ4X1C XXX | Carlon Part # DJ4X1C XXX |
- Where "XXX" refers to appropriate product length
- .3 Innerduct shall be sized appropriately to maintain the 40% fill ratio and allow for a proper bend radius of the cable(s) within.
- .4 Where Innerduct is installed for use with OM1 or OM2 Multimode Fibre, it shall be Orange. Where Inner duct is installed for use with OM3/OM4 Multimode Fibre, it shall be Aqua. Where Inner duct is installed for use with Single Mode Fibre, it shall be Yellow. All Inner ducts shall be installed with pre-lubricated pull tape.

PART 3 - EXECUTION

3.1 Cable Distribution

- .1 Exercise caution when pulling cables in pathways to avoid damage to any existing cables and follow manufacturer's maximum pull-force and minimum bend radii.
- .2 Install and terminate all cables and components in accordance with applicable Codes, Standards and Regulations.

3.2 Cable Support

- .1 Supply and install supports, hanger supports, and any other miscellaneous hardware required to support Telecommunications cabling where conduit/cable tray has not been provided. Any conduit and cable tray shall be provided by the Electrical Subcontractor as indicated on Division 27 Drawings, unless otherwise noted. Telecommunications Subcontractor is responsible for determining these requirements based on Telecommunications and/or Electrical Drawings.
- .2 Install hangars at 4' intervals (maximum). Do not exceed a cable sag greater than 4". Secure all cables to J-hooks/supports with Velcro straps. Comb and dress cables for all visible portions of the install. Comb and redress any cables that do not meet these criteria at no additional cost.
- .3 Run all cable support hangers and inner duct parallel to building lines.
- .4 Cable support hangers or hanger supports must not be drilled into post-tensioned beams under any circumstances.
- .5 Be responsible for coordinating the best time to install the supports with the Contractor. After hours Work may be required for this portion of the Work.
- .6 Size supports to accommodate the number of cables in each run. Provide other hardware such as hammer on clamps, screw on clamps and angled hanger brackets to support the backbone and/or horizontal cabling.

PATHWAYS FOR TELECOMMUNICATIONS SYSTEMS

- .7 In the Cable Support Hanger System, each individual run or pathway shall not contain more than fifty (50) UTP horizontal cables. Provide an additional hanger pathway to divide the cable bundle where the quantity exceeds this.
- .8 Completely and independently support the hangar system from the structural ceiling or walls (concrete slab/deck). Do not support the cable support hanger system from the suspended ceiling. Do not drill anchors for hangers into post tensioned beams under any circumstances. Do not use pneumatic hammers. All anchors must be drilled into slab.
- .9 Minimize the disturbance or removal of 'fire spray' insulation during installation of cable supports.

3.3 Velcro Straps

- .1 Use Velcro straps to neatly dress cables; they shall be placed at a maximum of 4' intervals for horizontal distribution (centre points between cable supports).
- .2 Use Velcro straps to dress horizontal cables into racks/cabinets. For each row of the patch panel, the maximum spacing of Velcro for horizontal cables into or along vertical cable managers shall be no more than 6", this includes cabling dropped from the ladder tray or ceiling above.

3.4 Spiral Wrap

- .1 Install spiral wrap from system furniture feed points to system furniture entry point. Spiral Wrap shall be butted so that no cables are exposed.

3.5 Innerduct

- .1 Install Fibre Cables in innerduct over the entire length inside the building. Exceptions to this are for:
 - .1 Armoured Fibre cabling; or
 - .2 Where a dedicated fibre conduit is installed that is 1.5" in diameter or less.
- .2 Under these situations, the fibre cabling may be installed without inner duct.
- .3 Minimise the number of separate innerducts installed by pulling multiple fibre cables through each innerduct.
- .4 Inner duct shall be CMR (FT4) or CMP (FT6) rated, as is appropriate for ceiling space classification and local code requirements. Size innerduct to suit installation requirements.
- .5 Fasten to the backboard, rack, cabinet, or enclosure by utilizing cradle mounts and plastic permanent cable ties.

3.6 Cable Distribution

- .1 Ensure ANSI/TIA-568.1, latest edition standard installation practices are followed for indoor cable distribution and ANSI/TIA-758, latest edition standard installation practices are followed for outdoor cable distribution.
- .2 Station personnel at each access point (i.e. Handhole, maintenance hole, etc.) to observe the cables being pulled. Submit tension pull calculation for installation of cables to Contract Administrator.

PATHWAYS FOR TELECOMMUNICATIONS SYSTEMS

- .3 Do not exceed the Copper/Fibre cables maximum tensile rating during installation. Monitor tension of the cable during installation. Use a dynamometer to record installation tension. Use a tension limiting device to prevent the exceeding of maximum pulling tension Specifications during installation. Set the tension limit at or below the manufacturer's limit. The cable shall be taken up at intermediate pulling points with an intermediate take-up device as approved by the Contract Administrator, to prevent over tension on the cable.
- .4 Do not exceed the minimum bend radius as per the manufacturer's recommendations.
- .5 Make cable pulls continuous and steady between pull points. Do not interrupt the pull unless necessitated by excessive tension on the cable.
- .6 Protect exposed cable ends from moisture ingress.
- .7 Provide sufficient slack for cable passing through maintenance holes for expansion/contraction and install clips to prevent sagging.

3.7 Cable Lubricant

- .1 The use of pulling lubricants of any kind is strictly prohibited

3.8 Duct and Conduit

- .1 Clean out each section of duct or conduit by pulling a steel wire brush and mandrel of the correct size through the duct or conduit before pulling cables. Bush, ream and remove any sharp projections on all conduits prior to installation of Telecommunications cables. When cleaning ducts, if obstructions are encountered which cannot be removed, advise the Contract Administrator of the problems encountered.
- .2 Pull cables in bottom ducts/conduits first, leaving top ducts/conduits for future use. Cable grip shall be attached to the sheath and its strength members so that no direct force is applied to the conductors/fibres. The cable grip shall have a ball bearing swivel to prevent the cable from twisting during pulling.

END OF SECTION

SEISMIC PROTECTION

PART 1 - GENERAL

1.1 Work Included

- .1 Project Submittal – Shop Drawings
- .2 Be responsible for all seismic resisting systems for all Telecommunications systems and equipment. Have one trade provide all seismic resisting systems for Telecommunications.

1.2 Definitions

- .1 Relevant Importance Category for the Building in accordance with the National Building Code of Canada and/or applicable Local Codes:
 - .1 Manitoba Building Code, latest edition.
 - .1 *Low*: Buildings that represent a Low Direct or Indirect Hazard to human life in the event of failure.
 - .2 *Normal*: All buildings except those listed in the Importance Categories Low, High and Post-disaster.
 - .3 *High*: Buildings likely to be used as Post-disaster shelters and manufacturing or storage facilities containing toxic, explosive or other hazardous substances in sufficient quantities to be dangerous to the public if released.
 - .4 *Post-disaster*: Buildings that are required to be operational after a disaster.
 - .2 SFRS: Acronym for Seismic Force Restraint System.
 - .3 SCS: Acronym for Slack Cable Restraint System.
 - .4 Seismic Consultant: A Professional Structural Engineer licensed in the respective jurisdiction who specializes in the seismic restraint of building elements and the design of SFRS.

1.3 General Description

- .1 This section covers the design, supply, installation, and commissioning of a complete SFRS for all systems.
- .2 Fully integrate SFRS into, and make compatible with:
 - .1 Noise and vibration controls specified elsewhere in this project specification, and
 - .2 Systems, and equipment not required to be operational during and after seismic event.
- .3 Provide SFRS that during a seismic event prevent systems and equipment from causing personal injury and from moving from normal position.
- .4 Obtain the services of a Professional Engineer, licensed in the Province / Territory of the Place of the Work, and specializing in the design of SFRS, to provide the necessary design and details for a complete SFRS including systems of structural supports and brazing of all electrical equipment as required to comply with Part 4, Structural Design of the Building Code. Require this Professional Engineer be responsible for ensuring that the installation conforms to the design.

SEISMIC PROTECTION

1.4 Shop Drawings and Product Data

- .1 Submit Shop Drawings and product data in accordance with Section 27 00 05.60 – Administrative Requirements.
- .2 Submittals to include:
 - .1 Full details of design criteria,
 - .2 Working drawings, materials lists, schematics full specifications for all components of each SFRS to be provided,
 - .3 Design calculations including restraint loads resulting from seismic forces in accordance with all applicable Codes,
 - .4 Separate Shop Drawings for each SFRS and devices for each system, equipment,
 - .5 Identification of location of each device,
 - .6 Schedules of types of SFRS equipment and devices,
 - .7 Details of fasteners and attachments to structure, anchorage loadings, attachment methods,
 - .8 Installation procedures and instructions, and
 - .9 These drawings shall be designed and bear the signed stamp of a Professional Engineer licensed to practice in the appropriate discipline and in the Place of Work.

PART 2 - PRODUCTS

2.1 Approved Manufacturers

- .1 The SFRS's shall be from one manufacturer regularly engaged in production of same.
 - .1 Approved manufacturers:
 - .1 Eaton B-Line Series
 - .2 Kinetics,
 - .3 Mason, or
 - .4 Vibro-Acoustics.
- .2 Provide positive seismic and wind resisting on those systems and components required by the Building Code and the Authority Having Jurisdiction.
 - .1 Refer to Code Data Matrix on Architectural Drawings as well as the Structural Drawings for seismic design criteria values prior to bid.
 - .2 Seismic design criteria mentioned above includes: Design Spectral response acceleration for short periods, $S_a(0.2)$; Site Classification; Acceleration based site coefficient, F_a ; Importance Factor for Earthquake Loads, I_E ; and Wind reference velocity pressure, q .
- .3 Provide SFRS for conduit systems that is compatible with:
 - .1 Expansion, anchoring, and guiding requirements.
 - .2 Equipment vibration isolation and equipment SFRS.
- .4 Do not utilize cast iron, threaded pipe, and other brittle materials as part of SFRS.
- .5 Ensure seismic control measures do not interfere with integrity of fire stopping.

SEISMIC PROTECTION

2.2 Sfrs For Vibration Isolated Equipment

- .1 Equipment installed on vibration isolation requiring seismic restraint shall be in accordance with noise and vibration controls specified elsewhere in this project Specification.

PART 3 - EXECUTION

3.1 Installation

- .1 Install SFRS at least 25 mm from all other equipment, systems, and/or services.
- .2 Co-ordinate connections with all disciplines.
- .3 Install SFRS in accordance with the Seismic Professional Engineer's design.
- .4 Following the completion of the installation of the seismic resisting systems, have the designing Contract Administrator submit a stamped letter stating that the installation has been completed in accordance with the applicable Building Codes and their design. Require the Contract Administrator to complete and submit signed and sealed letters of assurance (e.g. Schedules, where applicable) and letters of compliance for all equipment that requires seismic resisting in accordance with latest codes, standards and requirements of the Authorities Having Jurisdiction.
- .5 Require Contract Administrator to include additional documentation to identify the equipment and device types and quantities that were reviewed to ensure that all components requiring seismic resisting were completed.
- .6 Require Contract Administrator to indicate in letters that "All Telecommunications equipment shown on the Smith and Andersen Drawings has been seismically resisted in accordance with the local Building Code."

END OF SECTION

IDENTIFICATION FOR TELECOMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 Work Included

.1 Labelling

- .1 Confirm the cable designations with the Contract Administrator prior to installation.
- .2 Adhere to CSA T528-93 (ANSI/TIA-606-latest version) colour codes.
- .3 Confirm labelling schemes with the Contract Administrator and The City's IT representative prior to installation. The cable labelling scheme for all cables at both ends shall be as follows:

.2 Horizontal Cable Labelling Schema for Recreation Center

.1 Main Data Centre

- .1 MDC (18mm lettering on door frame and rack)
- .2 Backbone Patch Plate. Identify first plate as **Backbone** (12mm)
- .2 A patch plate identifier (12 mm lettering on left side of plate)
- .3 01 sequential port number (6mm lettering under port unless OEM numbering is existing)

.2 Intermediate Data Centre

- .1 IDC4* (18mm lettering on door frame and rack)
- .2 IDC = Intermediate Distribution Centre
- .3 4 = indicates floor level of rack
- .4 * = variable identifier for use with multiple centres per floor
 - .1 (N= north, S= south, W= west, E= east, * = only one centre/floor)

.3 Workstation

.4 4*A01 (6 mm lettering on faceplate and top of pedestal)

- .1 4 indicates floor level of MDC or IDC
 - .1 B = basement/below ground level
 - .2 1 = first/main/ground floor
 - .3 2 =second floor
- .2 * = variable identifier for use with multiple centres/floor (see above)
- .3 A = patch plate identifier
- .4 01 = sequential code for patch plate port, match OEM

.3 Copper Backbone Labelling Schema

- .1 Provide labelling schema for Copper Backbone cabling shall be as follows:
- .2 For each labelling strip for pairs on the IDC mount, provide labels showing the first and last pair for every wafer. On each label indicate the pair count and destination of the multipair cable.

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.9 Install colour designation strips as follows:

Item	Color
C.O. Circuits	Orange
Common Equipment: PBX, LAN's, Muxes	Purple
First Level Backbone Cable	White
Second Level Backbone Cable	Gray
Horizontal Wiring	Blue
Auxiliary Circuits – Alarms, Security	Yellow
Future use and Key Systems	Red
Inter building Campus Backbone	Brown

.6 **ZZZ** = Room Number or Designation

Note: Each strand shall be identified individually at the Fibre Connector.

- .1 All adhesive cable labels shall meet the legibility, defacement, and adhesion requirements specified in ANSI/UL 969 (Ref. D-16). In addition, the labels shall meet the general exposure requirements in ANSI/UL 969 for indoor use.
- .2 Provide self-laminating vinyl cable labels with a white printing area and a clear tail that self laminates the printed area when wrapped around a cable. The clear area shall be of sufficient length to wrap around the cable at least one and one-half times.

IDENTIFICATION FOR TELECOMMUNICATIONS SYSTEMS

- .3 Approved Manufacturers:
 - .1 Panduit: Part# LS8E,
 - .2 Brady.

2.2 Lamacoid Labels

- .1 Provide black lamacoid plates with white 60 point Arial Narrow, engraved upper case letters enclosed by a white border on black background for racks, cabinets, and enclosures.

PART 3 - EXECUTION

3.1 Installation

- .1 All active and passive equipment shall be labeled.

3.2 Labelling

- .1 All labels must be mechanically printed using a laser printer. Hand-written labels are not permitted.
- .2 Provide 25% spare labels in each telecommunications room.

3.3 Label Locations

- .1 Cable identification labels shall appear at the following locations with the numbers indicated on the cable schedule and Drawings:
 - .1 102 mm 4" (in) from each end of the cable after termination,
 - .2 Front of Patch Panels,
 - .3 Front of IDC termination blocks,
 - .4 Front of workstation/Telecommunications outlet faceplates, and
 - .5 Each end of each Telecommunications Conduit.
- .2 Fibre Optic safety Labels shall appear at the following locations:
 - .1 Along the length of the conduit or inner duct at 3m 10' (ft.) intervals,
 - .2 At all junction boxes,
 - .3 At all pull boxes, and
 - .4 On all Fibre Optic Patch Panels.
- .3 Labels must be visible during installation and normal maintenance of the infrastructure.
- .4 Affix lamacoid labels to the front and rear of equipment in racks, cabinets.

END OF SECTION

COMMISSIONING FOR TELECOMMUNICATIONS SECTIONS

PART 1 - GENERAL

1.1 Work Included

.1 General Testing Requirements

- .1 Test 100% of the installed cabling links. All cables must pass the requirements of the Standards as defined within this document. Any failing link must be diagnosed and corrected. Re-test to prove that the corrected link meets the performance requirements. Provide the final and passing result of the tests for all links in the test results documentation.
- .2 Correct all deficiencies before the Contract Administrator will provide a certificate to release the Holdback on the project.
- .3 Submit a soft copy of test results in PDF and another ODBC compatible database format.
- .4 Test Patch Cords for portable tester must be designed for testing by the manufacturer. Field assembled Patch Cords are not acceptable. Field testers must use the appropriate jack/tester adapter specified for use with the cabling jack(s) specified within this document.
- .5 Submit a test plan to the Contract Administrator for approval prior to testing.
- .6 Submit a test report based on the cable schedules. Indicate for each cable, when it was tested successfully and the signature of the technician that performed the test, location, cable type, cable number and tester make and model. An authorised person shall sign the test report at the completion of the project.

.2 Copper Cabling Test Requirements

- .1 Test every cabling link in the installation (as required by the Cabling specified) in accordance with the Telecommunications Industry Association (TIA) Standard ANSI/TIA-1152, latest edition.
- .2 Test installed twisted-pair horizontal links from the Telecommunications Room to the workstation against the "Permanent Link" performance limits Specification as defined in ANSI/TIA-568.2, latest edition.
- .3 Only trained technicians who have successfully attended an appropriate training program and have been certified must execute the tests. Appropriate training programs include installation certification programs provided by BICSI or the ACP (Association of Cabling Professionals) and Vendor supplied certifications for their product.
- .4 Test equipment shall comply with or exceed the accuracy requirements for enhanced level II and/or level III and/or level IIIe field testers (according to Cabling specified) as defined in ANSI/TIA-1152, latest edition. The tester including the appropriate interface adapter must meet the specified accuracy requirements. The accuracy requirements for the permanent link test configuration (baseline accuracy plus adapter contribution) are specified in ANSI/TIA-1152, latest edition.

COMMISSIONING FOR TELECOMMUNICATIONS SECTIONS

- .5 The tester interface adapters must be of high quality and the cable shall not show any twisting or kinking resulting from coiling and storing of the tester interface adapters. In order to deliver optimum accuracy preference is given to a permanent link interface adapter for the tester that can be calibrated to extend the reference plane of the Return Loss measurement to the permanent link interface. Provide proof that the interface has been calibrated within the period recommended by the Manufacturer. Ensure that normal handling on the job does not cause measurable Return Loss change, the adapter cord cable shall not be of twisted-pair construction.
 - .6 The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests. Any Fail or Fail* result yields a Fail for the link-under-test. In order to achieve an overall Pass condition, the results for each individual test parameter must Pass or Pass*.
 - .7 A Pass or Fail result for each parameter is determined by comparing the measured values with the specified test limits for that parameter. The test result of a parameter shall be marked with an asterisk (*) when the result is closer to the test limit than the accuracy of the field tester. Submit all Pass* categorized cable test results to The City's Engineering Representative for review and approval. The field tester manufacturer must provide documentation as an aid to interpret results marked with asterisks. (Reference TIA-568, latest edition;).
- .3 Copper Cabling Performance Test Parameters
- .1 The test parameters for Category 5e are defined in ANSI/TIA Standard 568.2, latest edition; Section 6. The test of each Category 5e link shall contain all of the following parameters as detailed below. In order to pass the link test all measurements (at each frequency in the range from 1 MHz through 100 MHz) must meet or exceed the limit value determined in the above-mentioned Category 5e Standard.
 - .2 The test parameters for Category 6 are defined in TIA Category 6 Standard, which refers to TIA-568.2-, latest edition. The test of each link shall contain all of the following parameters as detailed below. In order to pass the test all measurements (at each frequency in the range from 1 MHz through 250 MHz) must meet or exceed the limit value determined in the above-mentioned Standard.
 - .3 Testing of all 4 pairs of the horizontal cable (as specified in this document) shall include but not be limited to the following:
 - .1 Wire Map including; end to end continuity, open and shorts, pair polarity,
 - .2 Cable length,
 - .3 Attenuation,
 - .4 Return Loss,
 - .5 NEXT/FEXT,
 - .6 ACR,
 - .7 ELFEXT, PSELFEXT,
 - .8 Propagation Delay, Delay skew, and
 - .9 PSNEXT, PSACR.

COMMISSIONING FOR TELECOMMUNICATIONS SECTIONS

- .4 Permanent link testing of all horizontal and backbone cables shall be completed in accordance with the follow test criteria:
 - .1 Wire Map including; end to end continuity, open and shorts, pair polarity,
 - .2 Cable length, and
 - .3 Basic Link.
 - .5 The nominal velocity of propagation (NVP) must be set specific to each cable manufacturer before testing. The portable tester shall be within the calibration period recommended by the manufacturer in order to achieve the manufacturer-specified measurement accuracy. Refer to manufacturer's test procedure.
- .4 Optical Fibre Cabling Test Requirements
- .1 Every Optical Fibre Cabling link in the installation shall be tested in accordance with the field test Specifications defined by the Telecommunications Industry Association (TIA) Standard ANSI/TIA-568.3, latest edition (or by the appropriate network application Standard(s) whichever is more demanding).
 - .2 ANSI/TIA-568.0, latest edition, defines the passive cabling network to include cable, connectors, and splices (if present), between two optical fibre patch panels (connecting hardware). A typical horizontal link segment is from the telecommunications outlet/connector to the horizontal cross-connect. This TIA document describes three typical backbone link segments: (1) main cross-connect to intermediate cross-connect, (2) main cross-connect to horizontal cross-connect, or (3) intermediate cross-connect to horizontal cross-connect. The test shall include the representative connector performance at the connecting hardware associated with the mating of patch cords. The test does not, however, include the performance of the connector at the interface with the test equipment.
 - .3 Only trained technicians who have successfully attended an appropriate training program and have been certified must execute the tests. These certificates may have been issued by any of the following organisations or an equivalent organisation:
 - .1 The manufacturer of the Optical Fibre Cable and/or the Optical Fibre Connectors,
 - .2 The manufacturer of the test equipment used for the field certification,
 - .3 Training organisations authorised by BICSI (Building Industry Consulting Services International) or by the ACP (Association of Cabling Professionals™), or
 - .4 Vendor supplied certifications for their product.
 - .4 Field test instruments for Multimode Fibre cabling shall meet the requirements of ANSI/TIA-526-14, latest edition. The light source shall meet the launch requirements of ANSI/TIA-455-50, latest edition; Method A. This launch condition can be achieved either within the field test equipment or by use of an external mandrel wrap (as described in clause 11 of ANSI/TIA-568.1, latest edition) with a Category 1 light source. Field test instruments for Single mode Fibre cabling shall meet the requirements of ANSI/TIA-526-7, latest edition.

COMMISSIONING FOR TELECOMMUNICATIONS SECTIONS

- .5 The Optical Fibre launch cables and adapters must be of high quality and the cables shall not show excessive wear resulting from repetitive coiling and storing of the tester interface adapters.
- .6 The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests as detailed below.
- .7 A Pass or Fail result for each parameter is determined by comparing the measured values with the specified test limits for that parameter.
- .5 Optical Fibre Cabling Performance Test Parameters
 - .1 ANSI/TIA Standard 568.3, latest edition prescribes that the single performance parameter for field testing of optical fibre links is link attenuation when installing components compliant with this Standard.
 - .2 Calculate the link attenuation by the following formulas specified in ANSI/TIA/EIA 568, latest edition.
 - .3 Link attenuation does not include any active devices or passive devices other than cable, connectors, and splices, i.e. link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.
 - .4 The above link attenuation test limits are based on the use of the One Reference Jumper Method specified by ANSI/TIA/EIA-526-14, latest edition, Method B and ANSI/TIA/EIA-526-7, latest edition, Method A.1. The user shall follow the procedures established by these Standards or application notes to accurately conduct performance testing.
 - .5 The Horizontal Link (multimode): acceptable link attenuation for a multimode Horizontal Optical Fibre Cabling Solution is based on the maximum 90 m (295 ft.) distance. The Horizontal Optical Fibre Cabling link segments need to be tested at only one (1) wavelength. Because of the short length of cabling [90 m (295 ft.) or less], attenuation deltas due to wavelength are insignificant. The horizontal link should be tested at 850 nm or 1300 nm in one direction in accordance with ANSI/EIA/TIA-526-14, latest edition, Method B, and One Reference Jumper. The horizontal link may be tested using a fixed upper limit for attenuation of 2.0 dB. this value is based on the loss of two (2) connector pairs, one (1) pair at the telecommunications outlet/connector and one (1) pair at the horizontal cross-connect, plus 90 m (295 ft) of optical fibre cable.
 - .6 Test the Backbone Link (multimode) in one direction at both operating wavelengths to account for attenuation deltas associated with wavelength.
 - .7 Test multimode Backbone Links at 850 nm and 1300 nm in accordance with ANSI/EIA/TIA-526-14, latest edition. Because backbone length and the potential number of splices vary depending upon site conditions, the link attenuation equation shall be used to determine limit (acceptance) values.

COMMISSIONING FOR TELECOMMUNICATIONS SECTIONS

- .8 Notes:
 - .1 Link attenuation has been based upon the use of a light source categorised by a Coupled Power Ratio (CPR) of Category 2, Under filled, per Annex B of ANSI/EIA/TIA-526-14, latest edition. The use of a light source categorised as Category 1, Overfilled, may provide results higher than the 2.0 dB limit. A field test tool based on LED (light emitting diode) light sources is a Category 1 device and typically yields high attenuation results.
 - .2 Links destined to be used with network applications that use laser light sources (under filled launch conditions) shall be tested with test equipment based on laser light sources. this rule should be followed for Cabling Solutions to support Gigabit Ethernet. Gigabit Ethernet only specifies laser light sources.
 - .3 For Gigabit Ethernet compliant certification (IEEE STD 802.3z application), use test equipment which uses a VCSEL (Vertical cavity surface emitting laser) at 850 nm (compliant with 1000BASE-SX) and a FP laser at 1310 nm (compliant with 1000BASE-LX).
- .9 Each optical fibre link terminated with an optical adapter system which does not impose a transmission direction because the adapters are not or cannot be ganged should be tested and documented in both directions since the direction of the signal transmission cannot be predicted at the time of installation.
- .10 Test each strand of fibre with an Optical Time Domain Reflectometer for length and attenuation. Performance test must be below the total return loss budget for the cable connectors/balun. Provide comprehensive optical time domain reflectometry (OTDR) testing for all fibre runs. Include a hard copy chart recording with the test documentation.
- .6 Cable Test Result Documentation
 - .1 Record the test result information for each link in the memory of the field tester upon completion of the test.
 - .2 The tester must transfer saved test result records into a Windows™-based database utility that allows for the maintenance, review and archiving of these test records. Provide a guarantee that the measurement results are transferred to the PC unaltered, i.e., “as saved in the tester” at the end of each test and that these results cannot be modified at a later time.
 - .3 Provide a PDF copy of the test results that lists all the links that have been tested with the following summary information:
 - .1 The identification of the link in accordance with the naming convention defined in the overall system documentation,
 - .2 The overall Pass/Fail evaluation of the link-under-test including the Attenuation worst case margin (margin is defined as the difference between the measured value and the test limit value),
 - .3 The overall Pass/Fail evaluation of the link-under-test including the NEXT Headroom (overall worst case) number, and
 - .4 The date and time the test results were saved in the memory of the tester.

COMMISSIONING FOR TELECOMMUNICATIONS SECTIONS

- .4 Provide general information in the electronic data base containing the test result information for each link:
 - .1 The identification of The City site as specified by the end-user,
 - .2 The overall Pass/Fail evaluation of the link-under-test,
 - .3 The name of the Standard selected to execute the stored test results,
 - .4 The cable type and the value of the 'index of refraction' used for length calculations,
 - .5 The date and time the test results were saved in the memory of the tester,
 - .6 The brand name, model and serial number of the tester, and
 - .7 The revision of the tester software and the revision of the test Standards database in the tester.
- .5 Provide detailed test results data in the electronic database and PDF for each tested Copper Cable including:
 - .1 The identification of the link in accordance with the naming convention defined in the overall system documentation,
 - .2 The cable type and the value of NVP used for length calculations,
 - .3 The identification of the tester interface, and
 - .4 The test results information must contain information on each of the required test parameters that are listed in this document.
- .6 Provide the detailed test result data in the electronic database and PDF for each tested Optical Fibre Cable including:
 - .1 The identification of the link/fibre in accordance with the naming convention defined in the overall system documentation,
 - .2 The insertion loss (attenuation) measured at each wavelength, the test limit calculated for the corresponding wavelength and the margin (difference between the measured attenuation and the test limit value), and
 - .3 The link length for each optical fibre for which the test limit was calculated based on the formulas in this document.
- .7 Coaxial Cable Testing
 - .1 Sweep test all horizontal CATV Coaxial cables to industry standards using a Time Domain Reflectometer (TDR).
 - .2 Sweep test all horizontal CATV Coaxial cables after installation for opens, shorts, and kinks. Replace damaged cables by installing a new cable. Indicate on the floor plans the actual length of each cable section as installed.
 - .3 Provide a soft copy of cable test result for each CATV cable. Cable test results shall identify cable numbers and associated test results.

COMMISSIONING FOR TELECOMMUNICATIONS SECTIONS

PART 2 - PRODUCTS

2.1 Approved Manufacturers

- .1 Copper Testers
 - .1 HP/Agilent, or
 - .2 Fluke DSP-4000.
- .2 Fibre Testers
 - .1 EXFO,
 - .2 Fluke OptiFiber® Pro OTDR, or
 - .3 Fotec.

2.2 Optical Fibre Testing

- .1 Provide 850nm and 1300nm $\pm$ 20nm wavelength LED light sources.
- .2 Spectral width of sources shall be $\pm$ 50nm for 850nm wavelengths and $\pm$ 140nm for 1300nm wavelengths.
- .3 Provide 1300nm and 1500nm $\pm$ 20nm wavelength Laser light sources.
- .4 Output stability $\pm$ 0.40 dB from 0 to 50oC. Long term stability shall be $\pm$ 0.10 dB at 25oC.

2.3 Warranty and Certification

- .1 Provide to The City, one system certification at the end of the project.

PART 3 - EXECUTION

3.1 Warranty and Certification Requirements

- .1 Submit the Structured Cabling Solution certification and the user manual.
- .2 Provide letter(s) of Certification within two weeks of the date of substantial performance of the Contract of the project to the Contract Administrator. This document will include the following:
 - .1 Verification of the performance of the installed system,
 - .2 Identification of the installation by location and project number, and
 - .3 A copy of the Warranty.
- .3 Within 7 days of the award of Contract, submit copies of the Structured Cabling Solution certification request for Certification form complete with certification number(s) for the project. Provide a copy of the form with Specification submission.

END OF SECTION

TELECOMMUNICATIONS ENTRANCE PROTECTION

PART 1 - GENERAL

1.1 Work Included

- .1 Lightning Protection Backboards
 - .1 Use Backboards for mounting of Copper Backbone Cabling as it enters and exits buildings. Refer to Detail Drawings for location of Lightning Protection Backboards.
- .2 Building Entrance Terminals and Surge Protection Modules
 - .1 Not included in the Scope of Work of the Telecommunications Subcontractor. The Service Provider shall be responsible for all building entrance terminals, surge protection modules and grounding lug kits.

PART 2 - PRODUCTS

2.1 Grounding Lug Kits

- .1 Not included in the Scope of Work of the Telecommunications Subcontractor. The Service Provider shall be responsible for all building grounding lug kits.

2.2 Building Entrance Terminals

- .1 Not included in the Scope of Work of the Telecommunications Subcontractor. The Service Provider shall be responsible for all building entrance terminals.

PART 3 - EXECUTION

3.1 Plywood Backboards

- .1 Provide cable supports to securely mount Backbone Cabling to Backboard at maximum 6" intervals for every individual cable.
- .2 Backboards shall be constructed of 3/4" G1S CANPLY Exterior Grade plywood (4'x8' sheet), one side good. Place the plywood sheet vertically. Paint the backboard with two (2) coats of white fire retardant non-conductive paint and mounted directly on the wall. Refer to Drawings for location(s) of Backboard(s). Provide Backboards unless otherwise noted.

3.2 Building Entrance Terminal Grounding

- .1 Ground all Building Entrance Terminal(s) to the grounding Busbar using minimum #6 AWG green grounding wire. Each Building Entrance Terminal must be individually grounded to the grounding Busbar.
- .2 Ground all Building Entrance Terminal(s) to the Busbar provided by the Electrical Subcontractor. Attach Grounding Lug Kit (dual compression) to the Building Entrance Terminal(s) and Busbar after the paint for the Building Entrance Terminal(s) has been removed at the point of attachment. Remove 1" x 1" of paint to ensure good contact between Grounding Lug and Building Entrance Terminal(s). Securely affix the Grounding Lug Kit using hardware provided.

TELECOMMUNICATIONS ENTRANCE PROTECTION

3.3 Building Entrance Terminals

- .1 Install all pairs of the Indoor/Outdoor Copper Cable with Building Entrance Terminals and surge protection modules at both ends. Building Entrance Terminals must be installed within 50' of the Copper Cabling entering into a building.
- .2 Ground the Building Entrance Terminal frame to the grounding Busbar provided using Grounding Lug Kits.

END OF SECTION

TELECOMMUNICATIONS CABINETS, RACKS, FRAMES AND ENCLOSURES

PART 1 - GENERAL

1.1 Work Included

.1 Equipment Locations

- .1 Devices, Racks, Cabinets, Brackets and Backboards may be relocated, prior to installation, from the location shown on the Contract Drawings, to a maximum distance of 3.05m (10'-0") without adjustment to the Contract price.

.2 Telecommunication Racks and Cabinets

- .1 Provide all wall mount brackets, racks, cabinets and components as indicated in this document and on the Contract drawings.
- .2 Provide all racks, cabinets, wall mount brackets and components from the same manufacturer and identical style shall be used throughout the project, unless specifically noted in this section.
- .3 All racks, cabinets, wall mount brackets and components shall meet or exceed requirements as defined by ANSI/EIA-310-E, Cabinets, Racks, Panels and Associated Equipment.
- .4 All racks, cabinets, wall mount brackets and components required for this project will be reflected on Telecommunications Room Layout & Rack Elevation Detail drawings (If required).
- .5 At a minimum, provide one (1) new 2U horizontal cable management panel for each new patch panel installed, when no rack elevation drawing is provided. Quantities shown on rack elevation drawing(s) shall supersede this requirement.
- .6 In all cases wall mount brackets, racks, cabinets and components shall be powder-coated black.
- .7 Approved Manufacturers for Recreation Center:
 - .1 RF Mote LTD,
 - .2 Tripplite,
- .8 Approved Manufacturers for Child Care Center:
 - .1 Dell

.3 Cabling

- .1 Reference General requirements and the Execution requirements as applicable under Section 27 13 13 - TELECOMMUNICATIONS COPPER BACKBONE CABLING, Section 27 13 23 - TELECOMMUNICATIONS OPTICAL FIBRE BACKBONE CABLING, Section 27 15 00.19 - DATA TELECOMMUNICATIONS HORIZONTAL CABLING, and Section 27 15 01.16 - VOICE TELECOMMUNICATIONS HORIZONTAL CABLING.

PART 2 - PRODUCTS

2.1 Floor Mount Telecommunications Frame/Cabinet

- .1 Floor mounted, 482 mm (19") four-post frame with welded frame constructed of minimum 11 GA (0.120") steel.

TELECOMMUNICATIONS CABINETS, RACKS, FRAMES AND ENCLOSURES

- .2 Frame shall have a minimum of 44U standard EIA vertical rack positions with permanently marked U-spacing identification. Mounting holes as per EIA-310-E, size 10-32 tapped front and back rails.
- .3 Frame shall have removable positions for cable entry & cooling fans at top as well as adequate opening in base of frame for air distribution & cable entry.
- .4 Cabinets shall be complete with a minimum of one (1) dual bolt ground lug mounting position.
- .5 Frame shall have four (4) levelling feet & shall be properly leveled once in final position on top of the finished floor in all Telecommunications Spaces.
- .6 Cabinets shall be ganged together with proper ganging kit wherever two or more cabinets are positioned in a side-by-side configuration.
- .7 Utilize proper fasteners for the vertical cable managers, power bars and all accessories as per the manufacturer's recommendations.
- .8 Refer to Telecommunications spaces detail drawings for width & depth requirements.
- .9 Approved Manufacturer for Recreation Center:
 - .1 RF Mote
 - .2 Tripplite
- .10 Approved product for Child Care Center:
 - .1 Dell 4220 24U/42U Floor Rack with Doors and Side Panels

2.2 Wall Mount Telecommunications Cabinet

- .1 Wall mounted 482 mm (19") double swing out cabinet to accommodate a minimum 12 U standard EIA vertical rack positions shall be used.
- .2 Fully welded, fabricated from a minimum of 16GA. (0.060") steel.
- .3 The cabinet shall have the following product features:
 - .1 Lexan front door,
 - .2 Solid side panels,
 - .3 10-32 tapped mounting angle style,
 - .4 Hinged cabinet body,
 - .5 Minimum of one (1) 75 C.F.M or greater cooling fan,
 - .6 Vertical cable management panels with hinged doors with nonmagnetic closing mechanisms, and
 - .7 One (1) dual bolt ground lug.
- .4 Utilize proper fasteners for the vertical cable managers, power bars and all accessories as per the manufacturer's recommendations.
- .5 Approved manufacturer for Recreation Center:
 - .1 Tripplite

TELECOMMUNICATIONS CABINETS, RACKS, FRAMES AND ENCLOSURES

2.3 Telecommunications Rack & Cabinet Components

- .1 Overhead Cable Managers
 - .1 Construction consisting of a minimum of 16 GA (0.060") steel, with dimensions 6.5" wide x 8" deep.
 - .2 The overhead cable manager must run the full width of the rack mounting space, including vertical cable managers. Provide all ganging plates, end caps etc. to provide a complete system.
 - .3 The overhead cable manager must have hinged front doors and back and side cuts to allow for Patch Cords.
 - .4 One overhead cable manager shall be installed for every rack (length to suit).
- .2 Vertical Cable Managers
 - .1 Constructed of minimum 16 GA (0.060") steel with stiffeners riveted/welded inside for additional strength.
 - .2 Management panels shall have a hinged door with nonmagnetic closing mechanism. A fully shielded magnetic closing mechanism shall also be accepted.
 - .3 Openings for cable routing shall have grommets to ensure smooth transition of the cables.
 - .4 Management panels shall have lancets along the back of the cable manager to allow for the fastening of the cable(s) to the outside of the manager itself.
- .3 Horizontal Cable Management Panel
 - .1 Welded construction, fabricated of a minimum of 16 GA (0.060") steel & shall be a minimum of 2U and 76mm (3")D.
 - .2 Panel shall have hinged cover with nonmagnetic closing mechanism. A fully shielded magnetic closing mechanism shall also be accepted.
 - .3 Openings for cable routing shall have grommets to ensure smooth transition of the cables.
- .4 Shielded Cord Vertical Power Bar
 - .1 Fabricated from 18 GA (0.048") steel & mountable into 19" EIA cabinet frames or network racks.
 - .2 Each power bar shall have a NEMA 5-15 input plug that comes with a minimum of 3m 10'(ft) cord and the following output receptacles:
 - .1 TBC NEMA 5-20
 - .2 TBC IEC C13
 - .3 TBC IEC C19
 - .3 Shielded Cord features a 300V capacity, 100% coverage aluminum foil - polyester tape shield, 7x28 AWG tinned copper drain wire (20 AWG), and a durable PVC outer coating.
 - .4 The power bar(s) shall be UL/ULC listed and must meet UL/ULC 1363 and 1449 requirements.

TELECOMMUNICATIONS CABINETS, RACKS, FRAMES AND ENCLOSURES

- .5 Features breaker protection with reset button, three-stage surge protection, fused and non-switched with illuminated power switch showing power "ON".

2.4 Plywood Backboards

- .1 Backboards must be constructed of 3/4" G1S CANPLY Exterior Grade plywood (4'x8' sheet), one side good and painted with two (2) coats of white fire retardant non-conductive paint

PART 3 - EXECUTION

3.1 Telecommunications Wall Mount Brackets, Racks, Cabinets and Components

- .1 Properly secure the racks on top of the finished floor and wall. Ground all racks and cabinets in accordance with the parameters within this specification document.
- .2 Refer to detail drawings for location(s) of Telecommunications wall mount brackets, racks and cabinets.
- .3 Provide all Telecommunications rack and cabinet components as per the detail drawings. Provide (including levelling and ganging) all racks, cabinets and their components for a complete functioning system.
- .4 Secure all wall mounted equipment (i.e. rotating rack & wall mount cabinet) backboards.

3.2 Telecommunications Rack & Cabinet Components

- .1 Vertical Cable Managers
 - .1 Install two (2) vertical cable managers for each floor/wall mount rack, except where racks are ganged together.
 - .2 Where racks are ganged together, provide one (1) vertical cable manager between racks.
 - .3 For cabinets, provide minimum size of 215mm (8.5") W x 150mm (6") D vertical cable manager on each side of each cabinet. Two vertical Cable Managers shall be installed for each floor mount cabinet.
- .2 Horizontal Cable Management Panel
 - .1 Install one horizontal cable manager per rack plus an additional one for every patch panel and every network switch. Assume 24 port switches, one port for every horizontal cable installed.
- .3 Shielded Cord Vertical Power Bar
 - .1 Unless noted elsewhere on an elevated drawing, provide a minimum of one power bar to each rack/cabinet and mount on the rear right side of the rack with cord end located at the top of the rack/cabinet.

3.3 Plywood Backboards

- .1 Place plywood sheets vertically mounted directly on the wall. Refer to Drawings for location(s) of Backboard(s). Provide backboards unless otherwise noted.
- .2 Offset Backboards
 - .1 Constructed backboards to suit construction specifications prescribed in included detail drawing(s). Feed cables from behind the Backboard to the IDC mounts,

TELECOMMUNICATIONS CABINETS, RACKS, FRAMES AND ENCLOSURES

unless otherwise noted. Install offset backboards where required as shown on drawings.

.3 Flush Backboards

- .1 Use backboards for wall mounted racks, wall mounted cabinets, wall mount brackets, telephone equipment, service provider equipment, lightning protection, horizontal cables, riser cables, IDC punch down blocks, and/or any other use as identified in the scope of Work for this project, including for use by others. Install flush backboards where required as shown on drawings.

END OF SECTION

TELECOMMUNICATIONS TERMINATION BLOCKS AND PATCH PANELS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 27 00 05.10 – GENERAL INSTRUCTIONS FOR TELECOMMUNICATIONS SECTIONS.

1.2 Copper Patch Panels

- .1 The Patch Panel shall support the appropriate applications, and facilitate cross connection and inter-connection using Modular Patch Cords.

1.3 Optical Fibre Enclosure

- .1 The Patch Panel shall support the appropriate applications, and facilitate cross connection and inter-connection using Modular Patch Cords.

PART 2 - PRODUCTS

2.1 Copper IDC Termination Block Assembly

- .1 All IDC Termination Connectors shall be appropriate manufacturers “110” style connectors. Refer to backboard elevations for correct style.
- .2 Multipair cable IDC Termination Connectors (‘IDC’) shall have an insulation resistance of 100 mega ohms between clips.
- .3 The ‘IDC’ shall have a durability of 200 insertions/withdrawals of any combination of wire gauge.
- .4 The ‘IDC’ shall be FCC Part 68, subpart F/CS-03 Part 1 compliant.
- .5 The durability of the jack in a Modular Jack Connector shall be minimum 1000 mating cycles.
- .6 The contact material of the jack in a Modular Jack Connector shall be phosphor bronze with 50 micro-inches of gold over nickel with a maximum current rating of 1.5 amperes and the dielectric strength shall be 1000V RMS at 60 Hz for one minute.
- .7 Terminate all cables using IDC termination mounts. The IDC Connectors shall be able to terminate 22-26 AWG Conductors. The IDC mount shall be capable of feeding the cables to the IDC Connectors from behind the connector.

2.2 Copper Patch Panels

- .1 482 mm (19”) rack mountable MDVO or High Density style 1U 24-port Patch Panel. Refer to Rack Elevation Detail(s) for correct style.
- .2 Minimum 50 microns of hard gold over nickel or copper on outlet contact wires.
- .3 Patch Panels shall be suitable for rack mounting and shall incorporate integral labeling spaces for port identification. Provide blank labeling strips.
- .4 Colour: Black

TELECOMMUNICATIONS TERMINATION BLOCKS AND PATCH PANELS

2.3 Optical Fibre Enclosure

- .1 The Optical Fibre Patch Panel Tray shall be compatible with standard 19" Racks, must be serviceable from the front by allowing the Fibre Patch Panel to slide or pivot away from the Rack. Mount the panel as indicated on Detail Drawings.
- .2 Performance shall meet all requirements of ANSI/TIA-568.3 Section 5 – Connecting Hardware.
- .3 The Fibre Optic Patch Panel(s) shall:
 - .1 Be sized to accommodate the termination of all Fibre strands at each cable termination point,
 - .2 Be capable of terminating tight buffered and loose tube cable and accept all popular connector types, and
 - .3 Have a slide out shelf or swing out drawer for access to the Fibres.
- .4 An appropriately sized splice tray shall be included as required.
- .5 The Fibre Optic Patch Panel shall provide for bend radius control and strain relief to accommodate the Fibre Optic Cables.

2.4 Optical Fibre Adapter Strips and Connectors

- .1 The Optical Fibre Adapter Strips shall:
 - .1 Be colour coded to identify performance grade:
 - .1 OM3 / OM4 – Aqua,
 - .2 Have either phosphor bronze or zirconia ceramic sleeves,
 - .3 Accommodate either multimode or single mode optical fibre,
 - .4 Be pre-loaded with 6 adapters (single density),
 - .5 Be compatible with SC connectors for Recreation Center,
Be compatible with LC connectors for Child Care Center,
 - .6 Have an insertion loss of 0.2dB for multimode sleeves and 0.15 dB for single mode sleeves,
 - .7 Have a durability of 1000 matings, and
 - .8 Have a tensile strength of 50-lbs. (220 N), <0.2 dB change.

PART 3 - EXECUTION

3.1 Copper IDC Termination Block Assembly

- .1 Terminate all multi-pair Voice cables on the Backboard in the Telecommunications Room for that floor, unless otherwise specified in the scope of Work or Drawings.
- .2 Terminate all cables using IDC termination mounts.
- .3 Provide cable management in the form of Distribution Rings between columns and rows of IDC mounts to support cross connect management. Refer to Detail Drawings for typical Drawings of Voice Backboard layouts.

TELECOMMUNICATIONS TERMINATION BLOCKS AND PATCH PANELS

3.2 Patch Panels

- .1 Provide Patch Panels in each rack location in sufficient quantities to terminate all horizontal cables specified with no less than 6 spare ports per Patch Panel to be left vacant for future use.

3.3 Optical Fibre Enclosure

- .1 Provide all necessary accessories for a complete Fibre enclosure for all strands of Fibre, including but not limited to; clear cover plates, mounting brackets and hardware, duplex fibre bulkheads (adapter sleeves-plates/couplers), fibre connectors and fibre cable management. The Telecommunications Subcontractor is responsible for supplying blank mounting plates for all unused openings.

END OF SECTION

TELECOMMUNICATIONS CABLE MANAGEMENT AND LADDER RACK

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 27 00 05.10 – GENERAL INSTRUCTIONS FOR TELECOMMUNICATIONS SECTIONS.

1.2 Cable Installation

PART 2 - PRODUCTS

2.1 Overhead Cable Tray

- .1 Cable tray shall be aluminum or steel wire mesh, ladder type with manufactured fittings.
- .2 Minimum dimensions 300mm (12") wide x 100mm (4") deep
- .3 Provide continuous #6AWG minimum green insulated copper bond wire in the tray. Provide #6AWG green insulated copper bonding jumper between the cable tray and every associated conduit to ensure continuous bond between tray and low tension raceways.

PART 3 - EXECUTION

3.1 Product Delivery Requirements

- .1 Unload materials from delivery trucks in such a manner as to protect the materials from damage. In particular, reels of cable shall not be unloaded by dropping them off the vehicle.

3.2 Protecting Installed Systems and Construction

- .1 Be responsible for the assembly and protection of equipment/materials and related items until project cut over. Any damage to materials or equipment shall be the liability of the Telecommunications Subcontractor. All damage shall be repaired or at The City's request, the equipment shall be replaced at no extra charge to The City.

END OF SECTION

TELECOMMUNICATIONS COPPER BACKBONE CABLING

PART 1 - GENERAL

1.1 Work Included

- .1 Supply and install cabling as detailed in the Contract Documents. Use pathways installed by the Electrical Subcontractor to distribute the cables throughout the facility. Where the cables leave the pathways and extend to the termination point they shall use cable support hangers.
- .2 Ensure that all cable lengths are sufficient to allow for slack, vertical runs, wastage, connectorization and future moves.
- .3 Install backbone cables in accordance with manufacturer's specifications ensuring that proper installation techniques are used and that the cable's maximum pull-force and maximum bend radii specifications are adhered to.
- .4 Secure backbone cable/cable bundles properly when fastened to backboards or termination cabinets/racks.
- .5 Verify all backbone cable run lengths on site prior to ordering.
- .6 Copper cabling requirements for this project will be reflected on Telecommunications backbone riser diagram(s) (If required).

1.2 Cable Routing

- .1 Make any necessary changes or additions to routing of cables, pathways to accommodate structural, mechanical, electrical and architectural conditions. Where pathways or cables are shown diagrammatically run them parallel to building columns. If it is necessary to run cables otherwise to accommodate acceptable cable lengths, written permission must be obtained from the Contract Administrator prior to installation.
- .2 Any deviation from the cable routing, outlet and equipment locations shown on drawings must be approved by the Contract Administrator and documented on as-built drawings.

1.3 Backbone Locations

- .1 Backbone cabling locations may be relocated, prior to installation, from the location shown on the Drawings, to a maximum distance of 3.05m (10'-0") without adjustment to the Contract price.

1.4 Multipair Cable

- .1 The Multipair cable shall meet the ICEA S-90-661-latest version, and be compliant with Telcordia and REA specifications.
- .2 The Multipair cable shall meet or exceed the latest requirements of TIA-568, latest version.
- .3 The cable shall have 24 AWG solid copper conductors and polyolefin insulation.
- .4 The cable core shall consist of 25 pair sub-units.
- .5 The cable shall have sequential length markings printed on the cable jacket.
- .6 The cable shall have one jacket equipped with a jacket splitting cord.

TELECOMMUNICATIONS COPPER BACKBONE CABLING

1.5 Cable Ratings

- .1 The non-plenum/plenum cable shall be ETL or UL/ULC Listed and CSA Certified as type CMR/CMP, in accordance with the Binational Standard for Communications Cable, UL444/C22.2 No. 214-latest version.

1.6 Cable Connectors and Clamps

- .1 All connectors and clamps must be listed and rated for outside use and properly sized to accept the wire and strand size involved.

PART 2 - PRODUCTS

2.1 Multi-Pair Backbone Cable

- .1 Jacket - appropriately rated thermoplastic outer jacket where required by local codes. All individual conductors to be insulated with fluorinated ethylene propylene (FEP).
- .2 Cable must withstand a bend radius of 25.4 mm (1") at a temperature of -20 deg. C $\pm$ 1 deg. C without jacket or insulation cracking.
- .3 Conductors - 24 AWG solid copper insulated conductors to form twisted pairs formed into 25-pair binder groups. The binder groups to be distinctly coloured binders and assembled to form a single compact core.

2.2 System Performance

- .1 Multipair Copper Backbone System
 - .1 All components of the multipair copper backbone channel shall meet the Minimum performance characteristics of: Category 5E – 100MHz and a data rate of 1.0Gb/s

2.3 Certification

- .1 Acceptable manufacturers for the complete Structured Cabling Solution for the Recreation Center:
 - .1 Manufacturer / Subcontractor Certification
 - .1 Belden Incorporated / CSV – Certified Systems Vendor
 - .2 CommScope Incorporated (Systimax) / CPP – CommScope Partner Pro
 - .3 CommScope Incorporated (Uniprise) / CPP – CommScope Partner Pro
 - .4 Amp
- .2 Acceptable manufacturers for the complete Structured Cabling Solution for the Child Care Center:
 - .1 Manufacturer / Subcontractor Certification
 - .1 Leviton Manufacturing Company Incorporated / CNI – Certified Network Installer
 - .2 Amp

TELECOMMUNICATIONS COPPER BACKBONE CABLING

2.4 Vertical Cable Support

- .1 Closed mesh type, galvanized finish metal vertical cable support system
- .2 Double eye attachment system
- .3 Support(s) shall be sized to accommodate size & quantity of vertical cabling.
- .4 Approved Manufacturers:
 - .1 Pass & Seymour Flexcor Wire Mesh Grip system, or
 - .2 Kellem Closed Mesh Support Grip system.

2.5 Cable Lubricant

- .1 The use of pulling lubricants of any kind is strictly prohibited.

PART 3 - EXECUTION

3.1 Installation

- .1 Avoid scraping, denting, or otherwise damaging cables, before, during or after installation. Replace damaged cables without any additional compensation.

3.2 Backbone Cable Distribution

- .1 Provide appropriately sized multipair copper cable(s) as depicted on the Telecommunications Riser Diagram(s). Refer to backboard and rack elevation Drawings for mounting type & locations.
- .2 In the Telecommunications Rooms, cross-connect of all horizontal voice cabling to the backbone copper cabling. Submit a cross connect schedule prior to installation.
- .3 Exercise caution when pulling cables in pathways to avoid damage to any existing cables and follow manufacturer's maximum pull-force and minimum bend radii.
- .4 All cables and components shall be installed and terminated in accordance with applicable Codes, Standards and Regulations.
- .5 Provide a minimum of 3.05 m (10'-0") of slack at both ends of each cable to permit future cable relocation. Neatly coil slack in cable tray and/or ladder tray. If cable tray and/or ladder tray is not available cable supports shall be used in the ceiling space to coil slack.
- .6 Neatly bundle all cables using Velcro straps. Separate Voice, Data and fibre cables into separate distinct bundles for identification purposes.
- .7 Pull all cables in a continuous run. Do not splice any cables for any reason, unless prior consent is given by the Contract Administrator.
- .8 Provide vertical cable support system(s) for cabling where vertical route length exceeds maximum distance that cable is rated to be self-supporting. Install vertical cable support system(s) as per manufacturer's guidelines.
- .9 Ground all components to manufacturer's specifications and Standard practices.
- .10 Terminate all pairs of each cable at both ends, including all spares.
- .11 Test, label and document as specified in this document.

TELECOMMUNICATIONS COPPER BACKBONE CABLING

3.3 Overhead Backbone Cable Installation

- .1 Install all cables identified as Overhead via the indoor and outdoor pathways as provided by Division 26. Division 26 will install all indoor conduit and outdoor overhead poles complete with a messenger wire.
- .2 Over the entire length, cables shall be installed so that they loosely lash around the messenger wire and/or are supported by suspension clamps. Every cable shall be individually and loosely lashed to the messenger wire to allow for expansion and contraction of the cables and messenger. Under no circumstance shall one of the cables be used to support other cables.
- .3 Minimise excess stress on the copper cabling.
- .4 Installation of cable(s) shall be with the use of a cable chute to pay out the cable as it is installed. Securely fasten the cable chute to the pole using a pole attachment and adapter.
- .5 Align the payout reel linearly with the pole and the direction of the cable travel. Locate the pay out reel a distance of twice the height of the messenger to avoid excess tension on the Cable as it is installed.
- .6 Use cable blocks or rollers at a distance of every 25 feet to support the cable or cables between poles.
- .7 Use a cable puller and adjustable pressure brake assembly as necessary to prevent slack from pulling back onto the strand line when tension is removed from the pull line.
- .8 Use spacers and bands to separate the cable from the messenger wire and hardware attached to the wire. The band shall be used to hold the cable and spacers next to the wire, it should not be drawn too tightly on the cable, and it should only support the cable.
- .9 Install one flat bottom expansion loop for every pole. Where distances between poles is greater than 200 feet, install two flat bottom expansion loops. Every cable installed should have a flat bottom expansion loop at every pole. Locate expansion loop directly at the pole. After the loop is formed, the Cable is lashed to the spacer and the lashing wire shall be secured on one side. The lashing wire should be wrapped around the Wire three times and then tied off at the lashing wire clamp.
- .10 Make any necessary penetrations to building walls to pass the cables through the wall. Penetration size shall be minimised. All penetrations shall be sealed with outdoor silicone to ensure no moisture or water ingress into the building(s). Silicone must be resistant to degradation from temperature cycles and UV exposure.
- .11 Use an approved cable guide and lashing device to secure the cable to the messenger strand.
- .12 Clamp cable to the exterior of the building with approved galvanized steel cable clamps.

3.4 Cable Bonding

- .1 Refer to Section 27 05 26 - GROUNDING AND BONDING FOR TELECOMMUNICATIONS SYSTEMS.

TELECOMMUNICATIONS COPPER BACKBONE CABLING

3.5 Cable Lubricant

- .1 The use of pulling lubricants of any kind is strictly prohibited.

3.6 Termination Requirements

- .1 Terminate test and label each cable in accordance to the parameters stated in this specification document.

END OF SECTION

TELECOMMUNICATIONS OPTICAL FIBRE BACKBONE CABLING

PART 1 - GENERAL

1.1 Work Included

- .1 Supply and install cabling as detailed in the Contract Documents. Use pathways installed by the Electrical Subcontractor to distribute the cables throughout the facility. Where the cables leave the pathways and extend to the termination point they shall use cable support hangers.
- .2 Ensure that all cable lengths are sufficient to allow for slack, vertical runs, wastage, connectorization and future moves.
- .3 Install backbone cables in accordance with manufacturer's specifications ensuring that proper installation techniques are used and that the cable's maximum pull-force and maximum bend radii specifications are adhered to.
- .4 Backbone cable/cable bundles shall be secured properly when fastened to backboards or termination cabinets/racks.
- .5 Fibre optic cables shall be completely protected with corrugated inner duct for the entire length of the cable run. Refer to section 27 05 28 for situations where inner duct is not required.
- .6 Verify all backbone cable run lengths on site prior to ordering.
- .7 Fibre Backbone cabling requirements for this project will be reflected on Telecommunications backbone riser diagram(s).

1.2 Cable Routing

- .1 Make any necessary changes or additions to routing of cables, pathways to accommodate structural, mechanical, electrical and architectural conditions. Where pathways or cables are shown diagrammatically run them parallel to building columns. If it is necessary to run cables otherwise to accommodate acceptable cable lengths, written permission must be obtained from the Contract Administrator prior to installation.
- .2 Any deviation from the cable routing, outlet and equipment locations shown on drawings must be approved by the Contract Administrator and documented on as-built drawings.

1.3 Backbone Locations

- .1 Backbone cabling locations may be relocated, prior to installation, from the location shown on the Drawings, to a maximum distance of 3.05m (10'-0") without adjustment to the Contract price.

1.4 Fibre Optic Cables

- .1 All fibre optic cables shall meet or exceed the latest requirements of TIA-568.3, latest version.
- .2 The cables shall have:
 - .1 Sequential length markings printed on the cable jacket,
 - .2 A Crush Resistance of 2000 N/cm as per TIA-455-41, latest edition,
 - .3 An Impact Resistance of 1000 impacts with 1.6 N-m as per TIA-455-25, latest edition, and

TELECOMMUNICATIONS OPTICAL FIBRE BACKBONE CABLING

- .4 A minimum Flexure rating of 2000 cycles as per TIA-455-104, latest edition.

1.5 Cable Ratings

- .1 The non-plenum/plenum cable shall be ETL or UL/ULC Listed and CSA Certified as type ONFR / ONFP, in accordance with the Binational Standard for Communications Cable, UL444/C22.2 No. 214-latest version.

1.6 Cable Connectors and Clamps

- .1 All connectors and clamps must be listed and rated for outside use and properly sized to accept the wire and strand size involved.

PART 2 - PRODUCTS

2.1 System performance

- .1 Multimode Fibre Optic Backbone System
 - .1 All components of the Fibre Optic Backbone channel for the Recreation Center shall meet the minimum performance characteristics of: OM4 – 50/125um laser optimized with minimum bandwidth of 4700MHz/km at 850nm and 500MHz/km at 1300nm up to 550 meters.
 - .2 All components of the Fibre Optic Backbone channel for the Child Care Center shall meet the minimum performance characteristics of: OM3 – 50/125um laser optimized with minimum bandwidth of 2000MHz/km at 850nm and 500MHz/km at 1300nm up to 300 meters

2.2 Certification

- .1 Acceptable manufacturers for the complete Structured Cabling Solution for the Recreation Center:
 - .1 Manufacturer / Subcontractor Certification
 - .1 Belden Incorporated / CSV – Certified Systems Vendor
 - .2 CommScope Incorporated (Systimax) / CPP – CommScope Partner Pro
 - .3 CommScope Incorporated (Uniprise) / CPP – CommScope Partner Pro
 - .4 Amp
- .2 Acceptable manufacturers for the complete Structured Cabling Solution for the Child Care Center:
 - .1 Manufacturer / Subcontractor Certification
 - .1 Leviton Manufacturing Company Incorporated / CNI – Certified Network Installer
 - .2 Amp

2.3 Vertical Cable Support

- .1 Closed mesh type, galvanized finish metal vertical cable support system
- .2 Double eye attachment system

TELECOMMUNICATIONS OPTICAL FIBRE BACKBONE CABLING

- .3 Size support(s) to accommodate size & quantity of vertical cabling.
- .4 Approved Products:
 - .1 Pass & Seymour Flexcor Wire Mesh Grip system, and
 - .2 Kellem Closed Mesh Support Grip system.

2.4 Cable Lubricant

- .1 The use of pulling lubricants of any kind is strictly prohibited.

PART 3 - EXECUTION

3.1 Installation

- .1 Avoid scraping, denting, or otherwise damaging cables, before, during or after installation. Replace damaged cables without any additional compensation.

3.2 Backbone Cable Distribution

- .1 Provide appropriately sized fibre optic cable(s) as depicted on the Telecommunications Riser Diagram(s). Refer to backboard and rack elevation Drawings for mounting type & locations.
- .2 Provide appropriate & size of optical fibre cable(s) as depicted on the Telecommunications Riser Diagram(s). At each cable end, terminate cable in a new fibre patch panel. See rack elevations for details. Coordinate mounting location with The City prior to termination for terminations to be made in an existing Telecommunications room.
- .3 Exercise caution when pulling cables in pathways to avoid damage to any existing cables and follow manufacturer's maximum pull-force and minimum bend radii.
- .4 Install and terminate all cables and components in accordance with applicable Codes, Standards and Regulations.
- .5 Provide a minimum of 3.05 m (10'-0") of slack at both ends of each cable to permit future cable relocation. Neatly coil slack in ladder tray. If ladder tray is not available cable supports shall be used in the ceiling space to coil slack.
- .6 Neatly bundle all cables using Velcro straps. Separate Voice, Data and Fibre cables into separate distinct bundles for identification purposes.
- .7 Pull all cables in a continuous run. Do not splice any cables for any reason, unless prior consent is given by the Contract Administrator.
- .8 Provide vertical cable support system(s) for cabling where vertical route length exceeds maximum distance that cable is rated to be self-supporting. Install vertical cable support system(s) as per manufacturer's guidelines.
- .9 Ground all components to manufacturer's specifications and standard practices.
- .10 Terminate all strands of each cable at both ends, including all spares.
- .11 Test, label and document as specified in this document.

TELECOMMUNICATIONS OPTICAL FIBRE BACKBONE CABLING

3.3 Overhead Backbone Cable Installation

- .1 Install all cables identified as Overhead via the indoor and outdoor pathways as provided by the Electrical Subcontractor. The Electrical Subcontractor will install all indoor conduit and outdoor overhead poles complete with a messenger wire.
- .2 Install cables so that they loosely lash around the messenger wire and/or are supported by suspension clamps over the entire length. Every cable shall be individually and loosely lashed to the messenger wire to allow for expansion and contraction of the cables and messenger. Under no circumstance shall one of the cables be used to support other cables.
- .3 Minimise excess stress on the Optical fibre cabling.
- .4 Installation of cables shall be with the use of a cable chute to pay out the cable as it is installed. Securely fasten the cable chute to the pole using a pole attachment and adapter.
- .5 Align the payout reel linearly with the pole and the direction of the cable travel. Locate the pay out reel a distance of twice the height of the messenger to avoid excess tension on the Cable as it is installed.
- .6 Use cable blocks or rollers at a distance of every 25 feet to support the cable or cables between poles.
- .7 Use a cable puller and adjustable pressure brake assembly as necessary to prevent slack from pulling back onto the strand line when tension is removed from the pull line.
- .8 Use spacers and bands to separate the cable from the messenger wire and hardware attached to the wire. The band shall be used to hold the cable and spacers next to the wire, it should not be drawn too tightly on the cable, and it should only support the cable.
- .9 Install one flat bottom expansion loop for every pole. Where distances between poles is greater than 200 feet, install two flat bottom expansion loops. Every cable installed should have a flat bottom expansion loop at every pole. Locate expansion loop directly at the pole. After the loop is formed, the cable is lashed to the spacer and the lashing wire shall be secured on one side. The lashing wire should be wrapped around the Wire three times and then tied off at the lashing wire clamp.
- .10 The Telecommunications Subcontractor will be required to make any necessary penetrations to building walls to pass the cables through the wall. Penetration size shall be minimised. Seal all penetrations with outdoor silicone to ensure no moisture or water ingress into the buildings. Silicone must be resistant to degradation from temperature cycles and UV exposure.
- .11 Use an approved cable guide and lashing device to secure the cable to the messenger strand.
- .12 Clamp cable to the exterior of the building with approved galvanized steel cable clamps.

3.4 Cable Bonding

- .1 Refer to Section 27 05 26 - GROUNDING AND BONDING FOR TELECOMMUNICATIONS SYSTEMS.

3.5 Cable Lubricant

- .1 The use of pulling lubricants of any kind is strictly prohibited.

END OF SECTION

DATA TELECOMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 Work Included

- .1 Supply and install cabling as detailed in the Contract Documents. The Telecommunications Subcontractor shall use pathways by the Electrical Subcontractor to distribute the cables throughout the facility. Where the cables leave the pathways and extend to the termination point they shall use cable support hangers.
- .2 Ensure that all cable lengths are sufficient to allow for slack, vertical runs, wastage, connectorization and future moves.
- .3 Ensure ANSI/TIA-568.2, latest edition installation practices are followed. Install horizontal cables in accordance with manufacturer's specifications ensuring that proper installation techniques are adhered to.
- .4 Terminate all pairs of cable at each cable end.
- .5 Inform the Contract Administrator immediately of any horizontal cable runs exceeding 90 m 295'(ft). Minimum horizontal cable run (if required) shall not be less than that specified in manufacturer's specifications.
- .6 The Contract Administrator shall determine the quality of workmanship during installation. Cables that have not been properly installed will be reinstalled by the Telecommunications Subcontractor at no additional expense to the Contract.

1.2 Cable Routing

- .1 Make any necessary changes or additions to routing of cables, pathways to accommodate structural, mechanical, electrical and architectural conditions. Where pathways or cables are shown diagrammatically run them parallel to building columns. If it is necessary to run cables otherwise to accommodate acceptable cable lengths, written permission must be obtained from the Contract Administrator prior to installation.
- .2 Any deviation from the cable routing, outlet and equipment locations shown on drawings must be approved by the Contract Administrator and documented on as-built drawings.

PART 2 - PRODUCTS

2.1 4-Pair Horizontal Copper Cable

- .1 Four pair, twisted pair cable consisting of #22-26 AWG solid conductors, formed into four individually twisted pairs and enclosed in an appropriately rated thermoplastic jacket as required by local codes. All individual conductors to be insulated with fluorinated ethylene propylene (FEP).
- .2 All cabling must be CSA certified and stamped accordingly
- .3 Cable to withstand a bend radius of 25.4 mm (1") at a temperature of -20 deg. C $\pm$ 1 deg. C without jacket or insulation cracking.

DATA TELECOMMUNICATIONS HORIZONTAL CABLING

- .4 All cables shall have an outer jacket colour as identified below:

Cable Designation	Colour
Data	Blue
Wireless Access Point	Blue
AV Data	Black
Security	Red
Inter-Cabinet Connectivity	Green

2.2 System Performance

- .1 4-Pair Horizontal Copper Cabling

- .1 All components of the horizontal data channel shall meet the minimum performance characteristics of:

Cable Designation	Performance
All Cable Types	Category 6 – 250MHz and a data rate of 2.4Gb/s

2.3 Certification

- .1 Acceptable manufacturers for the complete Structured Cabling Solution for the Recreation Center:

- .1 Manufacturer / Subcontractor Certification

- .1 Belden Incorporated / CSV – Certified Systems Vendor
- .2 CommScope Incorporated (Systimax) / CPP – CommScope Partner Pro
- .3 CommScope Incorporated (Uniprise) / CPP – CommScope Partner Pro
- .4 Amp

- .2 Acceptable manufacturers for the complete Structured Cabling Solution for the Child Care Center:

- .1 Manufacturer / Subcontractor Certification

- .1 Leviton Manufacturing Company Incorporated / CNI – Certified Network Installer
- .2 Amp

PART 3 - EXECUTION

3.1 General Conditions

- .1 Remove only enough cable jacket to perform termination, untwist pairs a maximum of 13 mm (1/2") for Category 5 to 6a cables and 25 mm (1") for Category 3 cables. Any specific manufacturer's installation guidelines shall supersede the above.
- .2 Do not splice any cables for any reason, unless prior consent is given by the Contract Administrator.

DATA TELECOMMUNICATIONS HORIZONTAL CABLING

3.2 Installation

- .1 Avoid scraping, denting, painting, or otherwise damaging cables, before, during or after installation. Replace damaged cables without any additional compensation.
- .2 Ground all cables and components to manufacturer's specifications and standard practices.

3.3 Horizontal Cable Distribution

- .1 Provide a minimum of 3.05 m (10'-0") of slack at both ends of each cable to permit future cable relocation. Neatly coil slack in ladder tray. If ladder tray is not available ceiling space and cable supports may also be used to coil slack. For completely enclosed zone conduit distribution systems, provide 3.05 m (10'-0") of slack at the Telecommunications room end only.
- .2 Follow proper installation and termination practices for UTP copper and Optical Fibre cables. Do not kink or exceed the cable minimum bend radius or maintain a minimum of four (4) times cable diameter as bend radii if the manufacturer specifies no bend radius. For Optical Fibre cables maintain a minimum of ten (10) times the cable diameter or 30 mm (1.2") whichever is larger for a bend radius.
- .3 Bundle all horizontal cables on the Telecommunications Racks using Velcro straps. Separate Voice, Data and fibre cables into separate distinct bundles for identification purposes where applicable.
- .4 Strap bundles in Telecommunications rooms, at a maximum of 203 mm 8"(in) separation. Bundles shall contain no more than fifty (50) cables to eliminate any excessive stress on the cable jackets.
- .5 When bundling cables, comply with manufacturer's recommended bundling practices for installation. Ensure that excess pressure is not placed on the cable at any point that may result in the compression or deformation of the cable jacket and internal pair/conductor geometry.
- .6 All exposed cabling at the workstation between wall/floor-input point locations and systems furniture is to be wrapped with black split loom tubing, size and length as required to suit.
- .7 Route/install Telecommunications cabling in systems furniture, lab casework furniture & mill work as denoted on floor plans.
- .8 Provide Data cables to each outlet indicated on the drawings. The Telecommunications Subcontractor shall refer to the legends on the drawing to determine the number of cables to each outlet location.

3.4 Termination Requirements

- .1 UTP Cables for Recreation Center
 - .1 Terminate cabling using TIA 568B configuration, unless noted otherwise.
- .2 UTP Cables for Child Care Center
 - .1 Terminate cabling using TIA 568A configuration, unless noted otherwise.

DATA TELECOMMUNICATIONS HORIZONTAL CABLING

.3 Fibre

.1 Terminate all multimode and single mode Fibre Optic Cabling using Choose an item. connectors unless expressly written otherwise in this document. Use splicing techniques such as mechanical and heat shrink fusion splicing where specified.

.4 Terminate test and label each cable in accordance to the parameters stated in this specification document.

END OF SECTION

VOICE TELECOMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 Work Included

- .1 Supply and install cabling as detailed in Contract Documents. Use pathways provided by Electrical Subcontractor to distribute the cables throughout the facility. Where cables leave the pathways and extend to the termination point use cable supports specified in this document.
- .2 Ensure that all cable lengths are sufficient to allow for slack, vertical runs, wastage, connectorization and future moves.
- .3 Ensure ANSI/TIA-568.2, latest edition installation practices are followed. Install horizontal cables in accordance with manufacturer's specifications ensuring that proper installation techniques are adhered to.
- .4 Terminate all pairs of cable at each cable end.
- .5 Inform the Contract Administrator immediately of any horizontal cable runs exceeding 90 m 295'(ft). Minimum horizontal cable run (if required) shall not be less than that specified in manufacturer's specifications.
- .6 The Contract Administrator shall determine the quality of workmanship during installation. Cables that have not been properly installed will be reinstalled by the Telecommunications Subcontractor at no additional expense to the Contract.

1.2 Cable Routing

- .1 Make any necessary changes or additions to routing of cables, pathways to accommodate structural, mechanical, electrical and architectural conditions. Where pathways or cables are shown diagrammatically run them parallel to building columns. If it is necessary to run cables otherwise to accommodate acceptable cable lengths, written permission must be obtained from the Contract Administrator prior to installation.
- .2 Any deviation from the cable routing, outlet and equipment locations shown on drawings must be approved by the Contract Administrator and documented on as-built drawings.

PART 2 - PRODUCTS

2.1 4-Pair Horizontal Copper Cable

- .1 Four pair, twisted pair cable consisting of #22-26 AWG solid conductors, formed into four individually twisted pairs and enclosed in an appropriately rated thermoplastic jacket as required by local codes. All individual conductors to be insulated with fluorinated ethylene propylene (FEP).
- .2 All cabling must be CSA certified and stamped accordingly
- .3 Cable to withstand a bend radius of 25.4 mm (1") at a temperature of -20 deg. C $\pm$ 1 deg. C without jacket or insulation cracking.

VOICE TELECOMMUNICATIONS HORIZONTAL CABLING

- .4 All cables shall have an outer jacket colour as identified below:

Cable Designation	Colour
Voice	Blue

2.2 System Performance

- .1 4-Pair Horizontal Copper Cabling

- .1 All components of the horizontal data channel shall meet the minimum performance characteristics of:

Cable Designation	Performance
Voice	Category 6 – 250MHz and a data rate of 2.4Gb/s

2.3 Certification

- .1 Acceptable manufacturers for the complete Structured Cabling Solution for the Recreation Center:

- .1 Manufacturer / Subcontractor Certification

- .1 Belden Incorporated / CSV – Certified Systems Vendor
- .2 CommScope Incorporated (Systimax) / CPP – CommScope Partner Pro
- .3 CommScope Incorporated (Uniprise) / CPP – CommScope Partner Pro
- .4 Amp

- .2 Acceptable manufacturers for the complete Structured Cabling Solution for the Child Care Center:

- .1 Manufacturer / Subcontractor Certification

- .1 Leviton Manufacturing Company Incorporated / CNI – Certified Network Installer
- .2 Amp

PART 3 - EXECUTION

3.1 General Conditions

- .1 Remove only enough cable jacket to perform termination, untwist pairs a maximum of 13 mm (1/2") for Category 5 to 6a cables and 25 mm (1") for Category 3 cables. Any specific manufacturer's installation guidelines shall supersede the above.
- .2 Do not splice any cables for any reason, unless prior consent is given by the Contract Administrator's Representative.

3.2 Installation

- .1 Avoid scraping, denting, painting, or otherwise damaging cables, before, during or after installation. Replace damaged cables without any additional compensation.
- .2 Ground all cables and components to manufacturer's specifications and standard practices.

VOICE TELECOMMUNICATIONS HORIZONTAL CABLING

3.3 Horizontal Cable Distribution

- .1 Provide a minimum of 3.05 m (10'-0") of slack at both ends of each cable to permit future cable relocation. Neatly coil slack in ladder tray. If ladder tray is not available ceiling space and cable supports may also be used to coil slack. For completely enclosed zone conduit distribution systems, provide 3.05 m (10'-0") of slack at the Telecommunications room end only.
- .2 Follow proper installation and termination practices for UTP copper cables. Do not kink or exceed the cable minimum bend radius, or maintain a minimum of four (4) times cable diameter as bend radii if the manufacturer specifies no bend radius.
- .3 All horizontal cables shall be bundled on the Telecommunications Racks using Velcro straps. Separate UTP copper and fibre cables into separate distinct bundles for identification purposes where applicable.
- .4 Bundles shall be tie-wrapped on in Telecommunications rooms, at a maximum of 203 mm 8" (in) separation and shall contain no more than fifty (50) cables to eliminate any excessive stress on the cable jackets.
- .5 When bundling cables, comply with manufacturer's recommended bundling practices for installation. Ensure that excess pressure is not placed on the cable at any point that may result in the compression or deformation of the cable jacket and internal pair/conductor geometry.
- .6 Wrap all exposed cabling at the workstation between wall/floor-input point locations and systems furniture with black split loom tubing, size and length as required to suit.
- .7 Route/install Telecommunications cabling in systems furniture, lab casework furniture & mill work as denoted on floor plans.
- .8 Provide voice cables to each outlet indicated on the drawings. Refer to the legends on the drawing to determine the number of cables to each outlet location.
- .9 Terminate test and label each cable in accordance to the parameters stated in this specification document.

3.4 Termination Requirements

- .1 UTP Cables for Recreation Center
 - .1 Terminate cabling using TIA 568B configuration, unless noted otherwise.
- .2 UTP Cables for Child Care Center
 - .1 Terminate cabling using TIA 568A configuration, unless noted otherwise.
- .3 Terminate test and label each cable in accordance to the parameters stated in this specification document.

END OF SECTION

TELECOMMUNICATIONS COAXIAL HORIZONTAL CABLING

PART 1 - GENERAL

1.1 Work Included

- .1 Supply and install cabling as detailed in the Contract Documents. Use pathways provided by the Electrical Subcontractor to distribute the cables throughout the facility. Where the cables leave the pathways and extend to the termination point they shall use cable support hangars.
- .2 Ensure that all cable lengths are sufficient to allow for slack, vertical runs, wastage and connectorization.
- .3 Terminate all pairs of cable at each cable end.
- .4 Cable lengths within boxes shall be adequate to permit installation and removal of device for inspection without damage to cable or connections (minimum of 6").
- .5 Cable bends shall not be greater than that recommended by the manufacturer of the cable.
- .6 The Contract Administrator shall determine the quality of workmanship during installation. Cables that have not been properly installed will be reinstalled by the Telecommunications Subcontractor at no additional expense to the Contract.

1.2 Cable Routing

- .1 Make any necessary changes or additions to routing of cables, pathways to accommodate structural, mechanical, electrical and architectural conditions. Where pathways or cables are shown diagrammatically on the Drawings run them parallel to building columns. If it is necessary to run cables otherwise to accommodate acceptable cable lengths, written permission must be obtained from the Contract Administrator prior to installation.
- .2 Any deviation from the cable routing, outlet and equipment locations shown on Drawings must be approved by the Contract Administrator and documented on as-built Drawings.

PART 2 - PRODUCTS

2.1 Horizontal Catv Copper Cable

- .1 All horizontal CATV cabling shall be RG6.
- .2 All cables shall have an outer jacket colour as identified below:

Cable Designation	Colour
CATV	White

- .3 Approved Products
 - .1 Commscope F-6 Series (Commscope Part # 4100903/10) coaxial cable,
 - .2 Belden,
 - .3 Leviton,
 - .4 Amp,

TELECOMMUNICATIONS COAXIAL HORIZONTAL CABLING

PART 3 - EXECUTION

3.1 General Conditions

- .1 When terminating coaxial cables, use only manufacturer recommended coaxial cable stripping tool to remove only enough cable jacket to perform termination.
- .2 Utilize only manufacturer recommended compression style tool to perform installation of Snap-N-Seal "F" connectors.

3.2 Installation

- .1 Avoid scraping, denting, or otherwise damaging cables, before, during or after installation. Replace damaged cables without any additional compensation.

3.3 Horizontal Coaxial Cable Distribution

- .1 Provide coaxial cables to each outlet indicated on the Drawings. Refer to the legends on the drawing to determine the number of cables to each outlet location.
- .2 Neatly bundle cables using Velcro straps.
- .3 Follow proper installation and termination practices for coaxial cables. Do not kink or exceed the cable minimum bend radius or maintain a minimum of four (4) times cable diameter as bend radii if the manufacturer specifies no bend radius.
- .4 When bundling coaxial cables, comply with manufacturer's recommended bundling practices for installation. Ensure that excess pressure is not placed on the cable at any point that may result in the compression or deformation of the cable jacket and cable geometry.
- .5 Terminate test and label each cable in accordance to the parameters stated in this specification document
- .6 Telecommunications Subcontractor to verify location of coaxial backbone cable within termination room. Provide adequate cable slack for termination and to reach backbone cable tap box.
- .7 Ground all cables and components to manufacturer's specifications and standard practices.

END OF SECTION

TELECOMMUNICATIONS FACEPLATES AND CONNECTORS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 27 00 05.10 – GENERAL INSTRUCTIONS FOR TELECOMMUNICATIONS SECTIONS.

1.2 Outlet Locations

- .1 Horizontal Cable outlets may be relocated, prior to installation, from the location shown on the Contract Drawings, to a maximum distance of 3.05m (10'-0") without adjustment to the Contract price.

1.3 Outlet Cover Plates

- .1 When Electrical and Telecommunications receptacles are ganged together, cover plates shall be supplied and installed by the Electrical Subcontractor, unless otherwise noted. Where Telecommunications receptacles are stand alone or separate from Electrical receptacles, cover plates shall be supplied and installed by the Telecommunications Subcontractor.

PART 2 - PRODUCTS

2.1 Eight-Position Modular Connectors

- .1 The eight-position modular connectors must be matched appropriately with the cables to ensure that end to end Manufacturer Warranties will be applicable.
- .2 Eight-position modular style outlet with insulation displacement contacts for termination of all eight conductors.
- .3 Outlets shall be suitable for installation in faceplates at workstation locations, surface raceway, or surface mount boxes.
- .4 All Data and Voice modules shall have the following minimum performance parameters:
 - .1 Modular Jack Current rating: 1.5 amperes maximum
 - .2 Modular Jack Durability: 1,000 mating cycles
 - .3 Modular Jack Contact Pressure: 100 grams, minimum per contact
 - .4 Dielectric Voltage Strength: 1,000 V RMS at 60 Hz for 1 minute
 - .5 Insulation Resistance: 200 MΩ minimum
 - .6 Contact Resistance: 1 M Ω per contact

TELECOMMUNICATIONS FACEPLATES AND CONNECTORS

- .5 All Horizontal 4-pair cables shall be terminated with the jack colours as described below for the Recreation Center. Where the specified Copper Patch Panels are modular, the same jack colours shall be used at both ends of each cable:

Function	Colour	Quantity
Voice	Yellow	As per Drawing
Data	Yellow	As per Drawing
Wireless Access Point	Yellow	As per Drawing
AV Data	Yellow	As per Drawing
Security	Yellow	As per Drawing
Inter-Cabinet Connectivity	Yellow	As per Drawing

- .6 All Horizontal 4-pair cables shall be terminated with the jack colours as described below for the Child Care Center. Where the specified Copper Patch Panels are modular, the same jack colours shall be used at both ends of each cable:

Function	Colour	Quantity
Voice	White	As per Drawing
Data	Blue	As per Drawing
Wireless Access Point	Blue	As per Drawing
AV Data	Blue	As per Drawing
Security	Red	As per Drawing
Inter-Cabinet Connectivity	Blue	As per Drawing

- .7 Outlets shall be suitable for installation in faceplates at workstation locations, surface raceway, or surface mount boxes.

2.2 Optical Fibre Adapter Strips and Connectors

- .1 The Optical Fire Adapter Strips shall:
- .1 Have either phosphor bronze or zirconia ceramic sleeves.
 - .2 Accommodate either multimode or single mode optical fibre.
 - .3 Be pre-loaded with 6 adapters (single density).
 - .4 Be compatible with FC, LC, MT-RJ, SC, SC Duplex, or ST connectors.
 - .5 Have an insertion loss of 0.2db for multimode sleeves and 0.15 db for single mode sleeves.
 - .6 Have a durability of 1000 matings.
Have a tensile strength of 50-lbs. (220 n), <0.2 db change.

TELECOMMUNICATIONS FACEPLATES AND CONNECTORS

.2 Multimode Optical Fibre

- .1 The Multimode Optical Fibre Patch Cord Connector shall be field installable, multimode PC polish-type with ceramic ferrule with a typical insertion loss of 0.3 dB (guaranteed 0.5 dB) and a reflectance of -20 dB.
- .2 All field installable Multimode Fibre Optic Connectors for the Recreation Center shall be SC.
- .3 All field installable Multimode Fibre Optic Connectors for the Child Care Center shall be LC.

2.3 CATV Cable Connectors

- .1 All CATV cable connectors shall be Snap-N-Seal "F" Connectors.
- .2 The Snap-N-Seal "F" Connectors shall have the following minimum performance parameters:
 - .1 Permanently stamped part number and colour-coded sleeves for easy identification before and after installation.
 - .2 Quad sealed system prevents moisture from migrating into the connection.
 - .3 360° radial compression provides superior RF integrity (-95dB typical, 60% bonded foil cable).
 - .4 1/4"x 1/4" cable preparation.
 - .5 Connector to cable retention 40 lbs minimum.
 - .6 Minimum return loss performance of -30dB to 1GHz.
 - .7 Manufactured of high quality 360 brass, cadmium plated with yellow chromate coating for maximum corrosion resistance. Plastic and O-ring providing a reliable environmentally sealed connector.
- .3 Terminate all CATV cable drops in Telecom Rooms on Snap-N-Seal "F" connectors. The Telecommunications Subcontractor shall coordinate with the CATV service provider, the exact termination locations and amount of slack to be left on each cable.

2.4 Workstation Outlets

- .1 Modular Furniture Faceplate
- .2 Use 3 or 4-port modular furniture faceplate adapters for furniture outlets that have modular furniture knockouts. Equip each outlet with the appropriate UTP modules as indicated in this section.
- .3 Use recessed blanks for all unused ports. Blanks must match the frame colour.
- .4 Verify furniture manufacturer prior to ordering.
- .5 Provide a 1/2" spacer/adaptor, if required, to ensure faceplate can be properly installed on systems furniture maintaining proper bend radius

TELECOMMUNICATIONS FACEPLATES AND CONNECTORS

2.5 Wall Faceplate

- .1 Provide all faceplates for wall boxes designated for Telecommunications use that are not ganged with electrical outlet boxes.
- .2 UTP Cables
 - .1 Faceplate colour and type (decora/modular style) shall match electrical. Visible mounting screws shall match the finish of their faceplate.
 - .2 Frames shall be 4 or 6-port frame (non-decora).
 - .3 Use recessed blanks for all unused ports. Blanks must match frame colour.
 - .4 Some locations on the floor plans may indicate a wall mount telephone. Provide a wall mount faceplate suitable for wall mounting a telephone set in these locations.
- .3 Fibre
 - .1 Faceplate colour and type (decora/modular style) shall match electrical. Visible mounting screws shall match the finish of their faceplate.
 - .2 Frames shall be 4 or 6-port frame (non-decora).
 - .3 Use recessed blanks for all unused ports. Blanks must match frame colour.
- .4 CATV
 - .1 Use 2-port modular style flush mounted faceplate adapters for all wall outlets. Equip each outlet with the appropriate "F" Female/Female bullhead modules.
 - .2 Coordinate colour of face plates with Contract Administrator.

2.6 Decora Adapters

- .1 UTP Cables
 - .1 Where Telecommunications wall boxes are ganged with electrical outlet boxes, floor or raceway outlets shall utilise 3 or 4-port Decora style adapters/inserts. Equip each outlet with the appropriate UTP modules as indicated in this section.
 - .2 Provide all Telecommunications workstation adapters/inserts for all Telecommunications outlets (ganged or single) when decora style faceplates are utilized. Provide decora style faceplates for all Telecommunications wall box locations where not ganged with Electrical.
- .2 Fibre
 - .1 Where Telecommunications wall boxes are ganged with electrical outlet boxes, floor or raceway, outlets shall utilise 3 or 4-port Decora style adapters/inserts. Equip each outlet with the appropriate UTP modules as indicated in this section.
 - .2 Provide all Telecommunications workstation adapters/inserts for all Telecommunications outlets (ganged or single) when decora style faceplates are utilized. Provide decora style faceplates for all Telecommunications wall box locations where not ganged with Electrical.
- .3 CATV
 - .1 Use 2-port Decora style adapters/inserts for Telecommunications boxes that are ganged with electrical boxes, wall, floor or raceway outlets. Equip each outlet with the appropriate "F" Female/Female bullhead modules.
 - .2 Coordinate colour of Decora style adapters/inserts with Contract Administrator.

TELECOMMUNICATIONS FACEPLATES AND CONNECTORS

2.7 Blank Inserts

- .1 Install Blank Inserts in unused Telecommunications ports. Blank inserts shall match faceplates.

2.8 Surface Mount Boxes

- .1 All systems furniture raceways that do not have a modular furniture knockout shall utilise 2- or 4-port surface mount boxes. Each outlet shall be equipped with the appropriate UTP modules as indicated in this section.

2.9 Floor Monument

- .1 Floor monuments and faceplates shall be provided by Division 26 (Electrical). Refer to Division 26 Specifications and Drawings for further information
- .2 Telecommunications Subcontractor shall determine type of module required to suit floor monument (i.e. MDVO, Keystone, etc.)
- .3 Where applicable, use recessed blanks for all unused ports. Blanks to match faceplate colour.

PART 3 - EXECUTION

3.1 General Conditions

- .1 When terminating Copper Cables remove only enough cable jacket to perform termination, untwist pairs a maximum of 13 mm (1/2") for Category 5e / 6 / 6A cables and 25 mm (1") for Category 3 cables.
- .2 At the workstation end, terminate each 4-pair Horizontal Cable on an appropriately colored 8-position module, located in the specified style faceplate. At the Telecommunications Room end, terminate cables within their respective termination fields. Refer to Detail Drawings for further details.

3.2 Workstation Outlet Orientation

- .1 Verify the position of jacks with the Contract Administrator prior to installation.
- .2 Modular Furniture Faceplate
 - .1 The orientation of the Data and Voice modules at the Workstation from the perspective of the user is as indicated below:

Data 1	Top		Data 1	Left
Data 2	Middle	or	Data 2	Middle
Voice	Bottom		Voice	Right
- .3 Wall Faceplate
 - .1 The orientation of the Data and Voice modules at the Workstation from the perspective of the user is as indicated below:

Data 1	Top Left		Data 1	Bottom Left
Data 2	Top Right	or	Data 2	Top Left
Voice 1	Bottom Left		Voice 1	Bottom Right
Voice 2	Bottom Right		Voice 2	Top Right
- .4 Decora Adapters

TELECOMMUNICATIONS FACEPLATES AND CONNECTORS

- .1 The orientation of the Data and Voice modules at the Workstation from the perspective of the user is as indicated below

Data 1	Top		Data 1	Left
Data 2	Middle	or	Data 2	Middle
Voice	Bottom		Voice	Right

.5 Surface Boxes

- .1 The orientation of the Data and Voice modules at the Workstation from the perspective of the user is as indicated below:

Data 1	Top Left		Data 1	Bottom Left
Data 2	Top Right	or	Data 2	Top Left
Voice 1	Bottom Left		Voice 1	Bottom Right
Voice 2	Bottom Right		Voice 2	Top Right

3.3 Cover Plates and Decora Style blanks

- .1 Provide cover plates and decora style blanks to all unused Telecommunications rough-ins.

3.4 Blank Inserts

- .1 All unused Telecommunications ports must be installed with blank inserts. For copper patch panels, use Black. For workstation outlets match existing/electrical.

END OF SECTION

TELECOMMUNICATIONS PATCH CORDS AND CROSS CONNECT WIRE

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 27 00 05.10 – GENERAL INSTRUCTIONS FOR TELECOMMUNICATIONS SECTIONS.

1.2 Optical Fibre Patch Cords

- .1 The type of fibre Patch Cords be consistent with type of fibre backbone.
- .2 Multimode Optical Fibre
 - .1 Multimode Optical Fibre Patch Cords shall be made of 50/125- or 62.5/125-micron fibre with a maximum attenuation of 3.5 dB/km @ 850 nm and 1.25 dB/km @ 1300 nm. Type of fibre Patch Cords shall be consistent with type of fibre backbone.
 - .2 The Multimode Optical Fibre Patch Cord connector shall be multimode PC polish-type with ceramic ferrule with a typical insertion loss of 0.3 dB (guaranteed 0.5 dB) and a reflectance of –20 dB.
- .3 The Optical Fibre Cord assembly shall be SC construction for the Recreation Center.
- .4 The Optical Fibre Cord assembly shall be LC construction for the Child Care Center.

1.3 Copper Patch Cords

- .1 Connect UTP Patch Cords in the Telecom Room to the active equipment using 8 position 4 pair T568A/B:T568A/B Patch Cords.
- .2 The Patch Cords shall be CMR (FT4) rated and stamped accordingly and shall be consistent with the diameter, grade, and manufacturer of the Telecommunications cable that is being Warranted.

1.4 Cross Connect Wire

- .1 The multi-pair cable IDC Termination Connectors shall have the same AWG sizing as the multi-pair conductors that it is connecting.

PART 2 - PRODUCTS

2.1 Optical Fibre Patch Cords and pigtail assemblies

- .1 Optical fibre Backbone cable strands shall be connected to the active equipment using Fibre Patch Cords. The Fibre Patch Cords shall be OFNR rated and stamped accordingly. Fibre Patch Cords shall be consistent with the grade and manufacturer of the Fibre cable that is being warranted.
- .2 Provide Fibre Patch Cords for complete connectivity of Fibre Cables. The City reserves the right to switch the Fibre Patch Cords to a different configuration at no extra cost, 10 business days prior to delivery.
- .3 Duplex Fibre Zip Cords quantities and lengths are as follows for Child Care Center:

Type	Length	End 1	End 2	Qty
MM	3'	LC	LC	As per Drawing

TELECOMMUNICATIONS PATCH CORDS AND CROSS CONNECT WIRE

- .4 Duplex Fibre Zip Cords quantities and lengths are as follows for Recreation Center:

Type	Length	End 1	End 2	Qty
MM	7'	SC	SC	As per Drawing

2.2 UTP Patch Cords and Pigtail Assemblies

- .1 All Data Patch Cords shall be connected in the Telecom Room to The City supplied active equipment using 8 position 4 pair patch cords.
- .2 The Patch Cords shall be CMR (FT4) rated and stamped accordingly and shall be consistent with the diameter grade and manufacturer of the Telecommunications cable that is being warranted.
- .3 Patch cords shall have stranded copper conductors (where system dictates) and designed to provide a mated-connection performance that exceeds the requirements per ANSI/TIA-568-D.
- .4 Patch cords and pigtail assemblies to be factory assembled and not site prepared, complete with snag less boot.
- .5 Patch Cord / Pigtail requirements:

Designation	Termination	Colour	Length	Location
Data	RJ45/RJ45	Blue	3' (ft) 0.91m	Telecom. Room
Data	RJ45/RJ45	Blue	10' (ft) 3m	Workstation
Data	RJ45/Open	Blue	3' (ft) 0.91m	Telecom. Room
Voice	RJ45/RJ45	White	3' (ft) 0.91m	Telecom. Room
Voice	RJ45/RJ45	White	10' (ft) 3m	Workstation
Wireless Access Point	RJ45/RJ45	Green	3' (ft) 0.91m	Telecom. Room
Wireless Access Point	RJ45/RJ45	Green	10' (ft) 3m	Workstation
AV Data	RJ45/RJ45	Blue	3' (ft) 0.91m	Telecom. Room
AV Data	RJ45/RJ45	Blue	10' (ft) 3m	Workstation
Security	RJ45/RJ45	Red	3' (ft) 0.91m	Telecom. Room
Security	RJ45/RJ45	Red	10' (ft) 3m	Workstation
Inter-Cabinet Connectivity (1)	RJ45/RJ45	Grey	3' (ft) 0.91m	Telecom. Room
Inter-Cabinet Connectivity (2)	RJ45/RJ45	Grey	10' (ft) 3m	Workstation

2.3 Cross-Connect Wire

- .1 For the multi-pair copper backbone cabling system, the Telecommunications Subcontractor shall supply and install Cross-Connect wire. All Cross-Connect Wire supplied and installed must maintain the Structured Cabling Solution.
- .2 Cross-connects shall be made with wire of equal gauge and Category to that of the highest Category cable, which it is being connected to.

TELECOMMUNICATIONS PATCH CORDS AND CROSS CONNECT WIRE

PART 3 - EXECUTION

3.1 Installation

- .1 Avoid scraping, denting, or otherwise damaging cables, before, during or after installation. The Telecommunications Subcontractor without any additional compensation shall replace damaged cables.

3.2 Optical Fibre Patch Cords

- .1 Assume all strands of optical fibre cable(s) shall be patched.

3.3 UTP Copper Patch Cords

- .1 At Telecommunications Room end, provide one (1) patch cord for each data cable installed. Communications Subcontractor shall be responsible for patching all data cabling. A patching schedule shall be provided to the Communications Subcontractor prior to installation. Patch Cords provided must maintain the Channel Solution.
- .2 At workstation end, provide one (1) patch cord for each data cable installed. Patch Cords supplied and installed must maintain the Channel Solution.

3.4 Cross-Connect Wire

- .1 Assume all pairs of backbone are cross-connected at both ends.

END OF SECTION

ADMINISTRATIVE REQUIREMENTS

PART 1 - GENERAL

1.1 Project Closeout Submittals

- .1 Provide the following project closeout submittals:
 - .1 Table of content
 - .2 As-built drawings
 - .3 Commissioning test results and reports for each device, each system, and each function
 - .4 Commissioning results for each video surveillance camera complete with sample field of view image
 - .5 Systems settings, configuration, and documentation
 - .6 Operation and Maintenance Manuals
 - .7 Warranty Letters and Certificates
 - .8 Cyber Security Report Letter
- .2 Mark all changes and deviations on construction drawing(s) during the construction process, including all conduit and cable pathways to and from equipment.
- .3 Update As-built drawing(s) during construction.
- .4 Include all additional devices and cables installed during the project on As-built drawings. The Contract Administrator will review the status of the as-built drawing(s) from time to time during the construction process. On completion of the project, forward to the Contract Administrator electronic drawings indicating all such changes and deviations for review within 10 business days of the completion of the project.
- .5 Request (via email) from the Contract Administrator a soft copy of drawings for use in preparation for Record Drawings.
- .6 Return record drawing(s) via secure file transfer using the latest native drawing file format or better. If this requirement cannot be met, Smith + Andersen will update all hand-drawn Record Drawings to the native drawing file format. The cost for this service is based on Smith + Andersen's per diem rates at the time of completion. Pay for all costs associated with this work.
- .7 The project is incomplete, and a holdback will be retained until satisfactory as-built drawing(s) are provided.

1.2 Submittals – Testing, And Commissioning

- .1 Provide testing and commissioning documentation in soft format for all items and their related components to the Contract Administrator before the completion of the project or at the Contract Administrator's request. Include maintenance manuals and operating instructions for The City's staff use.

1.3 Permits, License Reviews, And Fees

- .1 Where materials are specified which require special approval of CSA or local authorities obtain such approval for the installation with the cooperation of the material supplier.

ADMINISTRATIVE REQUIREMENTS

- .2 Submit required documents and shop drawings to authorities having jurisdiction to obtain approval for the work. Prepare any additional information, details, and drawings that these authorities may require.

1.4 Alternate Product

- .1 This document specifies the use of complete end-to-end Electronic Safety and Security Systems as manufactured, warranted, and certified by a single manufacturer. Alternate materials (from the overall system) is not accepted unless specifically noted.
- .2 Where the provision of the materials would compromise the schedule, submit a request to use an alternate product to the Contract Administrator. Depending on the circumstance, the Contract Administrator may provide written authorization to substitute the Product. The written authorization is to be obtained before alternatives are purchased or installed.

1.5 Seismic Force Restraint System.

- .1 Provide all seismic resisting systems for all Electronic Safety and Security systems equipment.
- .2 Definitions
 - .1 Low: Buildings that represent a Low Direct or Indirect Hazard to human life in the event of failure.
 - .2 Normal: All buildings except those listed in the Importance Categories Low, High and Post-disaster.
 - .3 High: Buildings likely to be used as Post-disaster shelters and manufacturing or storage facilities containing toxic, explosive or other hazardous substances in sufficient quantities to be dangerous to the public if released.
 - .4 Post-disaster: Buildings that are required to be operational after a disaster.
 - .5 SFRS: Acronym for Seismic Force Restraint System.
 - .6 SCS: Acronym for Slack Cable Restraint System.
 - .7 Seismic Consultant: A Professional Structural Engineer licensed in the respective jurisdiction who specializes in the seismic restraint of building elements and the design of SFRS.
- .3 Fully integrate SFRS into, and make compatible with:
 - .1 Noise and vibration controls specified elsewhere in this project specification, and
 - .2 Systems, and equipment not required to be operational during and after seismic event.
- .4 Provide SFRS that during a seismic event prevent systems and equipment from causing personal injury and from moving from normal position.
- .5 Obtain the services of a Professional Engineer, licensed in the Province / Territory of the Place of the Work, and specializing in the design of SFRS, to provide the necessary design and details for a complete SFRS including systems of structural supports and brazing of all relevant equipment as required to comply the applicable Building Codes. Require this Professional Engineer be responsible for ensuring that the installation conforms to the design.

ADMINISTRATIVE REQUIREMENTS

- .6 Submit Shop Drawings and product data for review by the Contract Administrator.
- .7 Shop Drawing Submittals to include:
 - .1 Full details of design criteria,
 - .2 Working drawings, materials lists, schematics full specifications for all components of each SFRS to be provided,
 - .3 Design calculations including restraint loads resulting from seismic forces in accordance with all applicable Codes,
 - .4 Separate Shop Drawings for each SFRS and devices for each system, equipment,
 - .5 Identification of location of each device,
 - .6 Schedules of types of SFRS equipment and devices,
 - .7 Details of fasteners and attachments to structure, anchorage loadings, attachment methods,
 - .8 Installation procedures and instructions, and
 - .9 These drawings are designed and bear the signed stamp of a Professional Engineer licensed to practice in the appropriate discipline and in the Place of Work.
- .8 Provide positive seismic and wind resisting on those systems and components required by the Building Code and the Authority Having Jurisdiction.
- .9 Coordinate all SFRS with all the Contract Administrator and all affected trades.
- .10 Provide SFRS for conduit systems that is compatible with:
 - .1 Expansion, anchoring, and guiding requirements.
 - .2 Equipment vibration isolation and equipment SFRS.
- .11 Do not utilize cast iron, threaded pipe, and other brittle materials as part of SFRS.
- .12 Ensure seismic control measures do not interfere with integrity of fire stopping.
- .13 Equipment installed on vibration isolation that requires seismic restraint must comply with the noise and vibration controls specified elsewhere in this project specification.
- .14 Install SFRS at least 25 mm from all other equipment, systems, and/or services.
- .15 Co-ordinate connections with all disciplines.
- .16 Install SFRS in accordance with the Seismic Professional Engineer's design.
- .17 Following the completion of the installation of the seismic resisting systems, have the designing engineer submit a stamped letter stating that the installation has been completed in accordance with the applicable Building Codes and their design. Require the engineer to complete and submit signed and sealed letters of assurance (e.g. Schedules, where applicable) and letters of compliance for all equipment that requires seismic resisting in accordance with latest codes, standards and requirements of the Authorities Having Jurisdiction.
- .18 Require engineer to include additional documentation to identify the equipment and device types and quantities that were reviewed to ensure that all components requiring seismic resisting were completed.

ADMINISTRATIVE REQUIREMENTS

- .19 Require engineer to indicate in letters that "All Electronic Safety and Security equipment shown on the Smith and Andersen Drawings has been seismically resisted in accordance with the local Building Code."

1.6 Scheduling

- .1 Within one week of the award of the Contract submit a formal project schedule to the Contract Administrator showing the start and finish dates of major tasks as denoted by System, material order, and delivery to site, installation, testing, and commissioning.
- .2 Submitted updated schedules as requested by the Contract Administrator.

1.7 Project Management

- .1 Provide complete project management for this project. Complete project management include:
 - .1 Develop a detailed Gantt chart project plan and submit it to The City and Contract Administrator for review and approval before the start of the project.
 - .2 Chair biweekly construction meetings for the duration of the project. Construction meetings will be on-site or via conference call at The City's and or Contract Administrator's discretion.
 - .3 Generate and submit detailed biweekly construction progress reports to The City and Contract Administrator. Include in each progress report itemized detailed description and extent of tasks completed, itemized detailed description and quantification of materials installed, and labeled photos that clearly show the extent of construction progress.

1.8 Project Meetings

- .1 Attend site meetings when requested by the Contract Administrator and/or the Project Manager. Regular meetings may occur once per week at the Contract Administrator's and/or the Project Manager's discretion.
- .2 Attend weekly project meetings throughout the project to review the status of current and planned activities, schedule, and conduct other business associated with the project.

1.9 Progress Reports

- .1 Issue a status report at the weekly project meeting including the status of progress, project completion for phases, material ordering, and delays.

1.10 Cleanup

- .1 Keep the site and surrounding area clean, safe, and free from debris always. Remove all debris from the site daily.
- .2 Upon completion of the work and before acceptance and final payment is made, remove from the site, all surplus and discarded materials, temporary structures, and debris of every kind. Dispose of surplus and waste materials removed from the site following applicable laws and regulations.

ADMINISTRATIVE REQUIREMENTS

1.11 Acceptance

- .1 Before acceptance by the Contract Administrator, all the equipment and cabling must be installed, cleaned, tested commissioned. At points of termination, all cabling and terminations must be labeled and must be free of any cable pulling lubricants before acceptance by the Contract Administrator.

1.12 Review And Testing Requirements

- .1 Develop a testing and commissioning checklist for each system and submit it to the Contract Administrator for approval 10 business days before commissioning commences.
- .2 The Contract Administrator must approve the testing and commissioning procedure before the commencement of testing and commissioning and may request to be present.
- .3 Invite the Contract Administrator to witness field testing and commissioning and notify them of the start date of the testing phase 10 business days before testing and commissioning commence.
- .4 Test and commission all electronic safety and security systems.

1.13 Quotes for Contemplated Change Notices

- .1 Itemize all quotes for contemplated changes notices and include the following:
 - .1 Itemised list of each device including respective make, model, and quantity quoted and unit price
 - .2 Total labour hours for installing and configuring each device
 - .3 Total length of wiring quoted for each device and labour hours for installing the quoted wiring
 - .4 Total length of conduit quoted for each device wiring and labour hours for installing the quoted conduit.
 - .5 Labour rate
 - .6 Subtotal cost of all materials/devices
 - .7 Subtotal cost of all labour
 - .8 Total quote value

1.14 Labour

- .1 Comply with all project job-site requirements for the duration of the project.
- .2 Do not assign or sub-contract any work without the prior written consent of the Project Manager. With the Tender Response submit a list of subcontractors.
- .3 For all work related to this project, use only tradesmen who are fully trained, qualified, and experienced in the installation and commissioning of the Electronic Safety and Security Systems.

ADMINISTRATIVE REQUIREMENTS

PART 2 - PRODUCTS

2.1 Not Used

PART 3 - EXECUTION

3.1 Not Used

END OF SECTION

CODES, STANDARDS, AND REGULATIONS

PART 1 - GENERAL

1.1 Codes, Standards, And Regulations Compliances

- .1 Adhere to the latest edition of all applicable Codes, Standards, Regulations, and documents listed throughout this document.
- .2 All products installed must meet or exceed all Local, Provincial, and Federal Building, Fire, Health, Safety, and Electrical Codes.
- .3 Ensure that non-plenum and plenum-rated cables are ETL or ULC (UL) Listed and CSA Certified as type CMR / CMP (respectively).
- .4 The equipment, material, and installation conform to the latest version of the applicable Codes, Standards, and Regulations of authorities having jurisdiction as indicated in the table below. In the case of conflict or discrepancy the more stringent code, standard or regulation will apply.

STANDARD	TITLE
ANSI/ICEA	
S-80-576	Standard for Category 1 & 2 Individually Unshielded Twisted Pair Indoor Cables (With or Without an Overall Shield) for Use in Communications Wiring Systems Technical Requirements
S-83-596	Optical Fibre Premises Distribution Cable, latest version
S-87-640	Optical Fibre Outside Plant Communications Cable, latest version
S-104-696	Standard for Indoor-Outdoor Optical Cable, latest version
Z136.2	American Standards for the Safe Operation of Optical Fibre Communication Systems Utilizing Laser Diode and LED Sources
TIA/EIA	
455-C	Optical Fibre Test Procedures
568-1-D	Commercial Building Telecommunications Cabling Standard: General Requirements
568-C.2	Commercial Building Telecommunications Cabling Standard: Balanced Twisted Pair Cabling
568-C.3-D	Commercial Building Telecommunications Cabling Standard: Optical Fibre Cabling Components Standard
569-D	Commercial Building Standard for Telecommunications Pathways and Spaces including all addenda
606-C	Administration Standard for Telecommunications Infrastructure
607-C	Telecommunications Grounding (Earthing) and Bonding for Customer Premises
758-B	Customer Owned Outside Plant Telecommunications Cabling Standard.

CODES, STANDARDS, AND REGULATIONS

862-B	Structured cabling infrastructure Standard for Intelligent Building Systems
RS232C	Interface between Data Terminal Equipment and Data Communications Equipment Employing Serial Binary Data Interchange
RS485	Electrical Characteristics of Generators and Receivers for use in Balanced Digital Multi-Point Systems
CSA	
C22.1-18	Canadian Electric Code Part I: Safety Standards for Electrical Installations.
C22.2 No. 182.4-M90	Plugs, Receptacles, and Connectors for Communication Systems. R2015
C22.2 No. 214-17	Communications Cables
CAN/CSA-C22.2 No. 0-10	General Requirements, Canadian Electrical Code, Part II (latest version)
CAN/CSA-C22.2 232-17	Canadian Electric Code Part II: Optical Fibre Cables.
C22.2 NO. 205-12	Signal Equipment
T527-94	Grounding and Bonding for Telecommunications in Commercial Buildings
T528-93	Design Guidelines for Administration of Telecommunications Infrastructure in Commercial Buildings.
T529-95	Design Guidelines for Telecommunications Wiring Systems in Commercial Buildings.
T530-99	Building Facilities, Design Guidelines for Telecommunications
NFPA	
NFPA70	National Electrical Code
OTHER	
CAN/ULC-S115:2018	Standard Method of Fire Tests of Firestop Systems
CAN/ULC-S101-14	Standard Method of Fire Endurance Tests of Building Construction and Materials
CAN/ULC-S102 latest version	Standard Method of Testing for Surface Burning Characteristics of Building Materials and Assemblies
CAN/ULC S316-14	Standards for Performance of Video Surveillance Systems
CAN/ULC S319-05	Electronic Access Control Systems
CLC	Canada Labour Code, Part II Occupational Health and Safety, and Provincial and Local Health and Safety regulations
UL 294	The Standard of Safety for Access Control System Units
UL 365	Police Station Connected Burglar Alarm Units and Systems
ULC1076	Proprietary Burglar Alarm Units and Systems

CODES, STANDARDS, AND REGULATIONS

UL 609	The Standard of Safety for Local Burglar Alarm Units and Systems
UL 639	Standard for Intrusion-Detection Units
UL 1610	Standard for Central-Station Burglar-Alarm Units
ULC-S306-03	The Standard of Safety for Intrusion Detection Units
UL 969	Standard for Marking and Labeling Systems
UL 1037	Standard for Antitheft Alarms and Devices
UL 1067	Standard for Electrically Conductive Equipment and Materials for Use in Flammable Anesthetizing Locations
UL 1492	Standard for Audio-Video Products and Accessories
UL 2044	Standard for Commercial Closed-Circuit Television Equipment
CEC, Part 1	The Canadian Electrical Code, Part 1
CSA ISO/IEC 11801	Information Technology: Generic Cabling for Customer Premises
ICEA S-80-576	Individually Unshielded Twisted Pair Indoor Cable for Use in Communications Wiring Systems
IEEE Std 1100	IEEE Specified Practice for Powering and Grounding Electronic Equipment (IEEE Emerald Book)
IEC 603-7, Part 7	Detailed Specifications for Connectors, 8-Way, Including Fixed and Free Connectors with Common Mating Schemes
ISO/IEC IS 11801A	Generic Cabling for Customer Premises
WC 63.1	Performance Standard for Field Testing of Unshielded Twisted-Pair Cabling System
OHSA	Occupational Health and Safety Act - R.S.O. 1990, c. 0-1
UL 444 and 13	Adopted Test and Follow-Up Service Requirements For The Optional Qualification of 100Ω Twisted-Pair.
CCTA	Canadian Cable Television Association
NCTA-02/89 rev. 93	NCTA Specified Practices for Measurements on Cable Television Systems.
Industry Canada	ICES 003 Emissions
RoHs	Restriction of Hazardous Substances Directive 2011/65/EU
Subpart B	RF Emissions
CE Standards	EN 55022 RF Emissions
CE Standards	EN 55024 RF Immunity
FCC	Federal Communications Commission
FCC Part 15	Radio Frequency Device
FCC Part 68	Connection of Terminal Equipment to the Telephone Network
CE Standards	EN 60950-1 Equipment Safety
	Manitoba Electrical Safety Code – latest edition.
O.R. 82/2023	Manitoba Fire Code – latest edition.

CODES, STANDARDS, AND REGULATIONS

O.R. 78/2023	Manitoba Building Code – latest edition.

- .5 Comply with applicable Electrical Safety Code, all Local, Provincial and Federal laws, where applicable, and with requirements of the Canadian Standards Association (CSA) when mandatory. Make any changes or alterations required by the authorized inspector of the authority having jurisdiction, at no extra charge to The City.

PART 2 - PRODUCTS

2.1 Not Used

PART 3 - EXECUTION

3.1 Code, Standard, And Regulation Compliances

- .1 All cables and components installed and terminated following CSA. Particular attention is given to ensuring proper distance is kept from fluorescent light fixtures, electrical cables, or any other source of EMI. Cables are combed and bundled in a neat and organized manner. The Contract Administrator determine the neatness of the installation. At no extra-cost, Cables are redressed that have not been properly combed and dressed. Coordinate with the Contract Administrator before termination in any Telecom Rooms.
- .2 The equipment manufacturer's specifications must not be exceeded by the horizontal run length. If the constraint cannot be met, notify the Contract Administrator of any cables that exceed the equipment manufacturer's stated limitations. Include for rectification of the limitation in their bid. Rectifications include active and passive devices, signal boosters, signal extenders, protocol converts, installation of wire gauge suitable to the cabling length being installed, and/or a combination of the aforementioned.

END OF SECTION

FIRE STOPPING AND WATER PROOFING

PART 1 - GENERAL

1.1 Work Included

.1 Fire Stopping

- .1 Provide seals in all Fire Rated Separations and Firewalls to form tight barriers to retard the passage of flame and smoke.
- .2 The installed seals provide and maintain the fire-resistance rating of the adjacent floor, wall, or other fire separation assembly to the Code Requirements.
- .3 For all floor penetrations, Moisture seals as well as fire and smoke seals are required.
- .4 Establish the integrity of all fire-rated structures and assemblies that they have created or disturbed.
- .5 Re-establish the integrity of all fire-rated structures and assemblies that they have created or disturbed.
- .6 Provide Fire Stop pillows for existing cable tray penetrations through firewalls.
- .7 For this specification, only Fire Stop Systems that have been tested to the applicable ULC Standard are acceptable.
- .8 Provide non-permanent CSA approved Fire Stop systems that are dielectric, water-resistant, non-hardening, permanently pliable/re-enterable putty along with the appropriate damming or backer materials (where required).
- .9 All fire stopping maintain a minimum one-hour rating and meet applicable Federal, Provincial and Local building codes.
- .10 Following the Standards, all Fire Stop Systems are listed and tested by an SCC and accredited Third-Party Testing Agency.
- .11 Fire-resistance rating of the surrounding Fire Separation or Firewall is less than the Fire resistance ratings of installed Fire Stop Systems.
- .12 All Smoke Seals selected for use should comply with Standards.
- .13 To allow for building settling and seismic movement, ensure all Fire Stop Materials and Smoke Seals have elastomeric characteristics. Verify all Fire Stop Materials and Smoke Seals are free of asbestos.

.2 Water Proofing

- .1 Seal all foundation penetrating conduits and service entrance conduits and sleeves to eliminate the intrusion of moisture and gases into the building. This requirement also includes spare conduits.
- .2 Upon cable placement all service entrance conduits through the building are sealed or resealed. Spare conduits are plugged with expandable plugs.

FIRE STOPPING AND WATER PROOFING

.3 Quality Assurance

- .1 Provide fire stopping systems that comply with the following requirements following:
 - .1 Fire stopping tests are performed by a qualified, testing and inspection agency. A qualified testing and inspection agency is UL, or another agency performing testing and follow-up inspection services for fire stop system acceptable to authorities having jurisdiction.
 - .2 Fire stopping products bear the classification marking of qualified testing and inspection agency
- .2 Provide the work of this Section using competent installers, experienced in the application of the materials and systems being used, approved, and trained by the material or system manufacturer.
- .3 Fire Stop Systems conform to the fire (F), hose (H), and temperature (T) ratings of Codes.
- .4 Fire Stop Materials and Smoke Seal materials must have a flame spread rating of 25 or less, National Fire Protection Association (NFPA Class "A").
- .5 For this specification, the only acceptable Fire Stop Systems are those that have been tested to the CAN/ULC S115 Standard.

.4 Performance

- .1 Fire-rated pathway devices are the preferred product and install these devices in all locations where frequent cable moves, add-ons, and changes are anticipated.
- .2 Where non-mechanical products are utilized, provide products that upon curing do not re-emulsify, dissolve, leach, break down, or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water, or other forms of moisture characteristic during or after construction.
- .3 Where it is not practical to use a mechanical device, openings within floors and walls designed to accommodate telecommunications and data cabling are provided with re-enterable products that do not cure or dry.
- .4 Openings for cable trays are sealed using re-enterable fire-stopping pillows.

.5 Project Conditions

- .1 Do not install fire stopping products when ambient or substrate temperatures are outside limitations specified by the manufacturer
- .2 Do not install fire-stopping products when substrates are wet due to rain, frost, condensation, or other causes.
- .3 Maintain minimum temperature before, during, and for a minimum of 3 days after installation of materials.
- .4 Do not use materials that contain flammable solvents.
- .5 Coordinate construction of openings and penetrating items to ensure that through-penetration fire stop systems are installed according to specified requirements.
- .6 Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration fire stop systems.

FIRE STOPPING AND WATER PROOFING

- .7 Schedule installation of fire stopping after completion of penetrating item installation but before covering or concealing of openings.

PART 2 - PRODUCTS

2.1 General

- .1 Use only fire-stopping products that have been tested for specific fire-resistance-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire rating involved for each separate instance.

2.2 Approved Manufacturers

- .1 Products manufactured by Hilti (or approved equivalent) are acceptable.
- .2 Obtain fire stop systems for each type of penetration and construction condition indicated only from a single manufacturer.

2.3 Materials

- .1 Firestop Sealants: The following products are acceptable.
 - .1 Hilti FS-ONE high-performance Intumescent Firestop Sealant
 - .2 Hilti CP 601S Elastomeric Firestop Sealant.
 - .3 Hilti CP 606 Flexible Firestop Sealant
 - .4 Hilti CP 604 Self-Leveling Firestop Sealant
- .2 Cast-In Firestop Device: A one-step cast-in firestop device for a variety of pipe materials and diameters. The following product is acceptable.
 - .1 Hilti CP 680-M Cast-in Firestop Device
- .3 Firestop Putty: An intumescent, non-hardening, firestop putty for cable and pipe penetrations. The following product is acceptable:
 - .1 Hilti CP 681 Firestop Putty Stick.
- .4 Firestop Plug: Ready-to-use intumescent and reusable plug for small openings. The following product is acceptable:
 - .1 Hilti CP 658T Firestop Plug.
- .5 Fire Rated Cable Pathways: Re-penetrable cable management device:
 - .1 Hilti CP 653 Speed Sleeve.

PART 3 - EXECUTION

3.1 Fire Stopping

- .1 Before beginning installation, verify that substrate conditions previously installed under other sections are acceptable for the installation of fire stopping following the manufacturer's installation instructions and technical information
- .2 Examine sizes and conditions of Fire Stop Material voids. Fill and or correct Fire Stop Materials to eliminate voids.

FIRE STOPPING AND WATER PROOFING

- .3 Ensure Surfaces are free of dirt, grease, oil, scale, laitance, rust, release agents, water repellents, and any other substances that may inhibit optimum adhesion
- .4 Prepare surfaces in contact with Fire Stop Systems and Smoke Seals to the manufacturer's instructions. Mask where necessary to avoid spillage and overcoating onto adjoining surfaces; remove stains on adjacent surfaces.
- .5 Install/replace sound barrier/fire stopping materials as soon as cables have been pulled through the opening.
- .6 Before, during, and after installation of sealant Fire Stop Materials make sure all Fire Stop Systems that require mineral wool or ceramic fibre backer or filler materials, these materials are dry and free of other contaminants. Alkaline water contamination of the backer or filler materials may cause corrosion of metallic penetrating items.
- .7 Apply Fire Stop Systems and Smoke Seals in strict accordance with manufacturer's instructions to prevent the passage of fire and smoke, and where required or specifically designated, the passage of fluids
- .8 Provide temporary forming and packing as required. Tool or trowel all exposed surfaces to a smooth, tidy finish.
- .9 Fire Stop and smoke seal gaps and holes in all Fire Separation and Firewall construction through which cables pass as a result of work in this document.
- .10 In Combustible Construction (membrane GWB type) where the framing members are wood or where paper-faced insulation is incorporated within the separation, a Fire and Temperature rise "FT" rating is required equal to that of the rating of the Fire Separation. Include openings that have been formed and sleeved.

3.2 Waterproofing

- .1 Conduits with cables in them are permanently sealed by firmly packing the void around the cable with oakum and capping with hydraulic cement or waterproof duct seal.

3.3 Exposed Service Penetrations In Ceiling Of Underground Parking Areas

- .1 Where the bottom of a Fire Stop System is exposed, seal the bottom side of the assembly with a fire-rated elastomeric Fire Stop sealant.

3.4 Clean Up

- .1 Remove excess materials and debris and clean adjacent surfaces immediately after application to satisfaction of the Project Manager. Remove and or correct staining and discoloring of adjacent surfaces as directed.

END OF SECTION

GENERAL INSTRUCTIONS FOR ESS SECTIONS

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to the requirements of Divisions 0 and 1, which apply to and form part of all sections of the work.
- .2 The more stringent and/or more onerous requirement is applied if there is a conflict between the requirements outlined in this Electronic Safety and Security specifications document and requirements indicated in Divisions 0 and 1.
- .3 Read and comply with all sections of this document.
- .4 The Specification is divided into Sections that are not intended to identify contractual limits between sub-contractors nor between the Contractor and Subcontractors. The requirements of anyone Section apply to all Sections. Refer to other Divisions and Sections to ensure a complete and operational system.
- .5 Provide Electronic Safety and Security components and accessories which may not be specifically shown on the Drawings or stipulated in the Specifications, but are required to ensure complete and operational systems.
- .6 Provide all labour, materials, tools, and equipment required for the complete installation, commissioning and start-up of Electronic Safety and Security systems called for in all sections of the Contract Documents.

1.2 Sections Affected

- .1 These instructions apply to and form a part of all Electronic Safety and Security Sections.

1.3 Scope Of Work

- .1 Include all necessary wiring, cabling, labor, tools, equipment, and ancillary materials required to furnish and install complete and operational Electronic Safety and Security Systems.
- .2 This specification includes a general description as well detailed functional and technical requirements for the Electronic Safety and Security Systems.
- .3 This specification provides all information necessary to produce a complete proposal for scalable multi-user, multi-tasking Electronic Safety, and Security Systems. The Electronic Safety and Security Systems include all computer hardware and software, controllers, interfaces, card readers/keypads, credentials, video recorders, cameras, alarm sensing devices, communication devices, electric door locking hardware, power supplies, cable/wire, conduit, raceways, enclosures, mounting hardware, and all other equipment as indicated on Contract drawings and as specified herein. Except where noted to reuse existing, ensure all materials are new, commercial-grade, and of good quality.
- .4 This document is the Specification for the supply and installation of Electronic Safety and Security Systems for the following project:

GENERAL INSTRUCTIONS FOR ESS SECTIONS

- .5 This project consists of the complete supply, installation, and commissioning of the following Electronic Safety and Security systems:
 - .1 Access Control
 - .2 Intrusion Detection System
 - .3 Video Surveillance System
 - .4 Intercom System
 - .5 Electronic Personal Protection System
- .6 All Electronic Safety and Security systems supplied and installed are ensured that it is turnkey complete and fully operational. All Electronic Safety and Security systems is integrated as per the Contract drawings and specifications.
- .7 The Electronic Safety and Security Systems is installed based on the drawing documents provided herewith.
- .8 All cables for the Electronic Safety and Security Systems is installed via J-hooks and or cable tray.
- .9 The scope of work includes but not limited to:
 - .1 Provide of all active and passive hardware and cables as specified within this document to support the Electronic Safety and Security Systems.
 - .2 Where active and passive hardware and cabling are not specified but are required to make the Electronic Safety and Security Systems turnkey and to meet the intent, provide such active and passive hardware and cabling at no extra cost.
 - .3 Supply and installation of equipment cabinets, complete with all accessories.
 - .4 Supply and installation of backboards.
 - .5 Supply and installation of all fire stop materials/mechanisms for all penetrations.
- .10 While every attempt has been made to ensure that all information is correct at the time of publication, the products specified are available, and that the part numbers identified are correct, verify all part numbers and report any errors and omissions in this Specification prior to bid submissions.
- .11 This document and all related drawings are read in conjunction with the project-related Door Schedule and Door Hardware Schedule.
- .12 Dimensions shown on Contract Drawings are approximate. Verify dimensions by reference to shop drawings and field measurements.
- .13 Quantities or lengths indicated in any of the Contract Documents are approximate only and not held to gauge or limit the work.
- .14 Include in bid all labour, materials, plant, transportation, storage costs, training, equipment, insurance, temporary protection, permits, reviews, bonding, taxes, and all necessary and related items required to provide a complete and operational Electronic Safety and Security Systems.

GENERAL INSTRUCTIONS FOR ESS SECTIONS

1.4 Scope Matrix

- .1 Devices shown on drawings shows the general locations. Determine and coordinate the final locations of each devices on site with the EC to ensure that all conduits and associate backboxes are located where respective devices will be installed. Be responsible for all costs resulting from failure to execute the above.
- .2 General Requirements This responsibility matrix to be read in conjunction with the Electronic Safety and Security Specifications.
- .3 This responsibility matrix not be used as the sole source of scope requirements and scope delineation. Refer to the Electronic Safety and Security Specifications and associated drawings for additional information and requirements.
- .4 Refer to the below scope matrix for scope or responsibilities for the Recreation Center:

Legend:
DHC: Door Hardware Subcontractor (DIV 08)
EC: Electrical Subcontractor (DIV 26)
SC: Security Subcontractor (DIV 28)
CC: Communications Subcontractor (DIV 27)
AVC: Audiovisual Subcontractor (Div 27)
CWIT: City of Winnipeg IT/Network team (City)
CWS: City of Winnipeg Security team (City)

Component	Supply	Install	Commission	Requirements
Access Control				
Wired Security Doors				
Card/Credential Reader	SC	SC	SC	
Credentials	SC	SC	SC	
Door Contact	SC	SC	SC	
Door Alarm	DHC	DHC	SC	Door alarm integrated in crash bar, allow for coordination with DHC to install and achieve proper operation.
Electrified Lock: *Electric Strike *Electric Latch Retraction *Electric Mortise Lock	DHC	DHC	SC	Coordinate the exact mount location of devices with EC to ensure that all conduits and back boxes are installed in the optimal locations.
Maglock	DHC	DHC	SC	Security Subcontractor to acquire maglock Permit
Motion Request To Exit	SC	SC	SC	
Controller	SC	SC	SC	
Controller Enclosure	SC	SC	SC	
Power Supply	SC	SC	SC	
Conduit	EC	EC	EC	Coordinate the exact mount location of devices with EC to ensure that all conduits and back boxes are installed in the optimal locations.
Category 6/IP Wiring	CC	CC	CC	

GENERAL INSTRUCTIONS FOR ESS SECTIONS

Non-Category 6/IP Wiring	SC	SC	SC	
Patch panel, patch cords	CC	CC	CC	
Server complete with: -software, -device licenses, -Integration licenses, -Client computer licenses	CWS	SC	SC	
Client Computer with Software	CWIT	SC	SC	
Electrical circuits, power connections and receptacles	EC	EC	EC	
Intrusion Detection System (Bosch)				
Door Contact	SC	SC	SC	
Motion Request To Exit	SC	SC	SC	
Motion Detector	SC	SC	SC	
Keypads	SC	SC	SC	
Break Glass Detector	SC	SC	SC	
Peripheral Devices	SC	SC	SC	
Conduit	EC	EC	EC	Coordinate the exact mount location of devices with EC to ensure that all conduits and back boxes are installed in the optimal locations.
Category 6/IP Wiring	CC	CC	CC	
Non-Category 6/IP Wiring	SC	SC	SC	
Patch panel, patch cords	CC	CC	CC	
Controller	SC	SC	SC	
Controller Enclosure	SC	SC	SC	
Communicators	SC	SC	SC	
Power Supply	SC	SC	SC	
Electronic Personal Protection System/Panic System (DSC)				
Relay	SC	SC	SC	
Push buttons	SC	SC	SC	
Keypad	SC	SC	SC	
Controller	SC	SC	SC	
Controller Enclosure	SC	SC	SC	
Graphical Annunciator/Peripheral devices	SC	SC	SC	
Power Supply	SC	SC	SC	
Conduit	EC	EC	EC	Coordinate the exact mount location of devices with EC to ensure that all conduits and back boxes are installed in the optimal locations.
Category 6/IP Wiring	CC	CC	CC	
Non-Category 6/IP Wiring	SC	SC	SC	
Patch panel, patch cords	CC	CC	CC	
Fibre optic cable, connectors, patch panel and patch cords	CC	CC	CC	
System Server complete with: -software, -device licenses, -Integration licenses, -Client computer licenses	SC	SC	SC	

GENERAL INSTRUCTIONS FOR ESS SECTIONS

Client Computer with Software	CWIT	SC	SC	
Electrical circuits, power connections and receptacles	EC	EC	EC	
Intercom /Entryphone System				
Master Station	SC	SC	SC	
Substation	SC	SC	SC	
Relay	SC	SC	SC	
Power Supply	SC	SC	SC	
Conduit	EC	EC	EC	Coordinate the exact mount location of devices with EC to ensure that all conduits and back boxes are installed in the optimal locations.
Category 6/IP Wiring	CC	CC	CC	
Non-Category 6/IP Wiring	SC	SC	SC	
Patch panel, patch cords	CC	CC	CC	
Fibre optic cable, connectors, patch panel and patch cords	CC	CC	CC	
Intercom System Server complete with: -software, -device licenses, -Integration licenses, -Client computer licenses	SC	SC	SC	
Client Computer with Software	CWIT	SC	SC	
Electrical circuits, power connections and receptacles	EC	EC	EC	
Video Surveillance (CCTV) System				
Video Surveillance (CCTV) Camera	CWS	SC	SC	Subcontractor to mount cameras using City supplied equipment. City to approve camera views and programming/configuration.
Video Surveillance (CCTV) Camera Mount/Bracket	CWS	SC	SC	Subcontractor to mount cameras using City supplied equipment
Decoder	CWS	SC	SC	One per monitor
Power Supply	SC	SC	SC	
Conduit	EC	EC	EC	Coordinate the exact mount location of devices with Electrical Subcontractor to ensure that all conduits and back boxes are installed in the optimal locations.
Category 6/IP Wiring	CC	CC	CC	
Non-Category 6/IP Wiring	SC	SC	SC	
Patch panel, patch cords	CC	CC	CC	
Fibre optic cable, connectors, patch panel and patch cords	CC	CC	CC	
Network Video Recorder (NVR) complete with: -software, -device licenses, -Integration licenses, -Client computer licenses	CWS	SC	SC	
Electrical circuits, power connections and receptacles	EC	EC	EC	
Security Systems Integration				
Core Switch	CWIT	CWIT	CWIT	
Edge switch	CWIT	CWIT	CWIT	
Firewall	CWIT	CWIT	CWIT	
Keyboard Video Mouse (KVM)	SC	SC	SC	
Communications Cabinet	CC	CC	CC	

GENERAL INSTRUCTIONS FOR ESS SECTIONS

Uninterruptable Power Supply (UPS)	CWIT	CC	CC	
Conduit	EC	EC	EC	Coordinate the exact mount location of devices with EC to ensure that all conduits and back boxes are installed in the optimal locations.
Category 6/IP Wiring	CC	CC	CC	
Non-Category 6/IP Wiring	SC	SC	SC	
Patch panel, patch cords	CC	CC	CC	
Fibre optic cable, connectors, patch panel and patch cords	CC	CC	CC	
Electrical circuits, power connections and receptacles	EC	EC	EC	

1.5 Intent

- .1 The Specifications are an integral part of the accompanying Drawings. Any item or subject omitted from one or the other, but which is either mentioned or reasonably implied, is considered as properly and sufficiently specified.
- .2 Be completely responsible for the acceptable condition and operation of all systems, equipment, and components forming part of the installation or directly associated with it. Promptly replace defective material, equipment, and repair related damages. Ensure that replacement of equipment and repair to damages is coordinated with other trades completed in a timely fashion so as not to affect the complete construction of the Electronic Safety and Security Systems and/or work by others.

1.6 Drawings, Changes, And Installation

- .1 The drawings are intended to show the general character and scope of the work and not the exact details of the installation. Ensure that installation is complete with all accessories required for a complete and operative installation.
- .2 The location, arrangement, and connection of equipment and material as shown on the drawings represent a close approximation to the intent and requirements of the Contract. The right is reserved by the Contract Administrator to make changes required to accommodate conditions arising during the progress of the work, at no extra cost.
- .3 Certain details indicated on the drawings are general and specific labeled detail references to each occurrence of use are not indicated, however, such details apply to every occurrence on the drawings.
- .4 The location and size of existing services shown on the drawings are based on the best available information. Verify the actual location of existing services in the field before commencing work.
- .5 At no extra cost, make all changes and modifications necessary to ensure coordination and to avoid interference and conflicts with other trades, or to accommodate existing conditions.
- .6 Leave areas clear where space is indicated as reserved for future equipment, and equipment for other trades.
- .7 Leave adequate space and provisions for removal of components and servicing of equipment, with minimum inconvenience to the operation of systems.
- .8 Where equipment is shown to be 'roughed in only' obtain accurate information from the Contract Administrator before proceeding with the work.

GENERAL INSTRUCTIONS FOR ESS SECTIONS

- .9 The location of outlets, luminaires, diffusers, grilles, registers, thermostats, sprinklers, and all other equipment shown on drawings (if shown) is diagrammatic.
- .10 Mark out work and fully coordinate with all other trades. Prepare dimensioned layouts of each room before rough-in for review by Contract Administrator. Review with Contract Administrator before rough-in. Do not proceed with any work until the Contract Administrator has reviewed and approved the layout drawings.
- .11 Remedy any work not installed in the correct location.

1.7 Approved Equal

- .1 Wherever the term "or approved equal" and or "approved equivalent" is used herein, it is understood that reference to the specified trade name, brand name, manufacturer's name, model number, and catalogue number has been made solely to indicate the minimum standard of quality required in material, workmanship, and service. Before procurement and installation submit any proposed alternate for review and acceptance. The review and acceptance is at the sole discretion of The City and their Contract Administrator.

1.8 Substitutions

- .1 Proposed substitutions assessed must include the following:
 - .1 Description of proposed substitution;
 - .2 Respective cost of items originally specified and the proposed solution;
 - .3 Compliance with the applicable Building Codes and the requirements of jurisdictional authorities;
 - .4 Compliance with the applicable standards;
 - .5 Affect concerning compatibility with and interface with adjacent building materials and components;
 - .6 Compliance with the intent of the Contract Documents;
 - .7 Reasons for the request.
- .2 The Contract Administrator's decision regarding the acceptance or rejection of the proposed substitution is considered final. Substitutions may be accepted if the delivery of the component or item is such that it does not jeopardize the construction schedule. Otherwise, substitution is not allowed.

1.9 Conflicting Requirements

- .1 In the case of conflict or discrepancy in the requirements indicated in the Contract documents the more stringent and/or more onerous requirement apply.

1.10 Equipment And Materials Minimum Requirements

- .1 Ensure that materials and equipment supplied by this Division is new and free from defects.
- .2 Ensure all equipment and material for which there is a listing service bear a UL/ULC and/or CSA and/or ESA label.
- .3 Ensure equipment meet all applicable FCC/CRTC Regulations.

GENERAL INSTRUCTIONS FOR ESS SECTIONS

- .4 Ensure materials have a flame spread rating of 25 or less and a smoke-developed rating of 50 or less, following NFPA 255.

1.11 Cooperation With Other Divisions

- .1 Ensure Electronic Safety and Security cabling not touch or be supported from piping, ductwork, conduits, ceiling supports, or any other structure/equipment.
- .2 Provide all items to be built in ample time for the rapid progress of the work. Schedule and proceed with work as required to satisfy the construction schedule.

1.12 Existing Services And Equipment

- .1 All changes and connections to existing services is made only in a manner and at a time approved by the Safety and Contract Administrator and/or The City to avoid any interruption of such services during normal working hours. If necessary, ensure changes and connections to existing services is made outside of normal working hours, at no extra cost to the Contract.
- .2 Where connections are made to existing services, existing fire stopping is made good under this Division.

1.13 Metric Conversions

- .1 Ensure particular care is taken with imperial versus S.I. metric conversions. This applies to all services including, equipment, material, and site services in both new and existing installations.

1.14 Schedule, Access, Protection, And Clean-Up

- .1 The construction schedule places restrictions on the duration of construction within areas and the duration of shut-down of equipment. Refer to the General Conditions for all requirements.
- .2 Refer to the General Conditions and conform to all requirements.
- .3 Refer to the security and protection requirements in the General Conditions and conform to all requirements. There is no smoking, and the site is kept clean at all times.

1.15 Cutting, Patching, And Repairing

- .1 Perform all cutting, patching, repair, and making good related to the Electronic Safety and Security Systems work including any penetrations through walls or floors.
- .2 Allow for all costs associated with cutting, patching, repair, and making good related to the Electronic Safety and Security Systems work including any penetrations through walls or floors.
- .3 Paint all visible Electronic Safety and Security systems conduit to match existing.
- .4 Coordinate the colour and location of all conduits, security devices, and their housing with Contract Administrator and architectural drawings on-site before installation.

1.16 Hoisting Facilities

- .1 Provide all hoisting required to perform all work.

GENERAL INSTRUCTIONS FOR ESS SECTIONS

PART 2 - PRODUCTS

2.1 Electronic Safety And Security Systems

- .1 Provide all materials as required for complete turnkey, end-to-end Electronic Safety and Security Systems.
- .2 Fasteners
 - .1 Provide security tamperproof fasteners for all visible exposed devices, equipment, and components in all areas. Coordinate fastener type with The City.

PART 3 - EXECUTION

3.1 Product Delivery Requirements

- .1 Unload materials from delivery trucks in such a manner as to protect the materials from damage. In particular, reels of the cable is not unloaded by dropping them off the vehicle.

3.2 Protecting Installed Systems And Construction

- .1 Be responsible for the assembly of equipment/materials, protection of equipment, and related items until the project cutover. Be responsible for any damage to equipment. All damage is repaired at The City's request, the equipment is replaced at no extra charge to The City.

3.3 Electronic Safety And Security Systems

- .1 Provide complete turnkey, end-to-end Electronic Safety and Security Systems.

3.4 Warranty Maintenance Services

- .1 Provide a Warranty for the completed work to be free of defects in workmanship and materials for 2 years from the date of system acceptance. If the workmanship or materials is found to be defective or not following the Contract documents during the warranty period, correct it promptly with factory-certified technicians at no cost. Provide all labor and materials to facilitate correction.
- .3 Ensure warranty covers all installation for the Electronic Safety and Security Systems including all hardware, hardware configurations, software, software configurations, wiring/cabling, conduit, pathways, and all active and passive components.
- .4 Provide maintenance at no extra cost during the warranty period. The maintenance include:
 - .1 Execute system health check every 6 months during the warranty period on all systems components including devices, cabling all passive and active hardware all software, and firmware. Correct all defects and make all corrections to components and software to ensure the entire system is functioning optimally and according to the manufacturer's recommendations.
 - .2 If the building cannot be armed or secured after hours, the security subcontractor will be responsible for the cost of the security company to monitor the building until the security subcontractor repairs the system in accordance with the City of Winnipeg's standards. The security company used to secure the site must be pre-approved by the City of Winnipeg.

GENERAL INSTRUCTIONS FOR ESS SECTIONS

- .3 Security subcontractor must respond to the following situations within the indicated time frame:

- .1 System fail: Within 4 hours
- .2 Component fail: Within 6 hours

3.5 General Requirements

- .1 Provide all services required and equipment necessary to maintain all operations of the installed Electronic Safety and Security Systems during the period of the warranty.

3.6 Software

- .1 Provide all available software and firmware updates during the period of the warranty and verify operation in the system. Ensure all updates are accomplished on time, fully coordinated with The City's representatives, include training for the new changes/features enabled, and incorporated into the operations and maintenance manuals, and software documentation.

3.7 Description Of Work

- .1 Provide respective systems manufacturer's required scheduled and unscheduled maintenance and all other work necessary to keep the system at its maximum performance.

3.8 Personnel

- .1 Ensure Service personnel are factory certified in the maintenance and repair of the system equipment installed under this specification. The City is advised in writing of the name of the designated service representative, and any change in personnel.

3.9 Records And Logs

- .1 Maintain records and logs of each task performed. Organize cumulative records for each component and the complete system chronologically. A continuous log is maintained for all devices. The log contain all initial settings. Complete logs is kept and available for inspection on-site, demonstrating that planned and systematic adjustments and repairs have been accomplished.

3.10 Work Requests

- .1 Record separately each service call request on a service request form. The form include the model and serial number identifying the component involved, its location, date and time the call was received, specific nature of the trouble, names of service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the materials used, the time and date work started, and the time and date of completion. Deliver a record of the work performed within five (5) days after work is accomplished.

3.11 System Modifications

- .1 Make any recommendations for system modification in writing to The City. No system modifications is made without prior approval of The City. Any modifications made to the system make sure it is incorporated into the operations and maintenance manuals, and other documentation affected.

END OF SECTION

OPERATION AND MAINTENANCE OF ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 Training

- .1 Include for adequate training of a minimum of 4 operations personnel on the operation and maintenance of the Electronic Safety and Security Systems. The training is a minimum of eight (8) hours of instruction in two (2) 4-hour segments.
- .2 Coordinate with The City to configure and or reconfigure and populate and or repopulate all Electronic Safety and Security system-related databases, configure and or reconfigure all the systems parameters to the Owners' satisfaction, until initial databases are complete and functional, and until all the security system parameters are working to the Owners satisfaction. Provide one technician to work side-by-side with The City's representatives to assist and instruct The City's representatives with further customization of all systems functionalities to The City's satisfaction.
- .3 The training includes oral and written presentations and onsite system interactive training sessions that ensure operational competency of operations personnel on each Electronic Safety and Security system.
 - .1 Provide an electronic copy of maintenance manuals and operating instructions. This include comprehensive descriptive datasheets, brochures, and technical manuals for all systems and equipment forming part of the Contract. Ensure that the manuals include wiring and schematic diagrams for the Electronic Safety Security System and all related subsystems.
 - .2 For each Electronic Safety and Security subsystem, Provide an A4 laminated sheet with short-form operating instructions on one side, and a site diagram showing systems components on the other.
 - .3 Submit a full schedule of maintenance that is carried out on each Electronic Safety and Security system during the warranty period and under subsequent maintenance contracts.
- .4 Training covers all aspects of all the systems under the electronic safety and security scope.
- .5 Record the training sessions on video with suitable audio enhancement. Provide systems manufacturer's training videos and recorded training sessions in digital format that can be viewed on a commercially available media player and edited for future training sessions. Submit all video files via secure file transfer.

PART 2 - PRODUCTS

2.1 Not Used

PART 3 - EXECUTION

3.1 Not Used

END OF SECTION

COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 Floor/Ceiling Tiles

- .1 Allow for the removal and re-installation of all floor/ceiling tiles in areas affected by work. This is done daily for all areas that are occupied during the construction period. Otherwise, remove and re-install the tiles after work is complete.
- .2 Replace all soiled and or damaged ceiling tiles during the installation of any work described in this document. Damages include chipping, breaking, or fingerprints. Final decisions on the trade responsible for any damage to ceiling tiles is made by the Project Manager and/or the Contract Administrator.
- .3 Store and protect all floor/ceiling tiles when they have been removed from the floor/ceiling grid.

1.2 Safety of Persons and Property

- .1 Comply with all laws, ordinances, rules, regulations, policies of The City, and lawful orders of any public authority having jurisdiction for the safety of persons or property or to protect them from damage, injury or loss.
- .2 Moderate public pedestrian traffic should be expected around all work locations. Ensure Ladders scaffold, installation materials, and all other hazardous conditions are fully protected at all times. Warning cones, signs, barricades, and warning tapes is used to warn and protect persons and property at all times in public corridors.
- .3 Ensure that the work done does not interfere with legal fire exits. Corridors, areas of egress, fire protection standpipes, hydrants, and exit stairs is maintained at all times.
- .4 No open flames/smoking permitted without the prior written approval of The City.
- .5 Set up and remove all signage and safety measures to ensure that other trades and non-trade personnel are safe from all work being performed.

1.3 Access To Site

- .1 Coordinate site access with the Contractor and City as determined during the initial project meeting.

1.4 Identification

- .1 All personnel are identified by either uniform or company ID. In addition, wear City provided ID for required card access locations or identification. All City ID must be returned daily or at the end of the project as determined by The City.

1.5 Emergency Facilities

- .1 Maintain at all times free access to fire lanes and emergency and utility control facilities such as fire alarm boxes, utility vaults, manholes, and junction boxes.

COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY

1.6 Product Delivery Requirements

- .1 Allow for complete delivery, handling, and installation of all materials used in the performance of the work.
- .2 Arrange for the delivery of City furnished equipment/materials related to this Specification and related items, including unloading of supplier's truck, elevator scheduling, and placement on City premises as indicated on Contract Drawings.

1.7 Product And Tools Storage Requirements

- .1 Allow for complete storage and handling of all materials used in the performance of the work.
- .2 Storage of job boxes on the site during construction may be allowed by The City. Coordinate the storage of job boxes onsite with The City. The City and their representatives are in no way responsible for any stored tools and or materials.

1.8 Confined Spaces

- .1 Comply with all code-related and City specific safety requirements when performing work in a confined space.

1.9 Co-Ordination With Occupants

- .1 Coordinate all work with The City/tenant of the floor space for daily work.

PART 2 - PRODUCTS

2.1 Not Used

PART 3 - EXECUTION

3.1 Product Delivery Requirements

- .1 Unload materials from delivery trucks in such a manner as to protect the materials from damage. Ensure reels of cable are not unloaded by dropping them off the vehicle.

3.2 Protecting Installed Systems And Construction

- .1 Assemble the above equipment/materials and protect the above equipment and related items until the project cutover. Replace all damaged equipment at no extra charge.

END OF SECTION

RECORD DRAWINGS

PART 1 - GENERAL

1.1 Not Used

PART 2 - PRODUCTS

2.1 Record Drawings

- .1 Request in writing from the Contract Administrator all Contract Drawings in native drawing file format (AutoCAD, Revit, .pdf, etc.) required to complete the Record Drawings. Complete the attached form and pay the Contract Administrator directly the costs identified within the form before receiving the Contract Drawings. After the final Record Drawings have been reviewed, provide a copy of the drawings via secure file sharing utility. Provide a copy to the Contract Administrator for their records and a copy with each set of operation and maintenance manuals. Provide additional copies if required under the General Conditions. Use the latest release of the native drawing file format software.
- .2 The Record Drawings include:
 - .1 native drawing file format and .pdf copies of Site and Floor Plans indicating locations of all devices
 - .2 native drawing file format and .pdf copies of Point-to-point wiring schematics of all systems and subsystems
 - .3 native drawing file format and .pdf copies of Elevations of all rack, cabinets, and backboard showing details device mounting
 - .4 MS Word/Excel and .pdf copies of All related schedules
 - .5 MS Word/Excel and .pdf copies of Testing and commissioning documentation for all devices
- .3 Identify the cost of Record Drawings and the Operation and Maintenance Manuals as a separate line item on progress draw. The following values are to be broken out:

\$3,500	For Contracts up to \$250,000
2% of Contract	For Contracts from \$250,000 to \$1,500,000
- .4 The project remains incomplete, and no money is released until the final electronic versions of Commissioning Test Results, As-built Drawings and Operations and Maintenance Manuals are received.
- .5 Ensure that Final Record Drawings does not contain markings or corrections by hand (i.e. marker, pen, pencil, etc.). References to the Architect and Engineer must be deleted from the drawings.
- .6 Ensure that Final Record Drawings include all revisions made to the drawings during construction, including all approved changes. The Record Drawings also include the routing of all feeders except for branch circuits. Include slab layout drawings in the as-built drawing package.

RECORD DRAWINGS

.7 Drawings Requirements:

- .1 Ensure all Record Drawings are prepared using The City's drawings standards. Obtain The City's drawing standards from The City before preparing Record Drawings
 - .2 All files must accompany a complete list of layer names and a brief description of each layer's use.
 - .3 Final Record Drawings drawings are returned via secure file transfer.
 - .4 Each file is dated and named with Contract Administrator and City, Contract number, file names, and Drawing number.
 - .5 Ensure all drawings are in the same units as issued on Bid Documents.
 - .6 Provide a complete list of symbols (block) names with a description of each symbol.
 - .7 Special effort is made to ensure that drafting is accurate: i.e. appropriate lines are indeed horizontal and vertical; lines that should intersect do but not over-intersect and ensure that entities are placed on correct layers.
 - .8 Make and models of all devices.
 - .9 Show locations of all installed devices and equipment.
 - .10 Shaded areas on the drawing of all of the device coverages.
 - .11 Zones and partition must be identified.
 - .12 Wire labels must be included. Indelible markings at both ends.
 - .13 Wire labels must contain device identification. (name, wire number, zone description)
 - .14 Signed verification/documentation that all devices have been tested to the head end.
 - .15 A copy of all hardware and/or software backup files that are required to install or operate the security system along with systems codes. Software keys must also be submitted.
 - .16 The electrical panel name and location along with the circuit number must also be included.
-
- .8 Maintain hard or electronic copy of drawings on-site on which mark as the job progresses, all changes and deviations from that shown on Contract Drawings.
 - .9 On completion of the building, forward to the Contract Administrator electronic copy of final drawings indicating all such changes and deviations for review by the Contract Administrator.

PART 3 - EXECUTION

3.1 Not Used

RECORD DRAWINGS

Project Name: _____

attention: _____

Project No.: _____ Date: YYYY-MM-DD _____ Issued by: _____

Conditions for Limited Use of Drawings

Authorization for limited use of the drawing files listed below is hereby granted, subject to the following conditions. The signing of this form constitutes acceptance and agreement with the conditions and limitations.

Copyright is reserved. The drawing and design contained in the drawing file is at all times the exclusive property of the Architect/Engineer and is not be used without the Architect/Engineer's written consent.

The drawing file may not be used wholly or in part for any purpose other than the intended use as stated on this form. Copying or distribution of this drawing file in whole or in part to parties other than those signing below is not allowed.

The file represents drawings that were prepared primarily to obtain tender prices. The drawings may or may not incorporate subsequent revisions, change orders, or addenda that have modified the drawings. files obtained from different disciplines may not be fully updated and coordinated with other disciplines and must be verified from the tender documents. The Architect/Engineer assumes no liability for errors or omissions in the drawing files. The authorized user assumes all risk and expense associated with the use of the drawing files in the production of his work.

References to the Architect and Engineer must be deleted from the drawings.

Please indicate a P.O. Number for charges associated with administrative costs to provide requested drawings.

Our charges are as follows:	\$50.00 each for the first 5 drawings			
	\$20.00 for each additional drawing from 6 to 19			
	\$500.00 for 20 drawings or more			
List of requested drawings:				
Total No. of Drawings:		Total Charge:		+ GST or HST, as applicable

Intended use (Shop drawings, As-built drawings, Installation and Interference drawings, etc.) _____

E-mail (please provide e-mail address) _____

Email address to have a link sent to (one-time download). A cheque in the above amount to be payable to Smith + Andersen or indicate the PO information below. Please sign and email this form to the sender or info@smithandandersen.com acknowledging the above charges and Conditions for Limited Use of Drawings

Accepted by: _____	_____
Signature	Name (print or type)
_____	_____
Company Name	P.O. #
_____	_____
Company Address	Phone #
_____	_____

c.c. Accounting; (Project Principal) – Smith + Andersen

END OF SECTION

SUBMITTALS - SHOP DRAWINGS

PART 1 - GENERAL

1.1 Not Used

PART 2 - PRODUCTS

2.1 SUBMITTALS/SHOP DRAWINGS

- .1 Submittals/Shop Drawings indicate the materials and/or equipment being supplied, all details of construction, accurate dimensions, capacity, operating characteristics, and performance. Each Shop Drawing give the identifying number of the specific assembly for which it was prepared (e.g. B-P2-AAA).
- .2 All shop drawings identify the specific model number of equipment being supplied.
- .3 Each Shop Drawing for non-catalogue items is prepared specifically for this project. Shop Drawings data sheets and brochures for catalogue items are marked clearly to show the items being supplied.
- .4 Each Shop Drawing or catalogue sheet is stamped and signed to indicate that the shop drawing has been checked for conformance with all requirements of the Contract drawings and specifications, that all proposed materials have been coordinated with other equipment to which it is attached, and/or connected and that all dimensions have been verified to ensure the proper installation of equipment within the available space and without interference with the work of other trades. Ensure that all electrical, mechanical, and architecture coordination are complete before submitting drawings for review.
- .5 Shop Drawings include:
 - .1 Table of content
 - .2 Door hardware coordination schedules
 - .3 For each product catalogue datasheets provided, highlight and mark the exact model number including all options of each propose product.
 - .4 Detailed schematic riser drawings indicating the physical and logical connectivity of each system and how each product is implemented in the physical and logical connectivity of each system.
 - .5 A system narrative explaining the physical and logical connectivity of each system as well as the functionality of each system.
 - .6 Detailed floor plan drawings with a legend indicating the location of each device that is installed.
 - .7 An itemized shop drawing index with a summary list of items being submitted for review. The list to indicate Item Number, Item Manufacture and Model Number and Item name and a Review Comments Column.
 - .8 Testing and commissioning plans
 - .9 Training Plans
 - .10 Manufacturer certifications
 - .11 All additional requested information as determined by the Contract Administrator

SUBMITTALS - SHOP DRAWINGS

PART 3 - EXECUTION

3.1 General

- .1 Submit all shop drawings as a single complete package.
- .2 Submit all submittals/shop drawings electronically in PDF format. Submittal is complete with a transmittal bound to the PDF file with the transmittal identifying the total number of pages in the submittal including the transmittal page.
- .3 Ensure that installation of any equipment does not start until after the Contract Administrator has reviewed Shop Drawings.
- .4 When requested, Shop Drawings is supplemented by data explaining the theory of operation
- .5 Provide space for Shop Drawing review stamps for Contract Administrator. This space is clear of all technical information and is not on the back of any sheets.
- .6 One original Shop Drawing is returned electronically.

END OF SECTION

DEFINITIONS AND ABBREVIATIONS

PART 1 - GENERAL

1.1 DEFINITIONS

.1 Generally, the following definitions are used in this Division:

Addendum	-	Normative document used to provide additional requirements and recommendations to a published document (e.g., standards, contracts). When published, an addendum effectively becomes part of the document that it supports.
Bonding	-	The permanent joining of metallic parts to form an electrically conductive path that will ensure electrical continuity and the capacity to conduct safely any current likely to be imposed.
Bonding Conductor (BC)	-	A conductor is used specifically for bonding.
Building Entrance Facility	-	The room or space inside a building where telecommunications cables enter and leave the building.
Change Notice	-	Normative documents approved to provide additional requirements and recommendations that describe and authorize the implementation of an engineering change to the product and its approved configuration documentation.
Contemplated Change Notice	-	Normative document to provide additional requirements and recommendations that describe the implementation of an engineering change to the product and its approved configuration documentation for pricing. This document does not authorize the implementation of a change to the product and its approved configuration documentation.
Cut Over	-	The live date(s) when The City will occupy the space as indicated by date and/or phasing.
Contract Documents	-	All Electronic Safety And Security Systems / Security, Electrical, Architectural, Mechanical and Structural Drawings and specifications and schedules issued about this project including any future changes and revisions of said documents.
Contract Drawings	-	All Electronic Safety And Security Systems / Security, Electrical, Architectural, Mechanical and Structural Drawings issued about this project including any future changes and revisions of said documents.
Grounded Conductor	-	A system or circuit conductor that is intentionally grounded.
Grounding System	-	A system of hardware and wiring that provides an electrical path from a specified location to an earth-ground point.
City	-	The Entity "in charge" of the overall project
Project	-	Supply and installation of a complete Integrated Electronic Safety and Security Systems as described in this document.
Provide	-	Supply, install and configure as per contract documents.

DEFINITIONS AND ABBREVIATIONS

Shop Drawing	-	Drawings, diagrams, illustrations, schedules, performance charts, and other data prepared to illustrate how specific portions of the work is installed. This includes point to point high-level integration diagram, riser diagram, termination diagram, panel layout, door types, and product datasheet.

1.2 Abbreviations

- .1 Generally, the following abbreviations are used in this Division:

A	-	Ampere
ac	-	Alternating current
ACR	-	Attenuation to Cross-Talk Ratio
ADC	-	Analogue to Digital Converter
A/E	-	Architect or Engineer
AFF	-	Above Finished Floor
AHJ	-	Authority Having Jurisdiction
AME	-	Architectural, Mechanical, Electrical
ANSI	-	American National Standards Institute
AP	-	Access Point
ASCII	-	American Standard Code for Information Interchange
ASTM	-	American Society for Testing and Materials
ATD	-	Asynchronous Time Division
ATDM	-	Asynchronous Time Division Multiplexing
ATM	-	Asynchronous Transfer Mode
Attn	-	Attenuation
AV	-	Audiovisual
AWG	-	American Wire Gauge
BAS	-	Building Automation System
BC	-	Bonding Conductor
BCD	-	Backbone Conduit
BCT	-	Bonding Conductor for Telecommunications
BEF	-	Building Entrance Facility
BER	-	Bit Error Rate
BERT	-	Bit Error Rate Test
BFOC	-	Bayonet Fibre Optic Connector
BIC	-	Building Industry Consultant
BICSI®	-	Building Industry Consulting Service International
bit	-	Binary Digit
BOM	-	Bill Of Material
b/s	-	Bit per Second
BWA	-	Broadband Wireless Access
CA	-	Cable
CAD	-	Computer Aided Design
CATV	-	Community Antenna Television (Cable Television)
CCIA	-	Computer Communications Industry Association
CCN	-	Contemplated Change Notice
CD	-	Compact Disc
CD	-	Change Directive (same as Change Notice and Change Order)
CEC	-	Canadian Electrical Code

DEFINITIONS AND ABBREVIATIONS

cm	-	Centimetre
CMP	-	Communications Plenum
CMR	-	Communications Riser
CN	-	Change Notice (same as Change Directive and Change Order)
CO	-	Change Order (same as Change Notice and Change Directive)
coax	-	Coaxial Cable
CP	-	Consolidation Point
CPU	-	Central Processing Unit
CPVC	-	Chlorinated Polyvinyl Chloride
CSA	-	Canadian Standards Institute
CSC	-	Construction Specifications Canada
CSI	-	Construction Specifications Institute
CT	-	Cable Tray
Cu	-	Copper
c/w	-	Complete With
dB	-	Decibel
dB/km	-	Decibel per Kilometre
dBm	-	Decibel milliwatt
dBmV	-	Decibel millivolt
demarc	-	Demarcation Point
DSL	-	Digital Subscriber Line
EF	-	Entrance Facility
EIA	-	Electronics Industry Alliance
ELFEXT	-	Equal Level Far-End Crosstalk
ESSS	-	Electronic Safety and Security System/s
e-mail	-	Electronic Mail
EMI	-	Electromagnetic Interference
EMI/RFI	-	Electromagnetic Interference / Radio Frequency Interference
ER	-	Equipment Room
ESD	-	Electrostatic Discharge
e/w	-	Equipped With
FC	-	Fibre Connector
FCC	-	Federal Communications Commission
FOV	-	Field Of View
ft	-	Foot / Feet
ft ²	-	Square Foot / Feet
G	-	Giga
Gb	-	Gigabit
GB	-	Gigabyte
Gb/s	-	Gigabit per Second
GHz	-	Gigahertz
HC	-	Horizontal Cross-connect
Hz	-	Hertz
I	-	Current
IC	-	Intermediate Closet
IC	-	Intermediate Cross-connect
ID	-	Identification
ID	-	Inside Diameter
IDC	-	Insulation Displacement Connection

DEFINITIONS AND ABBREVIATIONS

IDC	-	Insulation Displacement Connector
IDC	-	Insulation Displacement Contact
IDF	-	Intermediate Distribution Frame
IEEE®	-	Institute of Electrical and Electronics Engineers, Inc.®
IG	-	Isolated Ground
in	-	Inch
in ²	-	Square Inch
I/O	-	Input / Output (Device)
IOR	-	Index Of Refraction
IP	-	Internet Protocol
ISDN	-	Integrated Services Digital Network
ISO	-	International Organization for Standardization
IT	-	Information Technology
kb	-	Kilobit
kB	-	Kilobyte
kg	-	Kilogram
km	-	Kilometre
kV	-	Kilovolt
kVA	-	Kilovoltampere
kW	-	Kilowatt
kWh	-	Kilowatt hour
LAN	-	Local Area Network
laser	-	Light Amplification by Stimulated Emission of Radiation
lb	-	Pound
LED	-	Light Emitting Diode
LO	-	Laser Optimized
LSZH	-	Low Smoke Zero Halogen
m	-	Metre
m ²	-	Square Metre
mA	-	Milliampere
MAC	-	Move, Add, or Change
MAN	-	Metropolitan Area Network
Mb	-	Megabit
MB	-	Megabyte
Mb/s	-	Megabit per Second
MB/s	-	Megabyte per Second
MC	-	Main Cross-connect
MDF	-	Main Distribution Frame
MGB	-	Main Grounding Busbar
MHz	-	Megahertz
mi	-	Mile
min	-	Minute
mm	-	Millimetre
MM	-	Multimode
MMF	-	Multimode Fibre
MPP	-	Modular Patch Panel
ms	-	Millisecond
MSDS	-	Material Safety Data Sheet
MW	-	Megawatt

DEFINITIONS AND ABBREVIATIONS

NBCC	-	National Building Code of Canada
NESC	-	National Electrical Safety Code
NIC	-	Network Interface Card
NRCC	-	National Research Council of Canada
OD	-	Outside Diameter
OEM	-	Original Equipment Manufacturer
OF	-	Optical Fibre
OSDP		Open Supervised Device Protocol
PDU	-	Power Distribution Unit
PIR	-	Passive Infrared
PSACR	-	Power Sum Attenuation to Crosstalk Ratio
PSELFEXT	-	Power Sum Equal Level Far-End Crosstalk
PSNEXT	-	Power Sum Near-End Crosstalk
PSP	-	Physical Security Professional
PTZ	-	Pan Tilt Zoom
PVC	-	Polyvinyl Chloride
QA	-	Quality Assurance
QC	-	Quality Control
QoS	-	Quality of Service
Qty	-	Quantity
RCDD®	-	Registered Communications Distribution Designer
RF	-	Radio Frequency
RFI	-	Radio Frequency Interference
RJ	-	Registered Jack
rms	-	Root Mean Square
RU	-	Rack Unit (1.75")
RX	-	Receive
RX	-	Receiver
SAN	-	Storage Access Network
SC	-	Single Fibre Coupling Optical Fibre Connector
SCC	-	Standards Council of Canada
SCS	-	Structured Cabling System
ScTP	-	Screened Twisted Pair
SFTP	-	Screened Foiled Twisted Pair
SI	-	International System of Units (Le Système International d'Unités)
SLA	-	Service level Agreement
SM	-	Singlemode
SMF	-	Singlemode Fibre
SNMP	-	Simple Network Management Protocol
SNR	-	Signal-to-Noise Ratio
STP	-	Shielded Twisted Pair
STP-A	-	Shielded Twisted Pair A
TBB	-	Telecommunications Bonding Backbone
TBBIBC	-	Telecommunications Bonding Backbone Interconnecting Bonding Conductor
TC	-	Telecommunications Closet
TDD	-	Telecommunications Device for the Deaf
TGB	-	Telecommunications Grounding Busbar
TGR	-	Telecommunications Grounding Rod

DEFINITIONS AND ABBREVIATIONS

TIA	-	Telecommunications Industry Association
TMGB	-	Telecommunications Main Grounding Busbar
TP	-	Twisted Pair
TR	-	Telecommunications Room
TS	-	Technical Standard
TSB	-	Telecommunications Systems Bulletin (formerly Technical Systems Bulletin)
TTY	-	Teletypewriter / Text Telephone
TV	-	Television
TX	-	Transmit
TX	-	Transmitter
UD	-	Underfloor Duct
UL®	-	Underwriters Laboratories Inc.®
ULC	-	Underwriters Laboratories of Canada
UPC	-	Universal Product Code
UPS	-	Uninterruptible Power Supply
UTP	-	Unshielded Twisted Pair
V	-	Volt
VA	-	Volt-Ampere
VLAN	-	Virtual Local Area Network
VoIP	-	Voice over Internet Protocol
VPN	-	Virtual Private Network
W	-	Watt
WAN	-	Wide Area Network
WAP	-	Wireless Application Protocol
WiFi	-	Wireless Fidelity
Wi-Fi	-	Wireless Fidelity
WLAN	-	Wireless Local Area Network
WMAN	-	Wireless Metropolitan Area Network
WWAN	-	Wireless Wide Area Network

PART 2 - PRODUCTS

2.1 Not Used

PART 3 - EXECUTION

3.1 Not Used

END OF SECTION

CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 Work Included

- .1 All Electronic Safety and Security Systems conductors and cables is installed in pathways as shown on Contract drawings. Pathways include conduit, cable trays, and cable troughs.
- .2 Provide conductors and cables as detailed in Contract Documents and as required and as specified by the manufacturer to ensure proper operation of all devices and systems. Use pathways to distribute the cables throughout the facility. Where the cables leave the pathways provided by Div 26 and extend to the termination point provide conduit as needed to support and secure the cables. Where pathways are not provided by Division 26 and are required as noted on drawings and in this specification provide pathways for all Electronic Safety and Security Systems conductors and cables. Avoid scraping, denting, or otherwise damaging cables, before, during, or after installation. Without any additional compensation replace damaged cables.
- .5 Ensure that all cable lengths are sufficient to allow for horizontal and vertical runs, wastage, connectorization, and future moves.

1.2 Cable Routing

- .1 Make any necessary changes or additions to the routing of cables, pathways to accommodate structural, mechanical, electrical, and architectural conditions. Where pathways or cables are shown diagrammatically run them parallel to grid lines. If it is necessary to run cables otherwise to accommodate acceptable cable lengths, written permission must be obtained from the Contract Administrator before installation.

PART 2 - PRODUCTS

2.1 Cabling

- .1 Conductors and cables are to be CMR where installed completely in conduit or where installed in non-plenum rated areas. Conductors and cables are to be CMP where not completely installed in conduit or installed in plenum-rated areas. All cables conform to the recommendations of the manufacturers of the electronic safety and security systems.
- .2 Approved Manufacturers for Child Care Center:
 - .1 Leviton
 - .2 Amp
- .3 Approved Manufacturers for Recreation Center:
 - .1 Belden
 - .2 Amp
 - .3 CommScope
 - .4 Honeywell (Multi-Conductor Access Control wiring only)
 - .1 Profusion 3195 FT6 rated, or equivalent
- .4 Conductors and cables are outdoor-rated where installed outdoor or installed in locations where they will be exposed to weather elements.

CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

- .5 Conductors and cables are rated for the environment and or environments in which they are being installed.
- .6 Provide and install shielded cables where required and or recommended by the manufacturer of the electronic safety and security systems.
- .7 The cabling shown is for typical systems. All cabling is as required and specified by the manufacture of the electronic safety and security systems.
- .8 All wiring is of the proper gauge, type, and quantity of conductors as required and as specified by the manufacturer to ensure proper operation of electronic safety and security systems and peripheral devices.
- .9 Multiconductor cables have the conductors colour-coded.
- .10 Ensure all conductors and cables are CSA approved and is be stamped accordingly.
- .11 Card Readers: Minimum 3 pair, AWG 22, overall shielded or as required by the manufacturer
- .12 Door contact (magnetic contact): Minimum 4 conductor, AWG 22 or as required based on distance from the controller
- .13 Motion request to exit devices: Minimum 4 conductor, AWG 22 as required based on distance from the controller
- .14 Electric strikes, magnetic locks, electric latches, electric mortise locks, and all other electrified locks: Minimum 4 conductor, AWG 18 or as required based on distance from the power source
- .15 Push button and latch bolt monitor request to exit devices: Minimum 4 conductor, AWG 22 as required based on distance from the controller
- .16 Motion detector: Minimum 4 conductor, AWG 22 as required based on distance from the controller
- .17 Glass break detector: Minimum 4 conductor, AWG 22 as required based on distance from the controller
- .18 IP Video Surveillance Camera:
 - .1 Minimum 4 pair Category 6 cable for video and PTZ control
 - .2 RJ45 connectors
 - .3 Minimum 2 conductor, AWG 18 for power or as required based on distance from the power source
- .19 Fibre Optic Cable:
 - .1 Cable: 24 strand 50/125 micron OM4 multimode, 10 GB, indoor/outdoor rated, all-dielectric fibre optic cable
 - .2 Provide 50/125 micron OM4 multimode, 10 GB, fibre optic connectors
 - .3 Patch Panel: 24 port, 19" rack mount fibre optic patch panel
 - .4 Patch Cords: allow for six (6) 2M duplex 50/125 micron OM4 multimode, 10 GB, fibre optic patch cords
 - .5 Confirm fibre optic connector types with The City before procurement

CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

- .20 Increase conductor quantities and or sizes beyond the above-stated minimums as required to facilitate the proper and complete operation of each respective device and system.

PART 3 - EXECUTION

3.1 Cable Distribution

- .1 Where cables are not installed in conduit neatly bundle and tie-wrap all cables using Velcro straps.
- .2 Follow proper installation and termination practices for all cables. Do not kink or exceed the cable minimum bend radius. Maintain a minimum of four (4) times cable diameter as bend radii if the manufacturer specifies no bend radius.
- .3 When bundling cables, comply with the manufacturer's specified bundling practices for installation. Ensure that excess pressure is not placed on the cable at any point that may result in the compression or deformation of the cable jacket and internal pair/conductor geometry.
- .4 Do not exceed the copper cable's maximum tensile rating during installation. Monitor tension of the cable during installation. Use a dynamometer to record installation tension. Use a tension limiting device to prevent the exceeding of maximum pulling tension specifications during installation. The tension limit is set at or below the manufacturer's limit. Ensure the cable is taken up at intermediate pulling points with an intermediate take-up device as approved by the Contract Administrator, to prevent over tension on the cable.

3.2 Conductors And Cables

- .1 Provide all wiring as required for the proper operating of each electronic safety and security system and each peripheral device.
- .2 Provide and install metal wiring duct to facilitate proper organization and proper dressing of all cables at and around each electronic safety and security system panel.
- .3 Provide metal wiring duct from conduit endpoints to and around all control panels.
- .4 All wiring ducts is installed such that the ducts house, protect, and facilitate the routing of all cables at 90-degree angles to and around all access control panels.
- .5 Provide non-metallic wiring ducts within all control panels to manage all wiring to termination points.
- .6 All wiring duct is sized to house all cables while maintaining the manufacturer's specified bend radius.
- .7 Provide all fitting for all wiring duct as required, including; couplings, end caps, brackets, etc.
- .8 After installation, and before termination, ensure all wiring and cabling is checked and tested to ensure there are no grounds, opens, or shorts on any conductors or shields. A V.O.M. is utilized to accomplish these tests and a reading of greater than 20 Megohms is required to complete the test. All Category 6 and Category 6A cables is tested to EIA/TIA standards.
- .9 Visually inspect wire and cable for faulty insulation before installation. Protect cable ends at all times with acceptable end caps except during actual termination.

CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

- .10 Protect wire and cable from kinks.
- .11 Provide grommets and strain relief where required.
- .12 Comply with controller and peripheral device manufacturer's installation and termination recommendation.

END OF SECTION

GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 Work Included

- .1 Applicable Codes & Standards
- .2 Provide grounding & bonding following good industry practices and following the following Codes and Standards:
 - .1 CSA Standard C22.2 No.41 latest version – Grounding & Bonding Equipment
 - .2 CSA Standard T527 (ANSI/TIA/EIA-607-C)
 - .3 CSA Standard T 530-99 - Telecommunications Pathways and Spaces
 - .4 ANSI/EIA/TIA-942-B – Telecommunications Infrastructure Standard for Data Centers
 - .5 Local Codes & Bylaws
 - .6 BICSI requirements
- .3 Refer to Electrical Specifications for Electrical Codes and Building Codes.

PART 2 - PRODUCTS

2.1 General

- .1 Provide a Copper Grounding Busbar and associated hardware in each equipment room (Telecommunications Room, LAN Room, Hub Room, Security Room, etc.) where Electronic Safety and Security equipment will be installed. The Busbar is permanently connected to the building ground system.

2.2 Grounding & Bonding Infrastructure

- .1 Rack Grounding Strips
 - .1 Panduit Part# RGS134-1Y or approved equivalent
- .2 Rack Jumper Kits
 - .1 Panduit Part# ACG24K or approved equivalent
- .3 Thread forming screws
 - .1 Panduit Part # RGTS-CY or approved equivalent
 - .2 Panduit RGTSM6-C or approved equivalent
- .4 Bonding screws
 - .1 Panduit Part# RGTBS-C or approved equivalent
 - .2 Panduit RGTBSM6-C or approved equivalent
- .5 Provide a green jacketed #6 AWG Stranded Copper Conductor to bond the grounding system to all:
 - .1 Cabinets
 - .2 Racks
 - .3 Metallic Pathways including Cable Tray, Conduit, etc.

GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY

- .4 Metallic sheath of all shielded cables (use cable manufacturer's recommended bond clamp)
- .5 Metallic enclosures including equipment and controller enclosures, building entrance protection panels, etc.

PART 3 - EXECUTION

3.1 General

- .1 Confirm existing ground bus in each communications room.
- .2 Coordinate location of new ground bus in communications rooms.
- .3 Ground and or Bond all metal components of the Electronic Safety and Security Systems per all applicable codes and standards.
- .4 Provide, test, label, and document all grounding and bonding cables and related terminations.
- .5 Ensure that complete metal-to-metal contact is made when grounding to painted or powder-coated metal surfaces.
- .6 Where Grounding & Bonding Infrastructure is provided Ensure that the Grounding & Bonding Infrastructure does not interfere with, impede and or reduce the integrity of existing grounding systems and practices.

END OF SECTION

PATHWAYS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 WORK INCLUDED

- .1 Where cables leave the pathways, provide cable slings and/or j-hooks to support cabling up to point of termination.

1.2 CABLE DISTRIBUTION

- .1 Utilize all indicated and available cable pathways such as conduits, Communications cable tray, ducts, surface raceways, and furniture system channels except where otherwise noted.
- .2 Inside buildings minimize any possibilities of disruption by maintaining the following minimum clearances from electrical and heat sources when routing cables.

Item	Minimum Separation Distances		
	(<2kVA)	(2-5kVA)	(>5kVA)
Unshielded power lines or electrical equipment in proximity to open or non-metallic pathways.	127 mm (5" (in))	305 mm (12" (in))	610 mm (24" (in))
Unshielded power lines or electrical equipment in proximity to a grounded metal conduit pathway.	64 mm (2.5" (in))	152 mm (6" (in))	305 mm (12" (in))
Power lines are enclosed in a grounded metal conduit (or approved equivalent shielding) in proximity to a grounded metal conduit pathway.	---	76 mm (3" (in))	152 mm (6" (in))
Motors	1.2 m (4'-0")		
Transformers	1.2 m (4'-0")		
Fluorescent Luminaires	300 mm (12")		
Pipes (gas, oil, water, etc.)	120 mm (5")		
HVAC (equipment, ducts, etc.)	152 mm (6")		

PART 2 - PRODUCTS

2.1 Non-Continuous Cable Support

- .1 Provide cable support for the distribution of horizontal and backbone cables where conduit or ladder tray has not been provided.
- .2 Ensure the size of J-hooks/support suit the number of cables in runs used for distribution.
- .3 Include any other miscellaneous hardware (angled hanger bracket, hammer/screw-on clamps) required to support horizontal and backbone cabling.

2.2 Velcro Straps

- .1 Provide Velcro straps. Only Velcro straps is acceptable. Under no circumstance plastic tie-wraps be used.

PATHWAYS FOR ELECTRONIC SAFETY AND SECURITY

2.3 Grounding Wire

- .1 Provide #6 AWG green grounding wire for all metallic components that is grounded and Code Conductor Two Hole Long Barrel with Window Lug to bond the conductor to the ground bus.

PART 3 - EXECUTION

3.1 Cable Distribution

- .1 Exercise caution when pulling cables in pathways to avoid damage to any existing cables.
- .2 Follow the manufacturer's maximum pull-force and minimum bend radii.
- .3 All cables and components installed and terminated following applicable Codes, Standards, and Regulations.

3.2 Cable Support

- .1 Hangers installed at 1219mm (48") intervals (maximum). Cables run such that sag between supports does not exceed 100 mm (4"). Secure all cables to J-hooks/supports with Velcro straps. Cables combed and dressed for all visible portions of the install. The above-noted conditions are strictly checked. Comb and redress any cables that are unsatisfactory at no additional cost.
- .2 Attaching to T-bar support rods is not acceptable. Anchors for hangers must not be drilled into post-tensioned beams under any circumstances. Do not use Pneumatic hammers. All anchors must be drilled into the slab.
- .3 Do not 'fire spray' insulation during the installation of cable supports.

3.3 Velcro Straps

- .1 Ensure Velcro straps is used to neatly dress cables; Ensure they are placed at a maximum of 1219 mm (48") intervals for horizontal distribution (centre points between cable supports).
- .2 Velcro straps also used to dress cables into racks/cabinets. Maximum spacing of Velcro for cables into or along vertical cable managers no more than 152 mm (6"), this includes cabling dropped from the ladder tray or ceiling above.

3.4 Cable Distribution

- .1 The minimum conduit bend radius is as per the manufacturer's recommendations.
- .2 Make cable pulls continuous and steady between pull points. Do not interrupt the pull unless necessitated by excessive tension on the cable.
- .3 Protect exposed cable ends from moisture ingress.

3.5 Duct And Conduit

- .1 Clean out each section of duct or conduit by pulling a steel wire brush and mandrel of the correct size through the duct or conduit before pulling cables. Bush, ream and remove any sharp projections on all conduits prior to installation of communications cables. When cleaning ducts, if obstructions are encountered which cannot be removed, advise the Contract Administrator of the problems encountered.

PATHWAYS FOR ELECTRONIC SAFETY AND SECURITY

- .2 Apply manufacturer's specified lubricant to cables to reduce friction between the cable and the conduit. Cable grip attached to the sheath and its strength members so that no direct force is applied to the conductors/fibres. The cable grip has a ball bearing swivel to prevent the cable from twisting during pulling.

END OF SECTION

IDENTIFICATION FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 Work Included

- .1 Provide A Class 3 system as per the latest version of the ANSI/TIA/EIA 606 Standards.
- .2 All elements of the Electronic Safety and Security Systems is labeled with unique identifiers.
- .3 Where labeling schemes are not provided co-develop a labeling scheme with The City and the Contract Administrator before the installation of any permanent labels on the Electronic Safety and Security Systems components.
- .4 Labeling schemes are confirmed with the Contract Administrator before installation.

PART 2 - PRODUCTS

2.1 Labels

- .1 Ensure all cable and equipment labels meet the legibility, defacement, and adhesion requirements specified in ANSI/UL 969. In addition, the labels are required to meet the general exposure requirements in ANSI/UL 969 for indoor and outdoor use.
- .2 When wrapped around a cable ensure Cable labels are of self-laminating vinyl construction with a white printing area and a clear tail that self-laminates the printed area. The clear area should be of sufficient length to wrap around the cable at least one and one-half times. The width is required to be sufficient to accommodate the appropriate label designation.
- .3 Provide vinyl substrate with a white printing area and black print. If cable jacket or equipment is white, provide cable label with printing area that is any other colour than white, preferably orange or yellow – so that the labels are easily distinguishable.
- .4 Ensure Labels are flexible vinyl or other substrates to apply easily and flex as cables are bent.
- .5 Ensure Labels use aggressive adhesives that stay attached even to the most difficult to adhere to jacketing.
- .6 Labels should be resistant to the environmental conditions at the point of installation (such as moisture, heat, or ultraviolet light) and should have a design life equal to or greater than that of the labeled component.
- .7 Ensure all labels are mechanically printed using a laser printer. Hand-written labels are not permitted.
- .8 All backbone and horizontal cables including patch cord labels are printed in 10 point Arial Narrow, black, bold font.
- .9 Ensure all equipment labels are printed in 14 point Arial Narrow, black, bold font.
- .10 Ensure all Hub, Main Cabinets, and controlling device enclosure labels are black lamacoid plates with white 60 point Arial Narrow, engraved upper case letters enclosed by a white border on black background.

IDENTIFICATION FOR ELECTRONIC SAFETY AND SECURITY

PART 3 - EXECUTION

3.1 Labelling

- .1 Submit sample labels to Contract Administrator for approval before procurement and installation.
- .2 Provide all labels as indicated in this document and Contract drawings.
- .3 Provide all labels for all cables and all active and passive devices, conduits, and pull boxes.
- .4 Label all ends of conduits including ends of conduits that terminate in pull boxes. Ensure all the label is installed within 304mm (12") of each conduit end. Label designations for conduit and pull boxes is confirmed with the Contract Administrator before procurements and installation. Allow for adding label designations (soft) for conduits and pull boxes to soft cabling schedules.
- .5 Ensure all Labels are located on cables and equipment as indicated in this document and on Contract drawings.
- .6 Labels should be visible during the installation and normal maintenance of the infrastructure.
- .7 Ensure all Labels are affixed to the front and rear of equipment where required and 150 mm (6") from the end of all backbone and horizontal cables.
- .8 Labels are affixed 75 mm (3") from the end of all patch cords.
- .9 Labels should be attached at both ends of all cables (within 75 mm (3") of the end).
- .10 All temporary labels removed from cables and equipment before commissioning.
- .11 Ensure all labels are visible.
- .12 Ensure all active and passive equipment are labeled.

END OF SECTION

COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 Not Used

PART 2 - PRODUCTS

2.1 Test Equipment

- .1 Provide portable two-way radios and or other communication devices.

2.2 Proprietary Test Equipment

- .1 Provide all proprietary test equipment that is required to facilitate testing and commissioning of the Electronic Safety Security System. All proprietary test equipment become the property of The City upon completion of the commissioning.
- .2 Obtain and review design documents for overall design intent and the overall required systems configurations.
- .3 Obtain and review shop drawings and submittals for installation criteria and the required construction details, as they support and further define the system's features.
- .4 Make general reviews at the job site and review the following for configuration:
 - .1 Quality of construction
 - .2 Adherence to design requirements
 - .3 Conformance with shop drawings and submittal information.

PART 3 - EXECUTION

3.1 Commissioning Process

- .1 Execute the following:
 - .1 Identify all systems, equipment, components, and functions to be commissioned
 - .2 Develop itemized test procedures including itemized functional test forms and device test checklists
 - .3 Review commissioning plan and process with the Contract Administrator
 - .4 Perform pre-startup tests
 - .5 Perform device tests
 - .6 Perform functional tests
 - .7 Perform system integration functional tests
 - .8 Perform retests as necessary
 - .9 Turnover

3.2 COMMISSIONING

- .1 Identify all components, functions, and systems are commissioned.
- .2 Develop device checklists, functional test forms, and system integration test forms that are executed.
 - .1 Device Checklists

COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY

- .1 Each device checklist includes but not limited to:
 - .1 Unique identifier of each device and component of the respective system
 - .2 Location of device
 - .3 Name of commissioning agent
 - .4 Name of witness
 - .5 Date of commissioning
 - .6 For each device; all functions and performance requirements indicated in the relative system specifications sections of this document, all function and performance requirements indicated on all associated drawings, all industry-standard tests, all manufacturer-recommended tests, all test that are required to confirm that the respective device is in proper working order.
 - .7 Confirmation of device tests performed
 - .8 Confirmation of tests passed or failed and related comment
- .2 Functional Test Forms
 - .1 Each functional test form includes but not limited to:
 - .1 Identification of system under test
 - .2 Location of system
 - .3 Name of commissioning agent
 - .4 Name of witness
 - .5 Date of commissioning
 - .6 For each system; all function and performance requirements indicated in the relative system specifications sections of this document, all functions indicated on all associated drawings, all industry-standard functional tests, all manufacturer-recommended functional tests, and all functional tests that are required to confirm that the respective system is in proper working order.
 - .7 Confirmation of functional tests performed
 - .8 Confirmation of tests passed or failed and related comment
 - .9 For each video surveillance camera; include a video surveillance camera "Field of View Sample Snapshot" area in addition to all the above noted functional tests
- .3 Systems Integration Functional Test Forms
 - .1 Each system integration test form includes but not limited to:
 - .1 Identification of systems under test
 - .2 Location of systems
 - .3 Name of commissioning agent
 - .4 Name of witness

COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY

- .5 Date of commissioning
- .6 All integrated functions and performance requirements that are indicated in the electronic safety and security system integration specifications section of this document, all integrated functions indicated on all associated drawings, all industry-standard integration functional tests, all manufacturer-recommended integrated functional tests, and all integrated functional tests that are required to confirm that the respective systems are integrated and are in proper working order.
- .7 Confirmation of integrated functional tests performed
- .8 Confirmation of tests passed or failed and related comment
- .3 Forward the device checklists, functional test forms, and systems integration test forms to the Contract Administrator for review and approval before commencing commissioning.
- .4 Pre-Start-up Test
 - .1 Perform pre-start-up tests to verify that the devices and systems that are to be commissioned are powered, calibrated, operational, and ready for device and functional testing.
- .5 Perform Device Tests
 - .1 Perform device tests for all devices following the device checklists.
- .6 Perform Functional Tests
 - .1 Perform functional tests for all devices and systems following the functional test forms.
- .7 Perform System Integration Tests
 - .1 Perform system integration functional tests for all devices and systems following the system integration functional test forms.
- .8 Perform Retests as Necessary
 - .1 For all failed tests, make all necessary repairs and perform retests. Failure of the integrated test may require the retest of one or more individual tests. Conduct repairs and retests until all tests are passed.
- .9 Turnover
 - .1 Prepare a comprehensive commissioning report that includes but not limited to completed device checklists, completed functional test forms, completed systems integration functional test forms with measured data. The commissioning report is submitted along with system operation and maintenance manuals for review and approval by the Contract Administrator.

3.3 Acceptance Criteria

- .1 To be determined by the Contract Administrator.

3.4 Acceptance Procedures

- .1 To be determined by the Contract Administrator

COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY

- .2 To ensure The City and all contracting parties agree, a formal acceptance procedure has been established for the security sub-system of this Division. The acceptance is based on the successful completion of the testing requirements and therefore not open for punch list items. Final acceptance of the commissioning is when all tests are completed and the results of the tests are reviewed and accepted by Contract Administrator.

END OF SECTION

ACCESS CONTROL

PART 1 - GENERAL

1.1 Purpose

- .1 The building's and facility's Access Control System's primary function is to protect the assets. The contents of this document are critical and are considered confidential. Ensure this information is not disclosed to anyone other than authorized personnel.

1.2 Scope Of Work

- .1 The work covered by this section includes the furnishing, installation, and activation of all equipment & materials associated with the complete Access Control System as shown and as specified herein. This work may include, integration with the associated subsystems and components listed in these sections.

1.3 Controller System Function And Performance Requirements

- .1 The Access Control System is as described in this specification and illustrated on the drawings the access control system is an interconnected group of components consisting of the following minimum devices:
 - .1 Detecting and controlling devices
 - .2 Credential Readers
 - .3 Wired Electrified Door Locks
 - .4 Power supplies

PART 2 - PRODUCT

2.1 General

- .1 Where product model is specified and are deemed discontinued by the product manufacturer, provide the latest manufacturer recommend product model at the time of installation in leu of the specified model.
- .2 Where product performance specifications are provided, provide the latest manufacturer product model at the time of installation.
- .3 All products and materials must be new and approved in the pre-installation submittals.
- .4 Exterior devices are sealed and protected against weather conditions including heat, cold, moisture, dust, and sand.
- .5 Commercial-grade, high quality, and rated for the environment in which it is being installed
- .6 Compatible with the access control system.

2.2 Door Controller

- .1 Mercury LP1502 PoE+ Edge-capable Intelligent Controller
- .2 Mercury MR52-S3 Reader interface panel

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2.3 Input / Output Controller

- .1 Mercury MR16IN-S3 Multi-device interface panel
- .2 Mercury MR16OUT-S3 Multi-device interface panel

2.4 Credential Readers

- .1 Approved Manufacturers:
 - .1 HID
 - .1 HID® Signo™ Reader 20 (20NKS-00/T0-000000)
 - .2 HID® Signo™ Reader 40 (40NKS-00/T0-000000)

2.5 Peripheral Devices

- .1 For Child Care Center:
 - .1 Magnetic Contacts
 - .1 GE Magnetic contact 1076/1078 Series
 - .2 For Recreation Center:
 - .1 Magnetic Contacts (Steel)
 - .1 GRI 199-12W DPDT 1" Contact
 - .2 Magnetic Contacts (Wood)
 - .1 GRI 4545-12WG DPDT 3/8" Contact
 - .3 Magnetic Contacts (Overhead Door)
 - .1 GRI 4700-A
 - .4 End of Line Resistor Pack
 - .1 GRI 6444-1 Four State EOL Resistor Pack
- 2.5.2.4.1.1.1.1. Request to Exit Detector
- .2 Bosch – DS160
 - .1 Remote Release Button:
 - .3 GRI GR3045 Panic Switch Set with Screw Terminals

2.6 Power Supply

- .1 Power supplies include all controller power supplies, all electrified lock power supplies, and all peripheral device power supplies.
- .2 Provide separate power supplies for controllers, provide separate power supplies for maglocks, provide separate power supplies for electrified locks separate from maglocks (e.g., electric strikes, electric latch retraction, electric mortise locks), and provide separate power supplies for peripheral devices.
- .3 Ensure all electrified lock power supplies except maglocks power supplies provide a backup battery to facilitate the complete and simultaneous full operation of all connected and powered devices for up to one (1) hour operation upon loss of AC power.

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- .4 Ensure all maglock lock power supplies have the capacity to add a backup battery to facilitate the complete and simultaneous full operation of all connected and powered devices for up to one (1) hour operation upon loss of AC power.
- .5 Agency Listings
 - .1 UL Listed for Access Control Systems (UL294),
 - .2 Power Supplies for use with Burglar-Alarm Systems (UL603),
 - .3 Hospital Signaling and Nurse Call Equipment (UL1069),
 - .4 Power Supplies for Fire Protective Signaling Systems (UL1481),
 - .5 CUL Listed - CSA Standard C22.2 No.205-M1983, Signal Equipment.
- .6 Features/Specifications:
 - .1 Voltage: output as required to facilitate complete system operation.
 - .2 Amperage: Rating as required to facilitate the complete and simultaneous operation of all associated powered devices.
 - .3 Class 2 Rated power limited outputs.
 - .4 PTC (Positive Temperature Coefficient) protected outputs.
 - .1 Each connected and powered device is connected to a separate PTC power supply output.
 - .5 Fuse rating as required for complete operation of each connected and powered device
 - .6 115VAC 60Hz, input.
 - .7 Filtered and electronically regulated outputs.
 - .8 Short circuit and thermal overload protection.
 - .9 Built-in charger for sealed lead acid or gel-type battery backup.
 - .10 Zero voltage drop upon transfer to battery backup.
 - .11 AC input and DC output LED indicators.
 - .12 AC fail supervision.
 - .13 Low battery and battery presence supervision.
 - .14 Fire alarm system interface.
- .7 Approved products:
 - .1 Altronix eFlow 6NA8D - 24 VDC, 8 Output
 - .2 Altronix eFlow 104N16 – 24 VDC, 16 output
 - .1 A dedicated 120VAC 15A circuit is required, with a lockable disconnect switch within 3 feet of the cabinet.
 - .3 Outputs and connected wiring shall be labelled, as to clearly identify device and location.
 - .4 Approved Battery
 - .1 12V 7AH Yuasa SLA

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2.7 Access Control Controller Enclosures

- .1 Provide access control controller enclosures to house and protect all controllers.
- .2 Ensure all access control controller enclosures are a single key locking metal box.
- .3 Size as required to house and protect all controllers.
- .4 Equipped with door tamper switch. Connect each door tamper switch to the access control system.
- .5 New enclosures are equipped with door tamper switch. Connect each door tamper switch to the intrusion detection system. .
- .6 Ensure the quantity and size of access control controller enclosures does not exceed the real estate provided for mounting access control controller enclosures. Refer to Contract drawings and coordinate as such.
- .7 Enclosures shall be mounted no higher than 5'10" to the top of the enclosure.
- .8 Approved product:
 - .1 Altronix Trove T1M1CK1D – Accommodates up to 2 Mercury Controllers (4 Doors) – Pre-Wired with Power supply
 - .2 Altronix Trove T2M7XK1D – Accommodates up to 6 Mercury Controllers (12 Doors) – Pre-Wired with Power supply
 - .3 Altronix Trove T3M77XK1D – Accommodates up to 8 Mercury Controllers (16 Doors) – Pre-Wired with Power supply
 - .4 Altronix Trove 1M1 – Accommodates up to 4 Mercury Boards
 - .5 Altronix Trove 2M2 – Accommodates up to 8 Mercury Boards
 - .6 Altronix Trove 3M3 – Accommodates up to 16 Mercury Boards

2.8 Electrified Locks

- .1 All electrified locks are provided by others.
- .2 Electrified locks include electric strikes, electric mortise locks, electric latch retraction, maglocks all electrified locks noted on project door hardware schedule and or architectural drawings and schedules.
- .3 Provide a separate power supply for electrified locking devices to facilitate the complete operation of all electrified locks.

PART 3 - EXECUTION

3.1 Coordination

- .1 The ESSC is responsible for the systems specified in this Section, including coordination with related trades.
- .2 Engage a factory-authorized service representative to supervise and assist with startup service. Complete installation and startup checks in accordance with manufacturer's written instructions.

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- .3 Ensure the ESSC coordinate all work and submittal details with the electronic door hardware supplier to ensure proper sizing of control equipment and is responsible for proper sizing of interface equipment (i.e., relays, contact ratings, etc.) to eliminate interface problems.
- .4 Provide the following related work:
 - .1 Coordination of all work related to the door hardware subcontractor, all electrified door hardware, and electrified locks.
 - .2 Provide all interface, wiring, and connections to all electrified door hardware and electrified locks as required to facilitate a complete and operational electronic access control system.
 - .3 Related Electrical Works
 - .4 Related Control Work and/or annunciation
 - .5 All 120 Volt wiring and connections from a power source to terminal strips in electronic low-voltage controllers, power supplies, and devices.
 - .6 Provide cable troughs, raceway, conduits, including all back boxes and pull strings and device-specific and or proprietary and or special back boxes.

3.2 Controllers And Peripheral Devices

- .1 Update all firmware and or reinstall the latest version of firmware on all controllers, credential readers, and all active devices.
- .2 Use tamper-proof security screws to secure credential readers.
- .3 Enable and connect tamper alarms for credential readers, controllers and all supervised active and passive devices.
- .4 Provide and install access control controllers/enclosures as required to house and protect all controllers.
- .5 Ensure all controllers and peripheral devices are installed and configured following the manufacturer's installation instructions and recommendations, as per The City's requirements and as per Contract drawings and specifications.
- .6 Coordinate exact mounting locations of all controllers on-site with the Contract Administrator and City.
- .7 Provide all peripheral devices where indicated on Contract drawings and documents.
- .8 Refer to Architectural Door and Door Hardware Schedules and ensure that each peripheral device is coordinated with its respective door and door hardware.
- .9 Ensure peripheral devices are compatible with the access control system.
- .10 Submit shop drawings of all devices to the Contract Administrator for approval before procurement and installation.
- .11 Allow for "needs assessment sessions" with The City to determine the exact mode/s of operation of each peripheral device.
- .12 Configure each peripheral device and each controller to suit The City's requirements.
- .13 Configure each motion request to exit the device to shunt door contact (magnetic contact) and allow free egress without alarms.

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- .14 Configure permissible door hold open timeframe on doors with auto door operators to 30 seconds. Configure permissible door hold open timeframe on doors without auto door operators to 15 seconds.
- .15 Allow for setup and configuration of card/credential holder database including programming of each credential.

3.3 Power Supply

- .1 Provide power supplies as required for a fully functional access control system. Power supplies include all controller power supplies, all electric lock power supplies, and all peripheral device power supplies.
- .2 All power supplies are installed to the manufacturer's recommendations and as required to furnish a fully functional access control system.
- .3 Ensure power supplies are sized to facilitate the connection of each electrified lock and each powered device to separately fused power output.

3.4 Electric Locks

- .1 Electrified locks include:
 - .1 Electric strikes
 - .2 Magnetic locks/Maglocks
 - .3 Electric mortise locks
 - .4 Electric latch retraction
- .2 Make all wire connections to all electric locks as required for a complete access control system.
- .3 Provide wiring as required for the complete operation of all access control devices and systems.
- .4 Include all costs and work associated with acquiring permits for all magnetic locks.

3.5 Installation

- .1 Install all system components and appurtenances following the respective manufacturer's specifications, referenced practices, guidelines, and applicable codes. Furnish all necessary interconnections, services, and adjustments required for a complete and operable system as specified. Control signal, communications, and data transmission line grounding is installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.
- .2 Install the wiring system and integrate the system as indicated in this specification. All wiring is to be installed in a dedicated conduit throughout. Wiring is not pulled into conduits or placed in raceways, compartments, outlet boxes, junction boxes, or similar fittings with other building wiring.
- .3 All low voltage wiring outside the control console, cabinets, boxes, and similar enclosures, are plenum rated where required by code.
- .4 All wiring conductors is individually numbered and each cable or wiring group being extended from a controller or cabinet to a building-mounted device is identified with the name and number of the particular device.

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- .5 All exposed wiring inside and outside the control console, cabinets, boxes, and similar enclosures, are dressed down neatly and secured with wiring cleats or wire ties.
- .6 Ensure exposed metallic flexible conduit and armored cable is dressed down neatly and secured with low-profile, metal fasteners.
- .7 All cabinets, boxes, and similar enclosures containing security system components and/or cabling and which are easily accessible to employees or the public are provided with a lock. Boxes above ceiling level in occupied areas of the building is not considered to be accessible. Cabinets shall be mounted no higher than 5'10" to the top of the cabinet.
- .8 All junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public is covered with a suitable cover plate and secured with tamper-proof screws.
- .9 Ensure end-of-Line resistors is installed at the field device location and not at the controller location.
- .10 Riser diagrams are schematic and do not show every conduit, wire box, fitting, or other accessories. Provide such materials as necessary for a complete and functioning installation. Install following referenced codes and these specifications. Use weatherproof equipment or covers where installed in areas exposed to the weather.
- .11 Ensure equipment is mounted with sufficient clearance to meet all applicable codes and facilitate observation and testing. All equipment is securely fastened with appropriate fittings to ensure positive grounding and be free of ground loops.
- .12 Determine conductor requirements for each device following the Contract Documents and manufacturer requirements.
- .13 Install cable following Security System manufacturer requirements
- .14 Neatly route cables parallel or perpendicular to building lines.
- .15 Provide J hooks and other cable support systems (spaced at regular intervals) within accessible ceiling spaces. Fasten cables to the cable support systems and provide strain relief to protect cables and ensure compliance with required cable bends.
- .16 Keep cable not run in conduit a minimum of 18" from high voltage (120 VAC and above) circuits (e.g. light fixtures, wire run parallel with conduit, transformers, electric controllers, etc.).
- .17 Run cables at least six inches from the communications cable plant, intercom wires, input/output wires, and siren wires.
- .18 Route wire and cable as required preventing interference and signaling contamination of both Security System cable and cable associated with other systems. Coordinate the routing of wire and cable requiring isolation from power, radio frequency (RF), telephone, etc.
- .19 Provide sleeves and code-compliant fireproofing techniques for all penetrations of fire-rated partitions, masonry walls, and slabs, where the penetrations are made by or used for installation of Security Systems.
- .20 Separate high voltage (120 VAC and above) cables from low voltage cables within enclosures

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- .21 Run wire and cable continuously from the device location to the final point of termination. No mid-run cable splices are allowed
- .22 Bundle and tie wire and cable with cable ties.
- .23 Cover exposed high voltage (120 VAC and above) power terminations within the controller, power distribution cabinets, and other security enclosures.
- .24 Labeled frames, doors, and enclosures
- .25 In no instance any UL labeled door, frame, or enclosure be drilled, cut, penetrated, or modified in any way.
- .26 Setup all data for access control software. Set up software and hardware and provide access to software to City.
- .27 Setup all controller features and access requirements.
- .28 Coordinate with The City and propose start and stop times for schedules, and configure entry schedules to entries.
- .29 Enable and configure alert settings.
- .30 Establish interlocks between alarms, intruder detection, and video surveillance integrations.
- .31 Develop all user-defined fields.
- .32 Create lockdown plans.
- .33 Coordinate with The City and establish badge layout options and design badges.

3.6 Progress Observation

- .1 Contract Administrator conduct progress observations during construction to verify construction progress and verify the construction schedule.
- .2 Contract Administrator conduct the following minimum progress observations:
 - .1 Security Conduit Rough-in and Preliminary Wire and Cable Installation
 - .1 This observation intends to verify that adequate and proper conduit rough-in is installed, verify that wire and cable are being properly installed and labeled, and identify and resolve issues regarding conduit and wire and cable installation.
 - .2 Preliminary Wire Termination Progress
 - .1 This observation intends to verify that installations and equipment are following specifications and standards.
- .3 Observations occur upon initial installation of each type of equipment (i.e. Controllers, Card readers, alarm devices, junction boxes, etc.).
- .4 Observations must be complete before proceeding with the installation of remaining similar or like equipment.
- .5 Coordinate the appropriate timing of each observation with the Contractor, Contract Administrator as required to meet intended goals.
- .6 The reviewers issue reports for each observation to summarize findings and document clarifications noted during the observation.

ACCESS CONTROL

END OF SECTION

INTRUSION DETECTION

PART 1 - GENERAL

1.1 General

- .1 The building's and facility's Intrusion Detection System's primary function is to protect the assets. The contents of this document are critical and are considered confidential. This information is not disclosed to anyone other than authorized personnel.
- .2 Where product model is specified and are deemed discontinued by the product manufacturer, provide the latest manufacturer recommend product model at the time of installation in leu of the specified model.
- .3 Where product performance specifications are provided, provide the latest manufacturer product model at the time of installation.
- .4 All products and materials must be new and approved in the pre-installation submittals.
- .5 Ensure exterior devices are sealed and protected against weather conditions including heat, cold, moisture, dust, and sand.
- .6 Commercial-grade, high quality, and rated for the environment in which it is being installed
- .7 Compatible with the intrusion detection system.

1.2 Purpose

- .1 The intrusion alarm system and accessories form part of the overall security strategy implemented and the system provides the real-time intrusion detection and data transmission.

1.3 Scope

- .1 The work covered by this section includes the furnishing, installation, and activation of all equipment & materials associated with complete intrusion detection systems as specified herein. This work may include, integration with the associated subsystems and components listed in these sections.
- .2 The requirements of the conditions of the Contract, Supplementary Conditions, and General requirements apply to the work specified in this section.
- .3 This system includes components denoted with I on drawings from buttons, sirens, keypads, annunciators' panels and other peripheral devices.
- .4 System shall be based on Bosch.

1.4 References

- .1 Ensure Systems specified in this Section meet or exceed the requirements of the following:
 - .1 Underwriters Laboratories (UL):
 - .1 UL 365 – Police Station Connected Burglar Alarm Units and Systems
 - .2 UL 609 – Local Burglar Alarm Units and Systems
 - .3 UL 1076 – Proprietary Burglar Alarm Units and Systems
 - .4 UL 1610 – Central Station Burglar-Alarm Units

INTRUSION DETECTION

1.5 System Requirement

.1 General

- .1 Provide all intrusion detection system control panels and associated equipment, power supply, cabling, connectors, enclosures, and all other hardware and software to provide a fully operational system.
- .2 These "performance" specifications are to be translated into specific equipment and systems depicting proposed products.
- .3 Ensure the Intrusion Detection system is an interconnected group of components.
- .4 Ensure components are good quality commercial grade consisting of the following devices:
 - .1 Controllers and associated enclosures
 - .2 Communicators and associated enclosures
 - .3 Peripheral devices, Sensors, and accessories
 - .4 Keypads and associated card readers
 - .5 Power supplies

PART 2 - PRODUCTS

2.1 Controllers

- .1 Approved Manufacturer: Bosch
- .2 Approved Product: B9512G
- .2 Zone Expanders
 - .1 Approved Manufacturer: Bosch
 - .2 Approved Product: B208 8 Input expansion module
- .3 Modules
 - .1 Programmable Input Module
 - .2 Programmable Output Module
 - .3 Wireless Telephone Interface & Automation Control Module: As required
 - .4 TC/IP Integration Module IT: As required

2.2 Controller Enclosures

- .1 All controller enclosures are provided to house all controllers.
- .2 All controller enclosures are a single key locking metal box.
- .3 Size as required
- .4 Equipped with door tamper switch. Connect each door tamper switch to the intrusion detection system.
 - .1 Approved product: ICP-EZTS Dual Tamper Switch
- .5 Ensure quantity and size of controller enclosures not exceed the real estate provided for mounting controller enclosures. Refer to Contract drawings and coordinate as such.

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- .6 Approved product: B8108 Enclosure with D101 Cabinet lock.

2.3 Communicators

- .1 Internet/Intranet Alarm Communicator: as required
- .2 GSM/GPRS Wireless Alarm Communicator: as required
- .3 Internet and GSM/GPRS Dual-path Alarm Communicator: as required
- .4 Provide communicators as required

2.4 Peripheral Devices, And Sensors

- .1 Wiring
 - .1 UL/CSA approved
 - .2 FT6 Rated
 - .3 22/4 Stranded or 18/4 Stranded (Manufacturer specification)
- .2 Magnetic Contacts (Steel)
 - .1 GRI 199-12W DPDT 1" Contact
- .3 Magnetic Contacts (Wood)
 - .1 GRI 4545-12WG DPDT 3/8" Contact
- .4 Magnetic Contacts (Overhead Door)
 - .1 GRI 4700-A
- .5 End of Line Resistor Pack
 - .1 GRI 6444-1 Four State EOL Resistor Pack
- .6 Glass Break Detectors:
 - .1 Bosch DS1101i Series Glass break Detectors
- .7 Passive Infrared Motion Detector
 - .1 Bosch ISC-CDL1-W15 Commercial Series Tri-Tech Motion detector
 - .1 Built-in End of line Resistors
- .8 Silent Panic buttons
 - .1 GRI GR3045 Panic Switch Set with Screw Terminals
- .9 Request to Exit Detector
 - .1 Bosch – DS160
- .10 Keypads
 - .1 Master Keypad / Panel:
 - .1 Bosch B930 Alpha-Numeric Keypad

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- .2 Arming Stations:
 - .1 Bosch B915 Alpha-Numeric Keypad
- .3 Enclosure:
 - .1 STI-7510F
- .11 Panel Power Supply
 - .1 16.5 V 75VA Wire In Power Supply, CSA/cUL/ULC Listed
 - .2 16.5 V 40VA Wire In Power Supply, CSA/cUL/ULC Listed
- .2 Auxiliary Intrusion Device Power Supply
 - .1 Bosch B520 2A 12V Power Supply
- .3 Approved Battery Type
 - .1 12V 7AH Yuasa SLA – No Substitutions
 - .2 D122 Battery Harness
- .4 Wiring
 - .1 18/4 or 18/2 Stranded

PART 3 - EXECUTION

3.1 Coordination

- .1 Engage a factory-authorized service representative to supervise and assist with startup service. Complete installation and startup checks in accordance with manufacturer's written instructions.
- .2 Coordinate all installations with related trades.
- .3 Related work required to be provided:
 - .1 Communications (IT)
 - .2 Electrical Works
 - .3 All 120 Volt wiring and connections from power panels to terminal strips in electronic low-voltage panels, power supplies, and devices A

3.2 Controllers And Peripheral Devices

- .1 Ensure all Controllers, Controller enclosures, Communicators, Peripheral Devices, Sensors, and Keypads are installed and configured following manufacturer's installation instructions and recommendations, as per the Owners' requirements and as per Contract drawings and specifications.
- .2 Coordinate the exact mount location of all Controllers, Controller enclosures, Communicators, Peripheral Devices, Sensors, and Keypads to ensure that all conduits and back boxes are installed in the optimal locations.
- .3 Coordinate exact mounting locations of all controllers and devices on-site with the Contract Administrator and City. Cabinets shall be mounted no higher than 5'10" to the top of the cabinet.

INTRUSION DETECTION

- .4 Provide all Controllers, Controller Enclosures, Communicators, Peripheral Devices, Sensors, and Keypads where indicated on Contract drawings and documents and as required for a complete and operational intrusion detection system.
- .5 All Controllers, Controller Enclosures, Communicators, Peripheral Devices, Sensors, and Keypads are inter-compatible.
- .6 Submit shop drawings of all Controllers, Controller Enclosures, Communicators, Peripheral Devices, Sensors, and Keypads to the Contract Administrator for approval before procurement and installation.
- .7 Allow for “needs assessment sessions” with The City to determine the exact mode of operation for each Controller, Controller enclosure, Communicator, Peripheral Device, Sensor, and Keypad.
- .8 Configure each Controller, Controller Enclosure, and Communicator, Peripheral Device, Sensor, and Keypad to suit the Owners' requirements.

3.3 Power Supply

- .1 System Power – The Intrusion Alarm System operate using standard 120 volts AC, 50/60 Hz power.
- .2 Supply and install power supplies as required for a fully functional intrusion detection system. Power supplies include all controller power supplies, all peripheral device power supplies.
- .3 Ensure systems have a minimum of Control Primary Power and Backup Battery. The battery is able to support the system and devices for 24 hours of continuous operation.
- .4 The battery input, auxiliary, and alarm outputs are protected using PTC circuit breakers. All outputs are power limited.
- .5 All power supplies are installed to manufacturer's recommendations and as required to furnish a fully functional intrusion detection system

3.4 Installation

- .1 Install the wiring system and integrate the system as indicated in this specification.
- .2 All equipment is wall-mounted with sufficient clearance to meet all applicable codes and facilitate observation and testing. All equipment is securely fastened with appropriate fittings to ensure positive grounding and be free of ground loops.

END OF SECTION

VIDEO SURVEILLANCE

PART 1 - GENERAL

1.1 Purpose

- .1 The building's and facility's Network Video Management System's primary function is to protect the assets. The contents of this document are critical and are considered confidential. Ensure this information is not disclosed to anyone other than authorized personnel.
- .2 The Network Video Management Systems (NVMS) system, cameras, and accessories form part of the overall security strategy implemented and the system provide real-time video surveillance, recording of real-time events and historical video data for video evidence of a security event; and to provide a deterrent throughout the facility.

1.2 Scope Of Work

- .1 The work covered by this section includes the furnishing, installation, and activation of all equipment & materials associated with provision of a complete turnkey NVMS as specified herein. This work may include integration with the associated subsystems and components listed in these sections.
- .2 Provide new equipment, cabling, devices, software, hardware, licences, integration with other systems, testing & commissioning.
- .3 The requirements of the conditions of the Contract, Supplementary Conditions, and General requirements apply to the work specified in this section.
- .4 Coordinate with City, and install, configure, program and commission all components of the NVMS system, even for City supplied equipment.
- .5 Coordinate with City, use City provided material to install Video surveillance system.

PART 2 - PRODUCTS

2.1 General

- .1 Where product model is specified and are deemed discontinued by the product manufacturer, provide the latest manufacturer recommend product model at the time of installation in lieu of the specified model.
- .2 Where product performance specifications are provided, provide the latest manufacturer product model at the time of installation.
- .3 Exterior devices are sealed and protected against weather conditions including heat, cold, moisture, dust, and sand.
- .4 Commercial-grade, high quality, and rated for the environment in which it is being installed
- .5 Compatible with the video surveillance system.
- .6 All products and materials must be new and approved in the pre-installation submittals. Provide all equipment for a complete and operational IP-based Security Video Surveillance System. Provide City with the necessary licenses as required for a complete and operational IP-based video surveillance system.

VIDEO SURVEILLANCE

2.2 Power Supply

- .1 Power supplies for Video Surveillance cameras are powered to a maximum of 80% load. Add power supply specifications meeting the project-specific requirement.
 - .1 Indoor Single Camera Power Supplies
 - .1 Capacity – 4 Amps, (50VA)
 - .2 Output – 24 VAC output for 1 camera Fused output
 - .3 Input – 120 VAC input.
 - .4 Enclosure – Indoor
 - .2 Indoor Multiple Camera Power Supplies
 - .1 Multiple cameras – 24/28VAC power supply unit and cabinet
 - .2 Output Capacity – 20 amp capacity
 - .3 Output – multiple camera circuits
 - .4 Enclosure – Surface NEMA /19" Rack mounted
 - .3 Outdoor Camera Power Supplies
 - .1 Capacity – 4 Amps
 - .2 Output – 24/28 VAC for 1 camera.
 - .3 Input – 120 VAC or 230 VAC selectable input.
 - .4 Enclosure – NEMA 4/IP66 weatherproof

PART 3 - EXECUTION

3.1 Coordination

- .1 Provide the following related work:
 - .1 Communications (IT)
 - .2 Electrical Works
 - .3 All 120 Volt wiring and connections from power panels to terminal strips in electronic low-voltage panels, power supplies, and devices.
 - .4 All raceway, conduit to the device(s), including all back boxes and pull strings, and the installation of all special back boxes.

3.2 Cameras And Accessories

- .1 Install camera housing and mounting accessories for the complete operation of the videos surveillance system.
- .2 Coordinate exact mounting locations of all cameras on-site with the Contract Administrator and City.
- .3 Submit shop drawings to the Contract Administrator for review before procurement and installation.
- .4 Allow for “needs assessment sessions” with the City to determine the exact camera settings.

VIDEO SURVEILLANCE

3.3 Power Supply

- .1 Provide power supplies as required for a fully functional video surveillance system.
- .2 All power supplies are installed to the manufacturer's recommendations.

3.4 Installation

- .1 Provide all Video Surveillance system wiring, devices, and software as required for a complete and operational Video Surveillance System.
- .2 All camera installation, configuration, setup, program, and related work is performed by technicians thoroughly trained by the manufacturer in the installation and service of the equipment provided.
- .3 Use camera brackets/mounts provided by City to mount all cameras to suit Owners desired mounting methods.
- .4 Carefully follow instructions in documentation provided by the manufacturer to ensure all steps have been taken to provide a reliable, easy-to-operate system.
- .5 All equipment is tested and configured following instructions provided by the manufacturer before installation.
- .6 All firmware found in Video Surveillance System active devices is the latest and most up-to-date provided by the manufacturer.
- .7 All equipment requiring users to log on using a password is configured with user/site-specific password/passwords. No system/product default passwords are allowed.
- .8 Final camera viewing requirements to be determined by The City. Coordinate with The City and obtain viewing parameters for each Video Surveillance Camera. Adjust all Video Surveillance cameras to meet The City's requirements.
- .9 Adjust each Video Surveillance camera to obtain the best quality image or Video Surveillance camera image that is acceptable to The City.
- .10 All domes must have the password protection feature enabled to protect against unauthorized changes to dome programming. All PTZ domes are operated in continuous mode running an operator-defined pattern, pre-set tour, or combination pattern/pre-set tour. PTZ dome movement criteria are to be coordinated with the System Operator(s) and Contract Administrator to ensure camera coverage meets defined needs. PTZ domes must be programmed for "auto-resume" after a pre-defined period and on power-up.
- .11 The Contract Administrator conduct progress observations during construction to verify construction progress and verify the construction schedule. Coordinate progress observation site visits with the Contract Administrator.

3.5 Progress Observation

- .1 The Contract Administrator conduct progress observations during construction to verify construction progress and verify the construction schedule. Coordinate progress observation site visits with the Contract Administrator.

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- .2 Security Conduit Rough-in and Preliminary Wire and Cable Installation
 - .1 This observation intends to verify that adequate and proper conduit rough-in is installed, verify that wire and cable are being properly installed and labeled, and identify and resolve issues regarding conduit and wire and cable installation.
- .3 Preliminary Wire Termination Progress
 - .1 This observation intends to verify that the installations and terminations to equipment are following specifications and standards.
- .4 Observations occur upon initial installation of each type of equipment (i.e. Panels, Card readers, alarm devices, junction boxes, etc.).
- .5 Observations must be complete before proceeding with the installation of remaining similar or like equipment.
- .6 Coordinate appropriate timing of each observation with the Contractor, Contract Administrator as required to meet intended goals.
- .7 The reviewers issue reports for each observation to summarize findings and document clarifications noted during the observation.

END OF SECTION

ELECTRONIC PERSONAL PROTECTION SYSTEM

PART 1 - GENERAL

1.1 PURPOSE

- .1 The Electronic Personal Protection System (EPPS) facilitates emergency communication between Duress-Panic Alarms system components.

1.2 SCOPE OF WORK

- .1 Provide a complete turnkey EPPS.
- .2 The work covered by this section includes the furnishing, installation, and activation of all equipment & materials associated with complete EPPS as shown and as specified herein. This work may include, integration with the associated subsystems and components listed in these sections.
- .3 This system includes components denoted with P on drawings from buttons, sirens, keypads, annunciators panels and other peripheral devices.
- .4 System shall be based on DSC.

PART 2 - PRODUCTS

2.1 GENERAL

- .1 All equipment is rated for continuous operation. Environmental conditions (i.e. temperature, humidity, wind, and seismic activity) is taken under consideration at each facility and site location before installation of the equipment.
- .2 Ensure duress alarm system is installed, and programmed in a manner that allow for ease of operation, programming, servicing, maintenance, testing, and upgrading of the system.
- .3 Provide wire/cable recommended and approved by the OEM. Ensure Cabling meets the interconnecting wiring requirements of NFPA 70.
- .4 Systems are scalable and allow expansion as required.
- .5 All hardwired alarms, switches, and junction boxes are protected from tampering and include line supervision.
- .6 The installation and placement of devices in strategic locations also requires that signage be posted near these devices.
- .7 All system components are designed to provide continuous electrical supervision of the complete and entire system.
- .8 Ensure all alarm and initiating and signaling circuits is supervised for open circuits, short circuits, and system grounds. When an open, short or ground occurs in any system circuit, an audible and visual fault alarm signal is initiated at the master control station and all remote locations.
- .9 The system consists of the components to constantly monitor and verify alarm activation; identify zone of activation and location of activation.
- .10 Audible Signal Device for Duress: Provides alarm activation and audible sound for alarms, as well as supervisory and trouble signals that is distinctive.

ELECTRONIC PERSONAL PROTECTION SYSTEM

- .11 Assessment: This ability consists of electronic devices required to visually and audibly verify the validity of alarms. The assessment also includes providing an indication of tampering, fail-safe, low battery, and power losses.

2.2 Controller

- .1 Approved Manufacturer:
 - .1 DSC
- .2 Approved Product:
 - .1 Neo HS 2032
- .3 Modules
 - .1 Programmable Input Module
 - .2 Programmable Output Module
 - .3 Wireless Telephone Interface & Automation Control Module: As required
 - .4 TC/IP Integration Module IT: As required
- .4 Controller Enclosures
 - .1 All controller enclosures are provided to house all controllers.
 - .2 All controller enclosures are a single key locking metal box.
 - .3 Size as required
 - .4 Equipped with door tamper switch. Connect each door tamper switch to the intrusion detection system.
 - .5 Ensure quantity and size of controller enclosures not exceed the real estate provided for mounting controller enclosures. Refer to Contract drawings and coordinate as such.

2.3 Graphic Annunciator

- .1 Location: As indicated on drawings.
- .2 Quantity: As indicated on drawings.
- .3 Approved product:
 - .1 DSC HSM3632C Control Panel, 32-point Graphic Annunciator
 - .2 Provide all mounting hardware and brackets as required to achieve desired installation

2.4 Keypad

- .1 DSC HS2LCD Keypad

2.5 Siren/Strobes

- .1 ADI PRO 0E-OUTDSIRSA
 - .1 Tune output sound level to suit specific installation location

ELECTRONIC PERSONAL PROTECTION SYSTEM

- .2 Confirm Lens color with City prior to ordering material
 - .1 Siren Lens Color for EPP system denoted with P shall be different than siren lens color for intrusion system denoted with I
- .3 Coordinate with Division 26 and provide necessary power for proper operation of Siren/Strobes

2.6 Surface Mount Button:

- .1 STI SS2224EM-EN
 - .1 Confirm color with City prior to ordering material
 - .2 Confirm Print/Message on device with City prior to ordering material

PART 3 - EXECUTION

3.1 Devices

- .1 Ensure all devices are installed, configured, and programmed following the manufacturer's installation instructions and recommendations, as per The City's requirements and as per Contract drawings and specifications.
- .2 Ensure all devices, software, firmware, and warranty are registered in the sole name of and is in the sole ownership of The City.
- .3 Coordinate the exact mount location of devices on-site to ensure that all conduits and back boxes are installed in the optimal locations.
- .4 Provide devices as indicated on Contract drawings and documents.
- .5 Provide all wiring as indicated on Contract drawings and documents and as required to provide a complete turnkey duress alarm system.
- .6 Ensure all devices are compatible with the duress alarm system.
- .7 Submit shop drawings of all devices to the Contract Administrator for approval before procurement and installation.
- .8 Allow for "needs assessment sessions" with The City to determine the exact mode/s of operation of each and system
- .9 Configure each device to suit The City's requirements.
- .10 Provide power supplies as required for a fully functional duress alarm system.

3.2 Installation

- .1 Engage a factory-authorized service representative to supervise and assist with startup service. Complete installation and startup check in accordance with manufacturer's written instructions.
- .2 Install all system components and appurtenances following the respective manufacturer's specifications, referenced practices, guidelines, and applicable codes. Furnish all necessary interconnections, services, and adjustments required for a complete and operable system as specified.
- .3 Provide, install and configure all equipment, wiring, software, and software licenses to provide all systems configuration requirements and all system performance requirements as indicated in this section.

ELECTRONIC PERSONAL PROTECTION SYSTEM

- .4 Install the wiring system and integrate the system as indicated in this specification. All wiring is to be installed in a dedicated conduit throughout. Ensure wiring is not be pulled into conduits or placed in raceways, compartments, outlet boxes, junction boxes, or similar fittings with another building wiring.
- .5 All low voltage wiring is plenum rated where required by code.
- .6 Ensure all wiring conductors are individually numbered and each cable or wiring group being extended from a panel or cabinet to a building-mounted device is identified with the name and number of the particular device.
- .7 All exposed wiring inside and outside the control console, cabinets, boxes, and similar enclosures, are dressed down neatly and secured with wiring cleats or wire ties.
- .8 All cabinets, boxes, and similar enclosures containing security system components and/or cabling and are easily accessible to employees or the public is provided with a lock. Boxes above ceiling level in occupied areas of the building is not be considered to be accessible.
- .9 Ensure all junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public is covered with a suitable cover plate and secured with tamper-proof screws.
- .10 Riser diagrams are schematic and do not show every conduit, wire box, fitting, or other accessories. Provide such materials as necessary for a complete and functioning installation. Install following referenced codes and these specifications. Use weatherproof equipment or covers where installed in areas exposed to the weather.
- .11 All equipment is mounted with sufficient clearance to meet all applicable codes and facilitate observation and testing. Ensure all equipment are securely fastened with appropriate fittings to ensure positive grounding and be free of ground loops.
- .12 Determine conductor requirements for each device following the Contract Documents and manufacturer requirements.
- .13 Route wire and cable as required preventing interference and signaling contamination of both Security System cable and cable associated with other systems. Coordinate the routing of wire and cable requiring isolation from power, radio frequency (RF), telephone, etc.
- .14 Provide sleeves and code-compliant fireproofing techniques for all penetrations of fire-rated partitions, masonry walls, and slabs, where the penetrations are made by or used for installation of Security Systems.
- .15 Separate high voltage (120 VAC and above) cables from low voltage cables within enclosures
- .16 Run wire and cable continuously from the device location to the final point of termination. No mid-run cable splices are allowed
- .17 Bundle and tie wire and cable with cable ties.
- .18 Cover exposed high voltage (120 VAC and above) power terminations within DGP's, power distribution cabinets, and other security enclosures.
- .19 Ensure system installation is following NFPA 731 Standards for the Installation of Electric Premises Security Systems and appropriate installation manual for each type of subsystem designed, engineered, and installed.

ELECTRONIC PERSONAL PROTECTION SYSTEM

- .20 Ensure the location and type of duress alarm station are following physical security requirements as shown in the security systems layout drawings.
- .21 Wall, column, and pole-mounted stations are mounted to meet AODA requirements and use tamper-proof bolts and screws.
- .22 Cleaning: After installation, clean each system component of dust, dirt, grease, or oil incurred during installation following the manufacturer's instructions.
- .23 Adjustment/Alignment/Synchronization: prepare for system activation by following the manufacturer's recommended procedures for adjustment, alignment, or programming. Prepare each component following appropriate provisions of the component's installation, operations, and maintenance instructions.
- .24 Upon project commencement, provide qualified technical personnel on-site. Personnel are present on each consecutive working day until the system is fully functional and ready to begin the testing phase of this project.
- .25 During the installation process maintain an up-to-date set of as-built shop drawings, which is always be available for review by The City and/or Contract Administrator. This set of documents should be annotated with as-built data as the work is performed. These documents are reviewed as part of the approval process when evaluating payment request applications. At a minimum, the drawings should contain the following information:
 - .1 Quantity and location of all equipment installed.
 - .2 Cable and wire run along with the designation tags assigned to each.
 - .3 Wiring diagrams that indicate terminal strip layout, identification, and terminations.
- .26 Maintain continuous coordination with the Contract Administrator. Ensure the engineers are kept informed of the progress and all conflicts that arise during this project.
- .27 Coordinate all proprietary intercom substation back boxes for rough-in.
- .28 All installation, configuration, setup, program, and related work is performed by technicians thoroughly trained by the manufacturer in the installation and service of the equipment provided.
- .29 Install all devices and wiring as recommended by the intercom system manufacture.
- .30 Coordinate with The City, configure and program the system as required to suit operations of the facility as directed by The City.
 - .1 Coordinate the exact mount location of devices to ensure that all conduits and back boxes are installed in the optimal locations.
 - .2 Submit shop drawings to the Security Engineer's Representative for review before procurement and installation.

ELECTRONIC PERSONAL PROTECTION SYSTEM

- .3 Ensure all power supplies are installed to the manufacturer's recommendations. Provide power supplies where not shown on drawings but are required for complete operating of duress alarm system components. Provide all wiring from power supplies to each duress alarm station. All power supplies are centralized and located in the telephone room. Provide 120V 15A circuits from the electrical panel to power supplies.
- .4 Carefully follow instructions in documentation provided by the manufacturer to ensure all steps have been taken to provide a reliable, easy-to-operate system.
- .5 Ensure all equipment are tested and configured following instructions provided by the manufacturer before installation.
- .6 All equipment requiring users to log on using a password is configured with user/site-specific password/passwords. No system/product default passwords are allowed.

3.3 Progress Observation

- .1 Ensure Contract Administrator conduct progress observations during construction to verify construction progress and verify the construction schedule.
- .2 Contract Administrator conduct the following minimum progress observations:
 - .1 Security Conduit Rough-in and Preliminary Wire and Cable Installation
 - .1 This observation intends to review conduit rough-in, wires, and cables being installed and labeled, and identify and resolve issues regarding conduit and wire and cable installation.
 - .2 Preliminary Wire Termination Progress
 - .1 This observation intends to verify that review the installation and termination of equipment and following specifications and standards.
- .3 Observations occur upon the initial installation of each type of equipment.
- .4 Observations must be complete before proceeding with the installation of remaining similar or like equipment.
- .5 Coordinate appropriate timing of each observation with the Contractor, Contract Administrator as required to meet intended goals.
- .6 The reviewers issue reports for each observation to summarize findings and document clarifications noted during the observation.

END OF SECTION

ELECTRONIC SAFETY AND SECURITY SYSTEMS INTEGRATION

PART 1 - GENERAL

1.1 Configuration

- .1 For Recreation Center: by City.
- .2 For Child care center: by Others

PART 2 - PRODUCT

2.1 General

- .1 Where product model is specified and are deemed discontinued by the product manufacturer, provide the latest manufacturer recommend product model at the time of installation in leu of the specified model.
- .2 Where product performance specifications are provided, provide the latest manufacturer product model at the time of installation.
- .3 All products and materials must be new and approved in the pre-installation submittals.
- .4 Ensure exterior devices are sealed and protected against weather conditions including heat, cold, moisture, dust, and sand.
- .5 Commercial-grade, high quality, and rated for the environment in which it is being installed
- .6 Compatible with the system.

2.2 Keyboard Video Mouse (KVM)

- .1 Tripp LiteB030-008-17-IP complete with all cables to connect all servers or approved equal.

2.3 Uninterruptable Power Supply (UPS)For Recreation Center: by City

- .2 For Child Care Center: by Others

PART 3 - EXECUTION

3.1 Source Codes

- .1 The City becomes the owner of all proprietary and open source codes, software and programing developed under this project. Provide The City with all source codes, software, programing, configuration data and all relative passwords and keys developed and or generated under this project. Ensure The City has full and unhindered access to all source codes, software, programing, configuration data and all relative passwords and keys developed and or generated under this project.

3.2 Cyber Security

- .1 Coordinate with City's Information Technology representatives, obtain a copy of City's cyber security policy and provide all applicable cyber security configurations. Definitions
 - .1 Cyber Assets: Systems (including hardware, software, and data) and communication networks (including hardware, software, and data).

ELECTRONIC SAFETY AND SECURITY SYSTEMS INTEGRATION

- .2 Critical Cyber Assets: Cyber assets that perform critical system functions. The loss or compromise of these cyber assets would adversely affect the operational reliability of the system.
- .3 Cyber Attack: The use of electronic means to interrupt, manipulate, destroy, or gain unauthorized access to a computer system, network, or device.
- .4 Cybercrime: Any crime where cyber – the internet and information technologies, such as software, firmware, computers, tablets, personal digital assistants or mobile devices – has a substantial role in the commission of a criminal offence.
- .5 Cyber Hygiene: Practices and steps that users of computers and other devices take to maintain system health and improve online security. These practices are often part of a routine to ensure the safety of identity and other details that could be stolen or corrupted.
- .6 Cyber Incident: Any unauthorized attempt, whether successful or not, to gain access to, modify, destroy, delete, or render unavailable any computer network or system resource.
- .7 Cyber Security: Technologies, processes and practices designed to protect networks, devices, programs, and data from attack, damage, or unauthorized access.
- .8 Cyber Threat or Cyber Security Threat: Malicious act that seeks to damage data, steal data, or disrupt digital life in general. Cyber threats include computer viruses, data breaches, Denial of Service (DDoS / DoS) attacks and other attack vectors.
- .9 Cyber Threat Actors: Broad term for any states, groups, or individuals who, with malicious intent, aim to take advantage of vulnerabilities, low cyber-Security awareness, and technological developments to gain unauthorized access to information systems to access or otherwise affect victims' data, devices, systems and networks.
- .10 IP Multicast: Technique for one-to-many and many-to-many real-time communication over an IP Infrastructure network.
- .11 Endpoint: Remote computing device that communicates back and forth with a network to which it is connected. Such as a server, desktop, or laptop.
- .12 Network Certificates: Also known as a Digital Certificates, which are an electronic "password" that allows a person or organization to exchange data securely over the internet using the public key infrastructure (PKI). Digital Certificates are also known as a public key certificate or identity certificate. There are 3 Main types of certificates:
 - .1 Secure Socket Layer Certificate (SSL) Digi-SSL
 - .2 Software Signing (Code Signing Certificate) Digi-Code
 - .3 Client Certificate (Digital ID) Digi-ID
- .13 Social Engineering: Exploitation methods that target human vulnerabilities, such as carelessness and trust.
- .14 Technical Vulnerabilities: Weaknesses or flaws in the design, implementation, operation, or management of an information technology system, device, or service.

ELECTRONIC SAFETY AND SECURITY SYSTEMS INTEGRATION

3.3 Cyber Security Measures

- .1 Implement at minimum the following multi-layered Cyber Security measures to limit and / or reduce the City's potential risk from a cyber threat event; such as a Cyber Security data breach or Cyber Security attack.
- .2 Password Management
 - .1 Employ password management best practices such as:
 - .1 Do not use default passwords.
 - .2 Use strong and unique passwords for all applications. Use a minimum of 8 characters where there is no password policy inherent in the software; use a mixture of uppercase and lowercase letters, numbers, and include at least one special character (! @ # ?]).
 - .3 Reset passwords at regular intervals.
 - .4 Configure two-factor authentication for all accounts where possible in the system software.
 - .5 Do not use System Admin logins for simple tasks; create separate User accounts with rights levels appropriate for the job function. Create and define user accounts as appropriate such as Role based, Individual logins or assigned roles.
 - .6 Use different passwords for every account
 - .7 Enforce secure password policies within the business environment.
 - .8 Have interface lock after a predefined # of failed login attempts for a predetermined time interval.
 - .2 Port and Interface Management
 - .1 Employ Port Management techniques such as:
 - .1 Restrict access on network switch ports to assigned devices addresses.
 - .2 Lock down all open, unused and unsecure ports on the networking devices such as switches, routers, and firewalls.
 - .3 Shut off all unused communication services and hardware interfaces.
 - .4 Advise City on use of 3rd party port security monitoring.
- .3 Physical and Virtual Networks
 - .1 Provide a dedicated VLAN for the network connected systems where a dedicated LAN has not been provided.
- .4 Encryption
 - .1 Use minimum TLS 1.2 for all network attached equipment and use TLS 1.3 where available.

ELECTRONIC SAFETY AND SECURITY SYSTEMS INTEGRATION

- .5 Network Certificates
 - .1 Ensure Network Certificates are up to date and not expired for all equipment and systems.
- .6 Firmware & Software Update Management
 - .1 Use the latest stable Firmware / Software version on all devices / equipment as well as implement a Firmware / Software Update management process and procedure.
- .7 Manufacturer's System Hardening Guides
 - .1 Provide the Manufacturer's System hardening guides for the equipment being installed and implement as many recommendations / features as possible.
- .8 External Memory
 - .1 Restrict the use of external memory. Restrict or eliminate the use of devices such as external USB Thumb drives unless expressly allowed by The City's Information Technology representatives.
- .9 Log Off
 - .1 Enable auto-log off timer for all software, websites and logins. Set auto-log off timer on local Workstation(s) being used to access the equipment with a reasonable timer in the case that an employee leaves the workstation unattended.
- .10 Anti-Virus Software
 - .1 Enable and configure anti-virus software on PC endpoints in accordance with The City's Information Technology requirements, unless it is to be installed and configured by The City.
- .11 Filtering Techniques
 - .1 Apply filtering techniques including the types listed below where possible:
 - .1 Web Filtering: A Web filter adds another layer to anti-phishing defences by blocking the web-based component of phishing and malware attacks.
 - .2 Multicast Message Filtering: Filters the packets sent to multicast groups users are not subscribed to.
 - .3 Content Filtering: Is the use of a program to screen and / or exclude access to web pages or email deemed objectionable. Ensure a content filter is used to block access to this content.
- .12 Back up Regularly
 - .1 Provide backup schedule in the closeout submittals and configure system for automatic backups wherever possible.
 - .2 Identify files that require manual backup and the backup procedure. This helps to protect against many types of data loss, especially if a Cyber Threat Actor gains access.

ELECTRONIC SAFETY AND SECURITY SYSTEMS INTEGRATION

3.4 IT Devices and Systems

- .1 Apply the Cyber security measures listed in the clauses above in part or in full, as possible, to a wide range of Information Technology (IT) Devices including:
 - .1 Firewalls
 - .2 Routers
 - .3 Network switches (Core and Edge Devices)
 - .4 Servers and databases
 - .5 Workstation computers
 - .6 Network connected system devices and controllers
 - .7 Wireless Access Points and wireless controllers
 - .8 Mobile phones and tablets
 - .9 Any IT System or endpoint connected to the network

3.5 Operational Technology (OT) Devices and Systems

- .1 Apply the Cyber security measures listed in the clauses above, in part or in full, as possible, to a wide range of OT Network devices including:
 - .1 Industrial Control Systems such as:
 - .1 (PLC's) Programmable Logic Controllers are an industrial digital computer which has been ruggedized and adapted for the control of manufacturing processes, such as assembly lines, or robotic devices.
 - .2 (SCADA) Supervisory Control and Data Acquisition is a control system architecture comprising of computers, networked data communications and graphical user interfaces (GUI) for high level process supervisory management.
 - .3 (DCS) Distributed Control System is a computerized control system for a process or plant usually with many control loops, in which autonomous controllers are distributed throughout the system.
 - .4 (CNC) Computer numerical Control is the automated control of machining tools (Drills, boring tools, lathes) and 3D printers by means of a computer.
 - .2 Building Management Systems (BMS) and Building Automation Systems (BAS)
 - .3 HVAC equipment
 - .4 Lighting controls for both internal and external applications
 - .5 Energy monitoring and metering equipment
 - .6 Transportation and parking systems
 - .7 Scientific equipment
 - .8 Any other OT System or endpoint that can be connected to the network

3.6 Report Cybercrime

- .1 Advise The City and / or their representatives of any indication of a Cyber Incident of a criminal nature when performing any work on a network connected system.

ELECTRONIC SAFETY AND SECURITY SYSTEMS INTEGRATION

3.7 Cyber Security Report Letter

- .1 Provide a Cyber Security Report Letter in the closeout documents to The City stating which Cyber Security measures have been implemented, when implementing any and / or all of the Cyber Security Measures mentioned in this Specification.

END OF SECTION

INTERCOM SYSTEM

PART 1 - GENERAL

1.1 Purpose

- .1 The purpose of the Security Intercom System is to provide fast "duplex," (hands-free at both ends) communication as required to provide instant intercommunications for employees and visitors, emergency paging and signaling, alarm distribution, and audio program distribution. The system assists with personnel safety, facility security, security systems integration, operational efficiency, and maintenance functions.

1.2 Scope Of Work

- .1 The work covered by this section includes the furnishing, installation, and activation of all equipment & materials associated with the complete IP intercom system as shown and as specified herein. This work may include integration with the associated subsystems and components listed in these sections.

1.3 Systems Requirement

.1 PERFORMANCE REQUIREMENTS

- .1 Ensure the Intercom system are IP based.
- .2 The central exchange is connected in such a matter to create a single system. All necessary data, video and audio routing within the systems is via IP or other communicating protocols with the necessary software licenses based on the systems design. No additional proprietary hardware is necessary to do the networking between exchanges
- .3 Ensure systems consists of duplex master stations with direct access buttons, with or without buttons. Each master station calls all other stations within the systems unless specifically blocked or restricted through programming.
- .4 Ensure the master stations are desk, flush or surface wall mounted, or rack mounted as shown on the plans.
- .5 Ensure Substations are flush or surface mounted, tamper and weather resistant where needed and located as required for direct access calling masters.
- .6 Ensure the systems includes a master control station at or near the central exchange to function as system maintenance and fault indication station.
- .7 Ensure all features and functions is programmed on site with a standard PC via IP and or from master stations.

1.4 Intercom System Function Requirements

- .1 A designated group of master stations can be called from any door station; any designated master can answer the call.
- .2 A designated group master stations can be called from any substations; any designated master can answer the call. External speaker and emergency call button can also be added.
- .3 A designated group of up to the full capacity of the system with any mix of master stations and door stations can be called from a master station. System needs to be pre-programmed to function.

INTERCOM SYSTEM

- .4 Call (Communication) Transfer: A master station can transfer a conversation to any master station within the system.
- .5 Call Forwarding: Incoming calls can be automatically forwarded to another receiving station or telephone. The receiving station number or telephone number can be registered at the original forwarding station. Ensure unit number is assigned to each telephone number.
- .6 Time-Based Call Forwarding: All incoming calls to the original station can be automatically rerouted to a designated master station or telephone number during a specific period of the day.
- .7 No Answer Call Forwarding: Calls to the original station are automatically rerouted to a designated receiving station if the called party does not respond within a pre-set period of time.
- .8 Monitoring: Any door, room or substation can be monitored from a master station. A master station can also disable this function if monitoring is not necessary.
- .9 Scan Monitoring: Any pre-programmed door stations or room sub stations can be scan monitored.

PART 2 - PRODUCT

2.1 General

- .1 Where product model is specified and are deemed discontinued by the product manufacturer, provide the latest manufacturer recommend product model at the time of installation in leu of the specified model.
- .2 Where product performance specifications are provided, provide the latest manufacturer product model at the time of installation.
- .3 All products and materials must be new and approved in the pre-installation submittals.
- .4 Ensure exterior devices are sealed and protected against weather conditions including heat, cold, moisture, dust, and sand.
- .5 Commercial-grade, high quality, and rated for the environment in which it is being installed
- .6 Compatible with the intercom system.

2.2 Approved System

- .1 Approved manufacturers
 - .1 Intercom: Aiphone

2.3 Master Station

- .1 Manufacturer
 - .1 Intercom: Aiphone IX-MV7-HB-L

2.4 Substation

- .1 Manufacturer
 - .1 Intercom: Aiphone IX-DV Series

INTERCOM SYSTEM

2.5 Relays

- .1 Provide controllers and or relays to integrate the intercom system with the access control and door release.
 - .1 Intercom: Aiphone IXW-MA or equivalent

2.6 Wiring

- .1 Provide all intercom system manufacturer recommended wiring to facilitate a complete turnkey intercom system.

2.7 Power Supply

- .1 Provide all intercom system manufacturer recommended power supply to facilitate a complete turnkey intercom system.

2.8 Software Licence

- .1 Provide all intercom system manufacturer recommended software licence to facilitate complete turnkey systems.

PART 3 - EXECUTION

3.1 Installation

- .1 Engage a factory-authorized service representative to supervise and assist with startup service. Complete installation and startup checks in accordance with manufacturer's written instructions.
- .2 Upon project commencement, Provide qualified technical personnel on-site. Ensure personnel are present on each consecutive working day until the system is fully functional and ready to begin the testing phase of this project.
- .3 During the installation process maintain an up-to-date set of as-built shop drawings, which is always be available for review by The City and/or Contract Administrator. This set of documents should be annotated with as-built data as the work is performed. These documents are reviewed as part of the approval process when evaluating payment request applications. At a minimum, the drawings should contain the following information:
 - .1 Quantity and location of all equipment installed.
 - .2 Cable and wire run along with the designation tags assigned to each.
 - .3 Wiring diagrams that indicate terminal strip layout, identification, and terminations.
- .4 Maintain continuous coordination with the Contract Administrator. Ensure the engineers are kept informed of the progress and all conflicts that arise during this project.
- .5 Provide all proprietary intercom substation back boxes for rough-in.
- .6 Provide and install all wiring as required.
- .7 All installation, configuration, setup, program, and related work is performed by technicians thoroughly trained by the manufacturer in the installation and service of the equipment provided.
- .8 Install all devices and wiring as specified by the intercom system manufacture.

INTERCOM SYSTEM

- .9 Provide and install all intercom control units, add-on control units, and all miscellaneous hardware for a complete turnkey intercom system.
- .10 Provide and install all master intercom stations and intercom substations as indicated on Contract documents.
- .11 Coordinate with The City, configure and program the intercom system as required to suit operations of the facility as directed by The City.

END OF SECTION