

PROJECT MANUAL – Volume 2

Mechanical and Electrical Specifications

Issued for Tender

East Hants Aquatic Centre
East Hants, Nova Scotia

Project No. RFC50186

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MECHANICAL SPECIFICATION

PROJECT NAME:

EAST HANTS AQUATIC CENTRE

ENFIELD, NOVA SCOTIA

PROJECT NUMBER:

RFC50186

DATE:

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ISSUED :

FOR TENDER

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END OF SECTION

General Instructions for Mechanical Sections

PART 1 - GENERAL**1.1 Work Included**

- .1 Conform to the requirements of Division 1, which applies to and forms part of all sections of the work.
- .2 The Specification is divided into Sections which are not intended to identify contractual limits between Subcontractors nor between the Contractor and his 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. 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.
- .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 Mechanical Sections.

1.4 Regulations

- .1 Work shall be performed in accordance with codes, rules, regulations, by-laws and requirements of the authorities having jurisdiction.
- .2 The plumbing and drainage systems shall comply with regulations respecting plumbing made under the Nova Scotia Building code except as modified by rules, regulations and by-laws of authorities having jurisdiction.
- .3 Natural gas systems shall be in accordance with the Gas Protection Act and Installation Code of Natural Gas Burning Appliances and Equipment Code CAN-CSA-B149.
- .4 These specifications are supplementary to the requirements above.
- .5 Drawings and specifications should not conflict with the above regulations but where there are apparent discrepancies the Contractor shall notify the Consultant.

General Instructions for Mechanical Sections

1.5 Permits, Fees Inspection

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

1.6 Drawings, Changes and Installation

- .1 The Drawings shall be considered 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 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 Consultant to make reasonable changes required to accommodate conditions arising during the progress of the work, at no extra cost to the Owner.
- .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 Equipment installed by this Division shall be installed in accordance with the manufacturer's installation requirements. In the event of conflicts between the Drawings or Specifications and the manufacturer's installation requirements, the Contractor shall notify the Consultant.
- .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 shall be applicable to every occurrence.
- .6 All piping and ductwork in finished areas shall be concealed in ceiling spaces and shafts or chased into walls. No exposed piping or ductwork shall be installed in such areas unless specifically reviewed and accepted by the Consultant. No piping shall be concealed in outside walls.
- .7 Vent pipes, exhaust hoods or other mechanical equipment mounted on the roof, or housing for such equipment shall not be 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 Consultant.
- .8 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.
- .9 Changes and modifications necessary to ensure co-ordination and to avoid interference and conflicts with other Trades, or to accommodate existing conditions, shall be made at no extra cost to the Owner.
- .10 Leave areas clear of piping and ducts where space is indicated as reserved for future equipment and equipment for other Trades.
- .11 Adequate space and provisions shall be left for removal of coils and servicing of equipment, with minimum inconvenience to the operation of systems.

General Instructions for Mechanical Sections

- .12 Where equipment is shown to be 'roughed-in only' obtain accurate information from the Consultant before proceeding with the work.
- .13 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. Any problems that cannot be solved in agreement with the other Trades affected, shall be submitted to the Consultant for decision. If ductwork or piping is prefabricated prior to the investigation and reaching of a solution to possible interference problems, necessary changes in such prefabricated items shall be made at no extra cost to the Owner.
- .14 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 site instructions in all regards. Any work not installed in the correct location (at the sole discretion of the Consultant) shall be remedied by this Contractor at his expense. This Contractor is responsible for mark-out of his work, fully co-ordinated with all other trades, in sufficient time for review by Consultant prior to rough-in. All mechanical and sprinkler services shall be located precisely.
- .15 Prepare dimensioned layouts of each room prior to rough-in for review by Architectural Consultant. Do not proceed with any work until the Consultant has reviewed the layout.

1.7 Installation, Interference And Setting Drawings

- .1 Installation, interference and setting Drawings dimensioned and to scale, shall be submitted for review by the Consultant, as may be required or requested by the Consultant 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. Three copies of such Drawings shall be submitted for review, of which one will be retained by the Consultant.
- .2 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, shall be prepared by this Division.
- .3 Interference Drawings are required 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 Consultant 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 This Division shall 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. 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.

General Instructions for Mechanical Sections

- .6 Work shall not proceed in areas involved until after final review of such Drawings has been obtained.

1.8 Bid Form and Submissions of Bids

- .1 Where Contract Documents list one Product or system, that Product or system shall be considered the Basis of Design in accordance with Section 01 60 00.
- .2 Where two or more names are shown in the specifications as alternatives or equal to, the alternate equipment shall be accepted in accordance with section 01 25 00.
- .3 Any alternative 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 Bid Form.
- .4 The Owner reserves the right to accept or reject any substitution without question.

1.9 Materials

- .1 Make and quality of materials used in the construction of this work shall be subject to the approval of the Consultant.
- .2 Materials and equipment supplied by this Division shall be new and free from defects and shall be as specified by the manufacturer's name and catalogue reference.
- .3 Where a certain manufacturer's equipment has been specified by name or model number, the Contractor shall be responsible for ensuring that the performance and quality of any proposed alternative meets the specified equipment and that the same access or maintenance space is available for the alternative manufacturer's equipment and that piping, duct and electrical connections can be made at no extra cost to the Contract.

1.10 Co-Operation with Consultants

- .1 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 Consultant 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 Consultant shall review the information and checklist and shall identify when the information is complete. The Consultant'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 Consultant.

1.11 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 Pipes transporting hot fluids shall be installed at least 150 mm (6 in.) away from pipes carrying cold fluids, unless approval from the Engineer's Representative is obtained to install services closer than 150 mm (6 in.).
- .3 Electrical conduits shall not touch or be supported from piping or ductwork.

General Instructions for Mechanical Sections

- .4 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 Owner.
- .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 The Contractor shall 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. Any discrepancy between the requirements identified within the Contract Documents and those of the Electrical Division shall be reported to the Consultant and the equipment shall be adjusted to suit the appropriate power requirements. Failure to perform this coordination prior to ordering of the motors or equipment shall result in correction at no additional cost to the Owner.

1.12 Temporary Use of Equipment

- .1 Where the mechanical systems are operated during construction, the Mechanical Contractor shall maintain the system and equipment in proper operating condition.
- .2 Prior to application for substantial performance of the work as certified by the Consultant, the systems and equipment shall be returned to the initial new condition by replacing used air filters with new air filters, cleaning the air side of all coils in the air handling systems, replacing used belts in belt drives with new belts, lubricating all bearings according to manufacturer's factory standards and adjusting the thermostatic control system according to specifications and/or to suit the Owner.

1.13 existing Services and Equipment

- .1 All changes and connections to existing services shall be made only in a manner and at a time approved by the Consultant so as to avoid any interruption of such services during normal working hours. If necessary, changes and connections to existing services shall be made outside of normal working hours, at no extra cost to the Contract.
- .2 Whenever existing services or equipment are to be removed, all piping and ductwork for such services or equipment shall be removed back to the main, nearest pipe or duct and any open ends securely capped or plugged in an approved manner unless otherwise shown. If necessary to facilitate installation of new work, any existing services and equipment shall be removed and then replaced by this Division.
- .3 All shutdown, draining, filling and chemical treatment of any portion of the existing base building piping systems shall be performed to the satisfaction of the Landlord's building operations staff and shall be co-ordinated with the Landlord for time and duration of interruptions. Comply with all of the Landlord's instructions and include for all costs of this work, including work performed by the Landlord's chemical treatment supplier, in the tender price. All associated work to be as specified in Section 23 25 26.00 - CLEANING AND FILLING.

General Instructions for Mechanical Sections

- .4 Whenever it becomes necessary to relocate existing piping, ductwork or equipment to make possible installation of the work under this Contract, such relocation shall be done by this Division without additional cost to the Contract.
- .5 Where connections are made to existing services, existing insulation shall be made good under this Division.

1.14 Provision for Future Expansion

- .1 Where piping, ductwork and equipment is indicated for use in future expansion of the building, the Contractor shall leave sufficient clear space and shall install the piping, ductwork and equipment in such manner that connections to the future building expansion can be made without dismantling existing piping, ductwork and equipment and without removing existing floors, walls and ceilings.

1.15 Interruption of Services

- .1 Any interruption of the mechanical services to any part of the building shall come at a time agreeable to the Consultant. Make all necessary arrangements with those concerned and include for any overtime required to ensure that the interruption is held to a minimum.
- .2 Testing and operation of major equipment shall be approved by the Consultant to avoid excessive utility charges. Such testing to be generally carried out after normal working hours or on weekends.
- .3 All such overtime work shall be carried out without additional cost to the Contract.

1.16 Statement of Prices

- .1 For the purpose of progress applications the Contractor shall submit a statement of his 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 shall equal the total price of the work covered under the Mechanical Division.
- .2 The Contractor shall submit the breakdown of work for this Contract to the Consultant for review and approval. The breakdown shall be in sufficient detail to enable the Consultant to evaluate the progress of work and shall identify all major equipment, components and sub trades.

1.17 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, pipes, ductwork and site services in both new and existing installations.
- .2 Conform to the Canadian Metric Practice Guide CSA-CAN3-2234-1-89.

1.18 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.

General Instructions for Mechanical Sections

- .2 Refer to the security and protection requirements in the General Conditions and conform to all requirements. In particular no open flames shall be used without prior written approval of the Owner. There shall be no smoking, and the site shall be kept clean at all times.

1.19 housekeeping Pads, Curbs and Support Piers

- .1 Provide concrete housekeeping pads, curbs and support piers under all floor mounted mechanical equipment and around all floor penetrations for pipes and ducts. Housekeeping pads and curbs shall be minimum 100 mm (4 in.) high unless detailed otherwise. Refer to the Drawings and Details for additional information.
- .2 Housekeeping pads, curbs and support piers under all floor mounted mechanical equipment and around all floor penetrations for pipes and ducts shall be provided by Division 3. This Division shall coordinate all sizes and locations for housekeeping pads and curbs. Provide dimensioned drawings for review by the Consultant. All housekeeping pads shall be minimum 100 mm (4 in.) high unless detailed otherwise. Refer to the Drawings and Details for additional information.

1.20 Ashrae 90.1

- .1 All mechanical equipment shall comply with the minimum efficiency standards set out in ASHRAE 90.1 and the Model National Energy Code of Canada for Buildings. Submit all necessary information to substantiate conformance.

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 Generally, the following abbreviations are used in this Division:

A.A.B.C.	-	Associated Air Balance Council
AAP	-	Alarm Annunciator Panel
A.B.M.A.	-	American Boiler Manufacturers Association
ACO	-	Acid Resistant Cleanout
AD	-	Acid Resistant Drawings
AFD	-	Acid Resistant Floor Drain
AFF	-	Above Finished Floor
A.G.A.	-	American Gas Association
A.M.C.A.	-	Air Moving and Conditioning Association
A.N.S.I.	-	American National Standards Institute
A.R.I.	-	Air-Conditioning and Refrigeration Institute
A.S.H.R.A.E.	-	American Society of Heating, Refrigerating and Air Conditioning Engineers
A.S.M.E.	-	American Society of Mechanical Engineers
A.S.T.M.	-	American Society for Testing and Materials
AV	-	Acid Resistant Vent
A.W.G.	-	American Wire Gauge
AWS	-	American Welding Society
A.W.W.A.	-	American Water Works Association
B.H.P.	-	Boiler Horsepower or Brake Horsepower
Btu/hr	-	British Thermal Units per Hour
B.W.G.	-	British Wire Gauge
CAD	-	Computer Aided Drafting
CAFV	-	Controllable Air Flow Venturis
CAP	-	College of American Pathologists
CCA	-	Chromated Copper Arsenate
C.E.M.A.	-	Canadian Electrical Manufacturer's Association
CEMS	-	Central Energy Management System
CCF	-	Central Computer Facility
cfm	-	Cubic Feet per Minute
C.G.A.	-	Canadian Gas Association
C.G.S.B.	-	Canadian General Standards Board
C.I.	-	Cast Iron
CPU	-	Central Processing Unit
C.R.N.	-	Canadian Registration Number
CSA	-	Canadian Standards Association
cu.ft.	-	Cubic Feet
cu.m.	-	Cubic Meter
db	-	Dry Bulb
dB	-	Decibel
dBA	-	A-weighted Decibel
DDC	-	Direct Digital Control
deg. C	-	Degrees Celsius
deg. F.	-	Degree Fahrenheit
dia.	-	Diameter
DPDT	-	Double Pull Double Throw
DPTX	-	Differential Pressure Transmitters

Abbreviations

EAP	-	Excess Exhaust Alarm Panel
E.D.R.	-	Equivalent Direct Radiation
EF	-	Exhaust Fan
E.E.M.A.C.	-	Electrical and Electronic 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
F.E.	-	Flexible Elastomeric
FHC	-	Fume Hood Controller or Firehose Cabinet
F.L.A.	-	Full Load Amps
fpm	-	Feet per Minute
fps	-	Feet per Second
F.M.	-	Factory Mutual
ft.	-	Foot or Feet
ga	-	Gauge
gal	-	Gallons
GFD	-	Gallons per Square Feet per Day
G.P.D	-	Gallons per Day
G.P.H.	-	Gallons per Hour
GSS	-	Galvanized Sheet Steel
h-cu.ft.	-	Hour-cubic foot
HCFC	-	HydroChloroFlourocarbons
HEPA	-	High Efficiency Particulate Air
H.O.A.	-	Hand/Off/Auto
HOT	-	Hand Held Operator Terminal
H.S.S.	-	Hollow Steel Sections
HTK	-	Hood Termination Kit
hp	-	High Pressure or Motor Horsepower
hz	-	Hertz
I.A.O.	-	Insurance Advisory Organization of Canada
I.C.U.	-	Intensive Care Unit
(I.)G.P.H.	-	(Imperial) Gallons per Hour
(I.)G.P.M.	-	(Imperial) Gallons per Minute
in.	-	Inch or Inches
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 Diode
LCP	-	Laboratory Control Panel
lin.ft.	-	Linear foot
lin.m.	-	Linear meter

Abbreviations

ma	-	Milliamps
MAC	-	Make-up Air Controller
mADC	-	Milliamps Direct Circuit
M.B.H.	-	1000 British Thermal Units per Hour
M.C.C.	-	Motor Control Centre
mm	-	Millimetre
m	-	Metre
m/s	-	Metres per Second
mL	-	Millilitre
MCP	-	Motor Control Panel
M.O.V.	-	Motor Over Voltage
mPa	-	Millipascals
MSC	-	Master Summing Controller
MSG	-	Manufacturers' Standard Gauge
N.B.S.	-	National Bureau of Standards
N.C.	-	Noise Criterion as Defined by Graph in A.S.H.R.A.E.
NCCLS	-	National Committee for Clinical Laboratory Standard
N.E.M.A.	-	National Electrical Manufacturer's Association
N.F.P.A.	-	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
N.P.S.H.	-	Net Positive Suction Head
NPT	-	American National Standard Taper Pipe Thread
No.	-	Number
OAT	-	Outside Air Temperature
O.B.C.	-	Ontario Building Code
OC	-	On Centre
OCP	-	Operator Control Panel
OPSS	-	Ontario Provincial Standard Specification
O.S. & Y.	-	Outside Screw and Yoke
O.W.R.A.	-	Ontario Water Resources Act
oz.	-	Ounce or Ounces
PCU	-	Personal Computer Unit
PE	-	Pneumatic Electric
PIT	-	Portable Interface Terminal
ph	-	Hydrogen Ion Concentration
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
rpm	-	Revolutions per Minute
RPU	-	Remote Processing Unit
RPU-TU	-	Remote Processing Unit for Terminal Units
SCR	-	Silicone Controlled Rectifier
SMACNA	-	Sheet Metal and Air Conditioning Contractors National Association

Abbreviations

sp. in. wg.	-	Static Pressure, Inches Water Gauge
S.P.D.T.	-	Single Pull Double Throw
SPS	-	Sash Position Sensor
s.s	-	Stainless Steel
SF	-	Supply Fan
SPS	-	Sash Position Sensor
SPWM	-	Sine-Coded Pulse Width Modulated
S.S.P.C.	-	Steel Structures Painting Council (The Society of Protective Coatings)
sq.m.	-	Square Meter
STC	-	Supply/Exhaust Tracking Controller
SWS	-	Sidewall Velocity Sensors
T.D.S.	-	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
U.L.	-	Underwriter's Laboratories
U.L.C.	-	Underwriter's Laboratories of Canada
um	-	Ohm
USP	-	United States Pharmacopoeial
U.S. gal.	-	United States Gallons
USGPH	-	United States Gallons per Hour
USGPM	-	United States Gallons per Minute
VAC	-	Volts Alternating Current
VACFH	-	Closed Loop Variable Frequency Drive
VDC	-	Volts Direct Current
VFD	-	Variable Frequency Drive
VSC	-	Variable Speed Controllers
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

END OF SECTION

Record Drawings

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 Submit as-built documents in accordance with Section 01 77 00.

PART 2 - PRODUCTS

2.1 Not used

PART 3 - EXECUTION

3.1 Not used.

END OF SECTION

Shop Drawings

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Related Work Specified Elsewhere

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

PART 2 - PRODUCTS

2.1 Shop Drawings

- .1 Shop Drawings shall be organized by Specification Section. Do not combine more than one section into one submission. Incorrect submissions will be returned without review.
- .2 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 Drawings shall give the identifying number as noted in the documents of the specific pump, fan, etc. for which it was prepared.
- .3 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.
- .4 When requested, Shop Drawings shall be supplemented by data explaining the theory of operation – for example: a variable speed motor control – the Consultant may also request that this information be added to the maintenance and operating manual.
- .5 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 Consultant..

END OF SECTION

Electric Motors

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 Electric motors for all driven equipment supplied by this Division shall be provided and installed by this Division.

1.2 Submittals

- .1 Shop Drawings for all electrical motors shall be in accordance with the Section 21 05 03.00 – SHOP DRAWINGS and shall 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

PART 2 - PRODUCTS

2.1 Materials

- .1 Unless otherwise specified motors shall be squirrel cage induction type with standard drip proof enclosure.
- .2 Motors unless otherwise specified shall meet all requirements of E.E.M.A.C. and CSA standards for electrical motors and where possible shall be of Canadian manufacturer.
- .3 Generally, all motors shall have starting current-torque characteristics in accordance with E.E.M.A.C., Design B unless otherwise specified or unless load characteristics require a higher starting torque. Each motor shall have sufficient starting torque to start the driven equipment and to accelerate it to full speed within 10 seconds. Motor horsepower shown are minimums. Submit starting times for review.
- .4 All motors shall be nominal 1750 rpm, unless otherwise specified.

Electric Motors

- .5 Unless noted otherwise, all motors shall have Class B insulation and shall be designed for continuous operation at 40 deg. C. (104 deg. F.) Motors controlled from variable speed drives shall have Class H windings and Class F insulation.
- .6 Motor connection boxes shall be located 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 they shall be relocated.
- .7 Each multi-speed motor and associated switching device shall be circuited such that the overload device in the starter protects the motor on each step of the multi-speed switch. As an alternative to this requirement, the motor may have integral overload protection. Multi-speed motors shall be single winding variable torque for 50% motor speed reduction and double winding, two speed for all other speed reductions.
- .8 Motors shall have the following electrical characteristics
 - .1 For 0.375 kW (1/2 hp) and larger xxx volt, 3 phase, 60 cycle
 - .2 For 0.25 kW (1/3 hp) and smaller 115 volt, 1 phase, 60 cycle
- .9 Single phase motors 0.25 kW (1/3 hp) and smaller shall be capacitor start.
- .10 All motors 22.4 kW (30 hp) and larger shall have heat detector protection embedded in the windings for connection into the motor control circuit. Protection shall be Siemens thermistor.
- .11 All motors 74.6 kW (100 hp) and larger shall be suitable for reduced voltage starting, delta-wye.
- .12 Motor enclosures shall be 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 shall be selected to operate satisfactorily at maximum temperature and moisture levels of surrounding air.
 - .3 For all other locations, use totally-enclosed fan-cooled, service factor 1.0.
 - .4 Use explosion proof motors where scheduled.
- .13 High efficiency motors shall be T frame, A.C., three phase, meet or exceed the CSA-390M-2010 Table 3 Premium Efficiency Levels and be approved under the Canadian Electrical Safety Code:
 - .1 High efficiency motors shall be used on all fans and pumps having motors 0.75 kW (1 hp) or larger.
- .14 Each electric motor shall be complete with a lamacoid nameplate securely fastened in a conspicuous place on the motor. The nameplate shall be a 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 shall be engraved through to the white lamination with the following:
 - .1 Motor No.
 - .2 Mechanical Equipment Driven
 - .3 Circuit No.

Electric Motors

- .4 Panel No.
- .5 Panel Location
- .15 Manufacturer nameplate shall include the nominal full load motor efficiency.
- .16 Electric motors shall be manufactured by Canadian General Electric, Westinghouse, Lincoln, U.S. Motors, Weg. or Baldor.

PART 3 - EXECUTION

3.1 Installation

- .1 Drive between any motor and driven equipment shall be provided with a guard, except where casing acts as a guard. Guards for belt-driven equipment shall have a hole for tachometer reading on each shaft.

END OF SECTION

Wiring and Starters

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 All power and control wiring from starters, fused and non-fused switches, whether mounted in M.C.C.'s 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.

1.3 Submittals

- .1 Further to requirements of Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS, submit Shop Drawings of following:
 - .1 Submit an overload thermal element list with all supporting data for review prior to installation of the elements.
 - .2 Submit samples of nameplates for review before manufacturing.

PART 2 - PRODUCTS

2.1 Disconnect Switches

- .1 Disconnect safety switches shall either be fusible or non-fusible safety switches and shall be heavy duty type A with quick-make, quick-break contacts, and shall be horsepower rated to match motor protected. Manufacturer shall be Canadian Westinghouse, Schneider, Klockner Moeller, Cutler Hammer or Siemens. Provide hole for padlock in off position.
- .2 Fuse clips shall be supplied with non-renewable type fuses suitably rated to motor nameplate current for proper short circuit protection. All fuse holders shall be suitable for HRC Class J time delay fuses. Supply three (3) additional sets of spare fuses for each size of fuse used.
- .3 Utilize switches of one manufacturer throughout the building.

2.2 Motor Control Centres

- .1 All motor control centres shall be free standing E.E.,M.A.C.1 Class II, Type B construction in all areas without sprinklers and shall be E.E.M.A.C.-2 drip-proof in all areas with sprinklers as manufactured by Allen Bradley, Siemens, Klockner Moeller, Schneider, Cutler Hammer.

Wiring and Starters

- .2 All buswork shall be fully insulated and shall be copper, braced to withstand 40,000 AMP short circuit symmetrical.
- .3 No more than 7 NEMA size 1 or smaller combination of standard starters shall be installed in one section. Leave space for a fire alarm shutdown relay compartment as required.
- .4 All starters shall be complete with control transformer, pilot lights, and two normally open, normally closed auxiliary contacts. Separate pilot lights shall be used to indicate ON, OFF, LOW SPEED, and/or HIGH SPEED. Selector switches and pilot lights shall be heavy duty type. Provide high/low speed test positions in the hand mode for multi-speed motors. Starters smaller than size 1 shall not be used.
- .5 Provide elementary wiring diagrams to Class 2B standards to indicate the control scheme. A separate elementary wiring diagram shall be provided for each fan or pump and the following shall be indicated in each wiring diagram:
 - Breaker size
 - Motor hp
 - Motor F.L.A.
 - Control transformer KVA
 - Overload size
 - Interlock scheme
 - Remote connection, etc.
 - Thermistors
- .6 In each starter identify each wire and terminal with permanent number markings identical to the wiring diagrams.
- .7 The latching relay, pilot light and the alarm contact shall be housed as part of the starter in the motor control starter.
- .8 Size the overload thermal elements to the motor nameplate data and to the test curves (time/current/torque).
- .9 Overload relays, thermistor relays, heater elements and other devices shall be sized to fully protect the motor for all starting and locked rotor conditions with the overloads remaining active in the circuit at all times.
- .10 All three phase starters shall have 3 phase overload relays.
- .11 All starters shall operate with 120 V control circuits. The control circuit fuse shall be on the secondary side of the control transformer.
- .12 Provide an engraved lamacoid nameplate for the motor control centre and each individual starter within the motor control centre. M.C.C. identification shall be 50 mm (2 in.) high letters. All other identified shall be 6 mm (1/4 in.) high letters.

Typical Identification Plate for Motor Control Centre

First Line	- M.C.C. #1
Second Line	- Voltage/Phase/# of Wires
Third Line	- Fed from main secondary switchboard
Fourth Line	- In main electrical room

Typical Identification Plate for Individual Starters

First Line	- Supply Fan SF-1
Second Line	- Voltage/Phase/# of Wires

Wiring and Starters

All nameplates shall be fastened with self-tapping screws.

2.3 Individual Starters

- .1 Individual starters shall meet all requirements specified for M.C.C.'s except as noted below.
- .2 Individually mounted manual starters shall generally be the toggle operated type with quick-make, quick-break mechanism, heavy duty sliding contacts in E.E.M.A.C. 1 general purpose enclosure in all areas without sprinklers and in E.E.M.A.C.-2 (drip proof) enclosure in all areas with sprinklers, pilot lights in cover and cover engraved with ON-TRIP-OFF positions.
- .3 Manual starters installed in finished areas shall be as above except suitable for flush mounting with stainless or bronze coverplates.
- .4 All magnetic starters individually mounted, standard or combination type, shall be for operation with a 120 V AC control transformer and coil, three phase overload protection, pilot lights, reset and pushbuttons or selector switches on the cover. All magnetic starters shall have auxiliary contacts.
- .5 All combination starters individually mounted shall be combination fusible type complete with pilot lights, on/off selector and reset button on cover. All combination starters shall have auxiliary contacts.
- .6 Provide an engraved lamaroid nameplate for each individual starter. Identification shall be 6 mm (1/4 in.) high letters.

Typical Identification Plate

First Line	- Exhaust Fan EF-1
Second Line	- 208 V/3 ph/3 W
Third Line	- Fed from splitter #1

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 Refer to Electrical Drawings and Specifications for work provided under that Division.
- .3 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 are correct and that the motor control schematics reflect all requirements.
- .4 Unless otherwise stated, this Section shall be responsible for the complete supply, installation and wiring of all starters, fused and non-fused switches and circuit breakers, auxiliary 120 V controls such as relays and pushbutton stations for the equipment supplied under other Sections of this Division.
- .5 Use non-fused disconnect switches for local equipment isolation only (e.g. fan motor downstream of fused starter in M.C.C.) all other disconnect shall be fused.

Wiring and Starters

- .6 Where required provide a galvanized steel hood over switches, M.C.C.'s and individual starters. Hoods shall be suitably reinforced and securely supported from the structure.

END OF SECTION

Variable Frequency Drives

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to the Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Quality Assurance

- .1 The Variable Frequency Drive (VFD) manufacturing facility shall be ISO 9001 certified. The VFD shall be UL listed, Canadian UL listed and CSA listed.
- .2 Provide a minimum 100,000 hours mean time before 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.

1.3 Related Work

- .1 For motors connected to variable frequency drives, refer to requirements of Section 21 05 13.00 – ELECTRIC MOTORS.

PART 2 - PRODUCTS

2.1 General Requirements

- .1 Variable frequency drives (VFD) shall be Danfoss/Graham Company VLT6000, Allan-Bradley PowerFlex 700, and ABB ACH550 as specified herein for the fans, pumps, heat recovery wheels, and cooling tower fans designated on the schedules or in the respective specification 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 The VFD shall be housed in a UL Type 1 ventilated enclosure.
- .4 The VFD shall be a digitally controlled drive, using the Pulse Width Modulation (PWM) technology with sensorless vector control. It shall utilize IGBTs in its inverter section.
- .5 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 motors rated voltage is applied to the VFD input.
- .6 The VFD shall include an integral disconnect on the line side of the drive.

Variable Frequency Drives

- .7 The VFD including all specified options shall be assembled by the ANSI/UL Standard 508 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 certified facilities.
- .8 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.
- .9 The VFD's full load amp rating shall meet or exceed NEC Table 430-150. 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.
- .10 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.
- .11 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. Disconnects located between the drive and the motor shall be interlocked into the VFD's safety circuitry.
- .12 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.
- .13 VFD power components shall be designed for 600VAC where intended for 575V/600V service. Components designed for 480VAC installed on 575V/600V service shall not be acceptable.
- .14 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.
- .15 VFD's output switching shall be maintained within the requirements of NEMA standard MG1 part 30, VFD's with output exceeding 1000V shall employ DVDT 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 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.
- .4 The VFD assembly including all required options shall be rated for 100,000amp interrupting capacity (AIC).

Variable Frequency Drives

- .5 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 EN61800-3.
- .6 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 VAC on 600 volt systems and 300 VAC on 208/230 volt systems and 539 VAC on 460 volt systems.

2.3 Interface Features

- .1 Each VFD shall have the same operator's keypad, including digital display with Hand/Start, Off/Stop and Auto/Start, Help selector switches or buttons 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, either BACnet as defined by ANSI/ASHRAE standard 135-2001 or LONWorks as defined by ANSI/CEA standard 709.1 for seamless integration with Section 23 09 00.00 - 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 systems control and safety interlock circuitry.
- .7 As a minimum, the following hardware points shall be available for direct connection to Section 15900 - 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 preset speed or bypass.

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.

Variable Frequency Drives

- .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.

2.5 Bypass

- .1 Supply either a manual 3 contactor bypass as per Article 2.5.2 or supply an electronic bypass system as per Article 2.5.3 and all respective Sub-Articles.
- .2 Provide a manual 3-contactor bypass, were indicated in schedules or specified, consisting of a door interlocked main fused disconnect padlockable in the off position, a built-in motor starter and a four position DRIVE/OFF/BYPASS/TEST switch controlling three contactors. In the DRIVE position, the motor is operated at an adjustable speed from the VFD. In the OFF position, the motor and VFD are disconnected. In the BYPASS position, the motor is operated at full speed from the AC power line and power is disconnected from the VFD so that service can be performed. In the TEST position, the motor is operated at full speed from the AC line power while power is applied to the input of the VFD. This allows the VFD to be given an operational test while continuing to run the motor at full speed in bypass. In case of an external safety fault, a customer supplied normally closed dry contact shall be able to stop the motor whether in DRIVE or BYPASS mode. Supply VFD specific only fuses
 - .1 Service personnel shall be able to defeat the main power disconnect and open the bypass enclosure without disconnecting power. This shall be accomplished through the use of a specially designed tool and mechanism while meeting all local and national code requirements for safety.
- .3 Provide a complete factory wired and tested electronic bypass system, consisting of an output contactor and bypass contactor. Overload protection shall be provided in both drive and bypass modes.
 - .1 Include a door interlocked, padlockable circuit breaker or disconnect switch to disconnect all input power to the drive and bypass system.
 - .2 Supply fast acting fuses exclusive to and in front of the VFD only.
 - .3 The electronic bypass shall have its own keypad with, Drive, Bypass, Hand, Off, Auto, Reset operator keys.
 - .4 The keypad shall also have the following LED indication, Ready, Enable, Drive running, Bypass running, Drive fault, Bypass fault, Bypass H-O-A mode, Auto transfer to bypass selected, Drive selected, Bypass selected.
 - .5 All external safety interlocks shall remain fully functional whether the system is in Hand, Auto or Bypass modes.
 - .6 The electronic bypass shall be fully operable from the Serial Communications system which shall have capability to monitor the VFD/Bypass mode, check status of H-O-A, Bypass fault, and Override and also force the motor into Bypass mode.

Variable Frequency Drives

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 switch is installed, provide an auxiliary contact or switch at the disconnect, 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 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 00.00 – BUILDING AUTOMATION SYSTEM (BAS).
- .5 Measure the distortion of each phase at the load terminals of the branch breaker and report the results to the Consultant. Any deficiency shall be corrected and re-evaluated.
- .6 Implement a communication protocol for remote interface to match the communication protocol under Section 23 09 00.00 – BUILDING AUTOMATION SYSTEM (BAS).
- .7 BAS connection to drives provided under Section 23 09 00.00 – BUILDING AUTOMATION SYSTEM (BAS).

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 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Submittals

- .1 Shop Drawings: Further to requirements of Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS, 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 Eternal 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 C.R.N. registration number.
- .2 For ducts up to 750 mm (30 in.) in the largest dimension thermometers shall be similar to pipeline thermometers but with an additional perforated bulb guard and shall be flanged for mounting on ducts.
- .3 For ducts over 750 mm (30 in.) in largest dimension thermometer shall be complete with:
 - .1 115 mm (4½ in.) diameter, cast aluminum case construction
 - .2 Black pointer
 - .3 White face with black lettering
 - .4 Range normally 0 to 115 deg. C. (32 to 240 deg. F.) for heated supply air, 0 to 80 deg. C. (32 to 175 deg. F.) for cooled supply, mixed and return air and -40 to 90 deg. C. (-40 to 195 deg. F.) for outside air but range shall suit maximum and minimum temperature of location and shall be shown on Shop Drawings.

Indicating Instruments

- .5 Temperature marking in 1 deg. C. (2 deg. F.) increments in both imperial and metric scales.
- .6 Vapour filled
- .7 1500 mm (60 in.) minimum length copper averaging bulb with bronze braided armour.
- .8 Flanged for mounting on ducts.
- .9 For insulated ducts or plenums provide a bracket for mounting thermometer clear of insulation.
- .4 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.
- .5 Pressure gauges shall be complete with:
 - .1 Dust-tight nominal 115 mm (4½ in.) dia. case, solid front complete with back blow-out to A.N.S.I. B40-1 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.
 - .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
- .6 Manometers shall be inclined tube, differential type complete with:
 - .1 Adjustable scale of anodized aluminum or polished and chrome plated with black figure and graduations
 - .2 Range 0 to 0.5 kPa (0 to 2 in.) with 0.005 kPa (0.02 in.) graduations in both metric and imperial scales.
 - .3 Built in level vial
 - .4 Adjustable flanged base for mounting on duct or plenum
 - .5 Two static pressure tips, flanged for mounting on duct
 - .6 Two 1500 mm (60 in.) lengths of tubing
 - .7 Bottle of red gauge oil

Indicating Instruments

- .7 Manometers shall be Magnahelic 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.
- .8 Thermometers shall be Trerice, Taylor, Weksler, Winters or Ashcroft.
- .9 Pressure gauges shall be Trerice, Ashcroft, Morrison, Winters or Weksler.
- .10 Manometers shall be Airflow Developments or Dwyer.
- .11 Gauge glasses shall be Pyrex Red Line 12 mm (1/2 in.) equipped with leakproof pet cocks and ball check valves.

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 lamacoid nameplate identifying the system and service.
- .5 Insert pipeline thermometer into tanks, equipment tappings or in pipeline using screwed tees or forged steel couplings, welded into the lines.
- .6 Duct thermometers shall be attached to duct using sheet metal screws through thermometer flange.
- .7 Insert pressure gauges into equipment tappings or in pipelines using screwed tees or forged steel couplings welded into the lines.
- .8 Provide thermometers in the following locations in pipelines:
 - .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
- .9 When a common supply header provides the same temperature water to many coils or to many zones, provide a thermometer on the common header only, rather than a thermometer on each branch.
- .10 For control valves with by-pass located thermometer in common pipe to allow for manual temperature control.

Indicating Instruments

- .11 Provide thermometers in the following locations in ducts or plenums:
 - .1 Upstream and downstream from each coil, spray or humidifier, except individual reheat coils in ductwork.
 - .2 On each of 3 ducts or plenums at mixing dampers
 - .3 Return air from each zone
 - .4 Outside air entering air handling units
 - .5 And where specifically shown
- .12 Where a common duct or plenum provides the same temperature air to many zones, provide a thermometer on the common duct only, rather than at each branch of a zone.
- .13 Provide test wells for thermometers where shown. Test wells shall be compatible with the thermometers used. Wells shall be registered with the Provincial Boiler and Pressure Vessel Safety Branch and have a C.R.N. registration number.
- .14 Provide a Watts B6000 ball valve on the inlet to each gauge. In addition, install a coil syphon on each steam 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.
- .15 Provide pressure gauges in the following areas:
 - .1 City water line where it enters the building
 - .2 In and out of each pump
 - .3 In and out of all pressure reducing valves
 - .4 On each steam, hot water supply and hot water return header
 - .5 Air cushion tank or expansion tank
 - .6 City water make-up line
 - .7 Each fire standpipe at highest fire hose cabinet
 - .8 In and out of each heat exchanger, condenser, cooler or type of other heat exchanger
 - .9 And where specifically shown
- .16 Valved connections for pressure gauges shall be installed on each side of coils.
- .17 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.
- .18 Install gauge glasses on each fire water storage, expansion tank and where shown. Gauge glasses shall be full height of tank. Individual gauge glasses shall be a maximum of 450 mm (18 in.) high where more than one gauge glass is required to give full coverage on any tank, glasses shall overlap by a minimum of 150 mm (6 in.). Provide shut-off valves on all connections to gauge glasses.

Indicating Instruments

END OF SECTION

Flow Measuring Devices

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Materials

- .1 Provide a complete system as shown on the Drawings and as required for measuring flow in each of the heating and cooling piping systems. The flow meter shall be portable and calibrated to read the differential pressure and with use of a chart or charts, the flow of water directly in L/s (gpm). Depending upon system characteristics flow meters shall be venturi type as manufactured by Presco, or pitot tube type as manufactured by Annubar or a combination of the two types with meters for each type used.
- .2 Flow meter fittings shall be installed as indicated on the Drawing and in the following piping systems and locations for balancing and testing purposes:
 - .1 Each chilled water, condenser water, dual temperature or heating water main systems supply.
 - .2 In each condenser water and chilled water supply to individual chillers.
- .3 Venturi fittings for 19 mm (3/4 in.) through 50 mm (2 in.) shall be threaded and 65 mm (2½ in.) through 250 mm (10 in.) shall be flanged with gaskets, nuts and special bolts. All flow fittings shall have quick connect coupling, enabling fitting to be used with portable flow meter with gauge, purge and drain attachments.
- .4 Supply flow meters to cover the complete operating ranges of all systems and charts for all these conditions.
- .5 All components shall be rated at 121 deg. C. (250 deg. F.) at 1725 kPa (250 psi).
- .6 High temperature hot water meters shall be permanently installed and pressure and temperature ratings increased as required.

PART 3 - EXECUTION

3.1 Installation

- .1 Install measuring devices in sections of straight pipe as recommended by the manufacturer.

END OF SECTION

Hangers and Supports

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 Piping and equipment provided under the Mechanical Division shall be complete with all necessary supports and hangers required for a safe and workmanlike 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. 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 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 Consultant. 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 Engineer's Representative.

PART 2 - PRODUCTS

2.1 Materials

- .1 Provide hangers and supports manufactured by Anvil International, Taylor Pipe Supports, or E. Myatt & Co.
- .2 All pipe hangers and supports shall be manufactured to the latest requirements of MSS-SP-58. Where applicable, design and manufacture of hangers and supports shall also conform to ANSI/ASME Code for Pressure Piping B31.1.
- .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 MSS-SP-69. 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 domestic cold water, dual temperature, and chilled water to maintain the integrity of the insulation and vapour barrier and where slides can not 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 be minimum 150mm (6 in.) or as recommended by manufacturer for the specific pipe size.

Hangers and Supports

- .2 For hot services such as steam, heating water, etc. where the piping is 50mm (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 Consultant prior to proceeding with this arrangement.
- .5 Roof supports for pipe or duct runs greater than 30 ft. shall be Thaler Roof Specialities.
- .6 Roof supports for pipe or duct runs less than 30 ft. shall be Thaler Roof Specialities, 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 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.

2.2 Constant Support Hangers

- .1 For piping at hanger locations where the vertical movement of the piping is 12mm (1/2 in.) or more or where necessary to avoid the transfer of load to adjacent hangers or connected equipment, pipe hangers shall be constant support design.
- .2 The total travel for constant support hangers shall be equal to travel plus 20%. In no case shall the difference between the actual and total travel be less than 25mm (1 in.) The constant support hanger shall have travel scales on both sides of the support frame for inspection purposes.
- .3 Each constant support hanger shall be individually calibrated prior to shipment to support the exact loads specified.
- .4 Alloy springs shall meet the requirements of ASTM A-125 and shall be shot peened and examined by magnetic particle. The spring rate tolerance shall be +/- 5%.
- .5 Constant supports shall have a wide range of load adjustability. No less than 10% of this adjustability shall be provided either side of the calibrated load for plus or minus field adjustment. Load adjustment scale shall be provided to aid the field in accurate adjustment of loads and load adjustment shall be possible without the use of special tools and shall not impact the travel capabilities of the supports.
- .6 Constant supports shall be furnished with travel stops to prevent upward and downward movement of the hanger. The travel stops shall be factory installed so that the hanger level is at the cold position. The travel stops shall be designed to permit future re-engagement.

Hangers and Supports

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.
- .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 Consultant. 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 Consultant. Make adjustments as necessary to satisfy the requirements of the Structural Division.
- .6 For precast concrete construction, hanger rods shall pass between slabs and be supported on the slab within the topping by a 100mm x 100mm x 3mm (4 in. x 4 in. x 1/8 in.) steel plate welded to the hanger rod. A lock nut threaded to the hanger rod together with a 50mm (2 in.) minimum dia. washer shall be applied tight against the under surface of the deck to prevent rising of the hanger.
- .7 Approved type expansion shields and bolts may be used for pipe up to 100mm (4 in.) diameter where the presetting of concrete inserts is not practical. Submit proposed hanger details for review and acceptance by the Consultant. Make adjustments as necessary to satisfy the requirements of the Structural Division.
- .8 Suspension from metal deck shall not be allowed unless specifically accepted by the Consultant. Drawings of the proposed method of suspension must be submitted for review.
- .9 Hangers, hanger rods and inserts in all parking and ramp areas shall meet the requirements of CAN/CSA-S413-94 (R2005) and shall be of corrosion-resistant material or have an effective, durable corrosion resistant coating. Submit samples for approval.
- .10 Hanger rods shall be subject to tensile loading only. Suspended piping shall be supported by adjustable hanger rods sized as follows:

Hangers and Supports

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

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

Nominal Pipe Diameter	Maximum Span
Up to and including 25mm (1 in.)	2.1 m (7 ft.)
32mm (1-1/4 in.) to 125mm (5 in.)	3 m (10 ft.)
150mm (6 in.) and larger	4.6 m (15 ft.)

In addition, provide a hanger within 600mm (2 ft.) on each side of valves on pipes over 38mm (1½ in.) diameter, elbows or tees.

- .12 Hanger spacing for plumbing and drainage services shall be in accordance with the plumbing code.
- .13 Hanger spacing for fire protection services shall be in accordance with the N.F.P.A. codes.
- .14 All horizontal piping 50mm (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.
- .15 Suspending one hanger from another shall not be permitted.
- .16 For hot water or steam piping 50mm (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.
- .17 For hot water or steam piping 38mm (1-1/2 in.) and smaller, use line size hangers.
- .18 For cold water services such as domestic cold water, chilled water pipe on dual chilled and hot water pipe 25mm (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 21 07 00.00 – MECHANICAL INSULATION.
- .19 For cold water services such as domestic cold water, chilled water pipe or dual chilled and hot water pipe larger than 25mm (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 21 07 00.00 – MECHANICAL INSULATION.

The shield width shall be minimum 1/4 of the pipe circumference. The length and gauge shall be as follows:

- .1 150mm (6 in.) long and 14 US gauge for pipe larger than 25mm (1 in.) up to 50mm (2 in.) diameter
- .2 250mm (10 in.) long and 12 US gauge for pipes 65mm (2-1/2 in.) to 300mm (12 in.) diameter
- .3 300mm (12 in.) long and 10 US gauge for pipes 350mm (14 in.) to 400mm (16 in.) diameter

Hangers and Supports

- .20 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.
- .21 Unless otherwise specified or shown, all pipes supported from below shall be mounted on pipe rolls or pipe slides.
- .22 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.
- .23 Unless otherwise specified or shown, vertical pipes shall be supported at least every fourth floor or every 12 m (40 ft.) maximum.
- .24 Pipe slides shall be pre-engineered type. Structural or fabricated tees shall be welded to the pipe or to the protection saddle as shown.
- .25 Install resilient hangers in accordance with Section 21 05 48.00 – VIBRATION AND NOISE CONTROL.
- .26 Install additional seismic supports in accordance with Section 23 05 49.00 – SEISMIC RESTRAINT SYSTEMS.
- .27 Other means of support shall be as shown or as specified hereunder.
- .28 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 250mm (10") in depth unless reviewed or detailed by the Consultant. Where framing does not permit direct attachment, provide metal strut sub-framing or minimum 19mm (3/4 in.) fire retardant treated plywood backboards, unpainted, attached to the framing. Provide attachments for backboards at 600mm (24 in.) on centres with no less than 4 attachments.

END OF SECTION

Vibration and Noise Control

PART 1 - GENERAL**1.1 Work Included**

- .1 Conform to Section 21 05 00.00 – 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 Section 13080 [Division 13].

1.3 Submittals

- .1 Shop Drawings: Supply Shop Drawings of the vibration and noise control equipment being supplied. Provide Shop Drawings showing completely the various acoustic assemblies.

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 Consultant] 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.

AREAS	N.C. LEVELS
Residential Suites	30
General Offices	35
Meeting Rooms	35
Corridors and Lobbies	35
Storage Rooms	40
Entrance Halls	40
Amenity Space	35
Fitness	40
Pool	35
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.
- .2 All vibration isolation devices shall be Vibro-Acoustics, Kinetics Noise Control 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, or EH Price and shall be one manufacturer throughout the project.

Vibration and Noise Control

- .4 Provide vibration isolation devices in accordance with the Vibration Isolation Schedule. Static deflection of isolators shall be as given in the Schedule and specified below. The Vibration Isolation Schedule shall take precedence.
- .5 Provide silencers in accordance with the Silencer Schedule..

2.2 Vibration Isolation

- .1 Type EP (Elastomeric Pad) – Vibro-Acoustics Model N, Kinetics Model NPD, or Mason Industries Model W or Super W.
 - .1 Type EP shall be 8mm 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 NGS or Mason Industries Model WSW.
 - .1 Type MEP shall consist of two 8mm 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, or Mason Industries Model ND.
 - .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 9.5mm unless specified otherwise.
- .4 Type DDNH (Double Deflection Neoprene Hangers) – Vibro-Acoustics Model RHD, Kinetics Model RH or Mason Industries Model HD.
 - .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 19mm 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 obstructions.
 - .2 Unless otherwise specified the static deflection of DDNH hangers shall be 8mm.
- .5 Type SPNM (Spring and Neoprene Mounts) – Vibro-Acoustics Model FS, Kinetics Model FDS or Mason Industries Model SLFSW

Vibration and Noise Control

- .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 above grade level.
- .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 SPNMS (Spring and Neoprene Mounts – Seismic Restrained) – Vibro-Acoustics Model SFS, Kinetics Model FHS or Mason Industries Model SSLFH.
 - .1 Type SPNMS shall be laterally stable restrained steel spring type. 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 SPNMS 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 above grade level.
 - .3 Isolators shall be bolted to the floor and equipment. Provide 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.
- .7 Type SPH (Spring Hangers) – Vibro-Acoustics Model SH, Kinetics Model SH, or Mason Industries Model 30
 - .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.).
- .8 Type SPNH (Spring and Neoprene Hangers) – Vibro-Acoustics Model SHR, Kinetics Model SRH, or Mason Industries Model 30N

Vibration and Noise Control

- .1 Type SPNH shall be as above with the addition of a neoprene element in series with the spring. The neoprene element shall have a deflection of not less than 9mm 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.).
- .9 Type CSNM (Constrained Spring and Neoprene Mounts) – Vibro-Acoustics Model CSR, Kinetics Model FLS, or Mason Industries Model SLR
 - .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 6mm 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.).
- .10 Type SCSNM (Constrained Spring and Neoprene Mounts – Seismic Restrained) – Vibro-Acoustics Model SCSR, Kinetics Model FLSS, or Mason Industries Model SLRS.
 - .1 Type SCSNM shall be a spring and neoprene mount that incorporates welded steel housings and heavy top plates containing laterally stable restrained springs with built-in leveling device and vertically restraining limit stops to prevent spring elongation when partial load is removed and limits the movement of equipment when it is subjected to wind or seismic loading.
 - .2 A maximum clearance of 6 mm (1/4 in.) shall be maintained around the restraining bolts and between the housing and the spring so as not to interfere with the spring operation. Top plate and restraining bolts shall be out of contact with the housing during normal operation.
 - .3 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 6mm 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.

Vibration and Noise Control

- .6 Unless specified otherwise, the minimum static deflection for Type SCSNM mounts under actual load conditions shall be 50 mm (2 in.).
- .11 Type RTIC (Rooftop Isolation Curb) – Vibro-Acoustics Model RTR, Kinetics Model KSR or Mason Industries Model RSC
 - .1 Type RTIC shall be curb type rail with integral isolators which is designed to fit over the roof curb and under the isolated equipment. The top and bottom members shall contain weather resistant springs having a minimum 25 mm (1 in.) deflection with 50% additional travel to solid. Spring diameter shall not be less than 80% of the compressed height of the spring.
 - .2 Wind resistance shall be provided by means of resilient snubbers with a minimum clearance of 6 mm (1/4 in.) so as not to interfere with the spring action except in high winds.
 - .3 The weather seal shall consist of continuous closed cell sponge materials both above and below the base and a waterproof, flexible neoprene connection joining the outside perimeter of the upper and lower members.
 - .4 The curb shall be manufactured as a single assembly.
- .12 Type CB (Concrete Base) – Vibro-Acoustics Model C, Kinetics Model CIB-L or Mason Industries Type KSLFSW
 - .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.
 - .5 Height saving brackets or welded steel pockets shall be incorporated to 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 (galvanized).
- .13 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.

Vibration and Noise Control

- .14 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.
- .15 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.
- .16 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.
- .17 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.
- .18 Neoprene mounting sleeves for hold down applications of equipment with vibration isolators shall be Uniroyal Type 620/660 or as approved.
- .19 Grout: Non-shrink, self-levelling grout having ability to withstand thermal, vibratory and impact stresses; "Embeco 636 Grout", "Imperial Grout", or "Sauereisen F-100".
- .20 Acoustic Sealant: Non-hardening, non-skinning permanently flexible, to CAN/CGSB-19.21-M87. Tremco, CGC Acoustic Sealant or approved equivalent.

2.3 Internal Acoustic Duct Lining

- .1 Fiberglass duct liner shall be manufactured by Certainteed, Owens-Corning, Knauf Insulation, or Johns Manville.
- .2 Natural fibre duct liner shall be manufactured by Bonded Logic.
- .3 Duct lining shall have a minimum density of 24 kg/m³ (1.5 lbs/ft³).
- .4 Duct liner shall comply with the requirements of NFPA 90A and the "Duct Liner Materials Standard" of the Thermal Insulation Manufacturer's Association.
- .5 Sizes shown on the Drawing are free area dimensions (after the installation of duct liner). Duct liner shall be a minimum of 25 mm (1 in.) unless shown otherwise.
- .6 All acoustical duct lining shall incorporate means to prevent fiber entrainment in the air stream.
- .7 The following ductwork shall be internally lined:
 - .1 All return air transfer ductwork.
 - .2 All ductwork specifically identified on the Drawings.

2.4 Acoustical Duct And Pipe Lagging

- .1 Acoustical duct and pipe lagging shall be Kinetics Model KNM-100ALQ

Vibration and Noise Control

- .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/m³ (1 lbs/ft³) 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.
- .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 Factory-Built Silencers shall be completely pre-fabricated of incombustible materials and shall have a minimum insertion loss and a maximum air pressure drop as shown in Silencer Schedule. Submitted silencer performance shall be according to ASTM E477-06a "Standard Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers"
- .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. Where indicated on the Silencer Schedule silencers shall have acoustic media wrapped in Tedlar film liner to help prevent shedding, erosion and impregnation of the acoustic media.
- .5 No-media silencers shall contain no absorptive media of any kind. Attenuation shall be achieved with controlled impedance membranes and broadly tuned resonators.
- .6 Silencer materials, including acoustic media and Tedlar film, shall have the following combustion ratings when tested in accordance with ASTM E84-03: maximum Flamespread Classification 25, maximum Smoke Development Rating 50.
- .7 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.

Vibration and Noise Control

- .8 Rectangular type silencers for duct systems operating greater than 4 in. WG and less than 8 in. WG and 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.
- .9 Rectangular type silencers for duct systems operating under more than 8 in. WG and 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.
- .10 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.
- .11 Circular media filled silencers, unless noted on the Silencer Schedule as Class 3, 16 gauge 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.
- .12 Circular no-media silencers, unless noted on the Silencer Schedule as Class 3, 16 gauge construction shall have gauges and construction as follows: under 450 mm (18 in.) duct diameter, 22 gauge 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.
- .13 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 Consultant, provide breakout noise calculations for each air handling and fan system with silencer submittal to insure 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.

2.6 Acoustic Plenums

- .1 Wall and roof panels shall be 100 mm (4 in.) thick. The exterior shall be 1.425 mm thick (18 G.S. gauge) sheet metal, the interior 0.853 mm thick (22 G.S. gauge) perforated sheet metal and all edges and internal stiffeners on maximum 625 mm (25 in.) centres shall be 1.425 mm thick (18 G.S. gauge) sheet metal. All steel shall be galvanized. Acoustic media shall be inorganic, inert and rot-proof.

Vibration and Noise Control

- .2 Acoustical plenums shall have transmission loss performance at or above the following levels:

Octave (Hz)	63	125	250	500	1000	2000	4000	8000
Transmission Loss (dB)	13	21	26	37	47	53	55	55

- .3 Acoustical plenums shall have absorption coefficients at or above the following levels:

Octave (Hz)	63	125	250	500	1000	2000	4000	8000
Absorption Coef.	0.41	0.69	1.14	1.12	1.03	1.01	0.87	0.87

- .4 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 acoustic 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.
- .5 Inspection windows shall be double pane 300 mm x 300 mm x 6 mm (12 in. x 12 in. x 1/4 in.) thick safety glass with rubber seals. There shall be a window in each door.
- .6 Doors and windows shall have a transmission loss equal to the plenum panels.
- .7 The entire plenum shall be structurally designed to resist excessive deflection or bowing and be adequately sealed to prevent air leakage when subjected to a pressure differential between inside and outside of up to 2.5 kPa (10 in. W.G.). Structural steel framework shall be supplied for wall heights and/or roof spans over 3600 mm (12 ft.).
- .8 Unless specified otherwise, acoustical plenums shall be lined with 50 mm (2 in.) thick duct liner.

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.
- .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 6mm maximum, under all operating conditions. Lateral restraining isolators shall have the same static deflection as equipment being isolated.

Vibration and Noise Control

- .7 Seismic snubbers shall be installed on all equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 3.2mm (1/8 in.). Install seismic restraint devices using methods approved by required submittals for component.
- .8 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.
- .9 Piping, ductwork, conduit or mechanical equipment shall be supported from building structure, not hung from or supported on other equipment, pipes, or ductwork.
- .10 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.
- .11 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.
- .12 All wiring connections to mechanical equipment on isolators shall be made with a minimum long flexible conduit installed in a slack "U" shape.
- .13 Elastomeric isolators that will be exposed to temperatures below 0 deg. C. (32 deg. F.) shall be fabricated from natural rubber instead of neoprene.
- .14 Springs shall be designed and installed so that ends of springs remain parallel and all springs installed with adjustment bolts.
- .15 Springs shall be sized to be non-resonant with equipment forcing frequencies or support structure natural frequencies.
- .16 Fans and air handling units shall be levelled with fans operating before the flexible connectors are attached.
- .17 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. W.G.) 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 shall not be less than 50mm 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. W.G.) 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.
- .4 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.
 - .1 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.
- .5 Floor Mounted Packaged or Custom Air Handling Units less than 0.87 kPa (3-1/2 in. W.G.) static pressure and/or under 29.8 kW (40 hp) without internal fan isolation shall be isolated as follows:
 - .1 Where the fan section is separated from the rest of the unit with a flexible connection, mount the fan section as specified for floor mounted centrifugal fans less than 0.87 kPa (3-1/2 in. W.G.) static pressure and/or under 29.8 kW (40 hp).
 - .2 Where the fan section forms an integral part of the air handling unit isolate the entire unit as specified for floor mounted centrifugal fans less than 0.87 kPa (3-1/2 in. W.G.) static pressure and/or under 29.8 kW (40 hp).. If the frame is an integral part of the packaged unit no additional frame is required.
 - .3 Drain pipe for air handling units shall be supported only from the isolated air handling unit frame. The condensate shall drip into a funnel that is supported from the floor or floor drain. A gap of at least 50 mm (2 in.) shall be maintained between the end of the air handling unit drain pipe and funnel or floor drain. Hot and chilled water pipes shall be connected to the air handlers with flexible connectors.
- .6 Floor Mounted Packaged or Custom Air Handling Units 0.87 kPa (3-1/2 in. W.G.) static pressure and over and/or 29.8 kW (40 hp) and larger without internal fan isolation shall be isolated as follows:
 - .1 Where the fan section is separated from the rest of the unit with a flexible connection, mount the fan as specified above for floor mounted centrifugal fans 0.87 kPa (3-1/2 in. W.G.) static pressure and over and/or 29.8 kW (40 hp) and larger.
 - .2 Where the fan forms an integral part of the air handling unit isolate the entire unit as specified for floor mounted centrifugal fans 0.87 kPa (3-1/2 in. W.G.) static pressure and over and/or 29.8 kW (40 hp) and larger. Isolation includes both the base frame and concrete.

Vibration and Noise Control

- .3 Drain pipe for air handling units shall be supported only from the isolated air handling unit frame. The condensate shall drip into a funnel that is supported from the floor or floor drain. A gap of at least 50 mm (2 in.) shall be maintained between the end of the air handling unit drain pipe and funnel or floor drain. Hot and chilled water pipes shall be connected to the air handlers with flexible connectors.
- .7 Roof mounted air conditioning units without internal fan isolation shall be mounted on RTIC isolator. Static deflection shall be as shown in the Schedules.
- .1 For roof mounted units that have openings through the structure directly below the unit provide a flexible neoprene coated canvas connection to provide an air tight/weather tight finish between the unit and the curb.
- .8 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 up to 3.73 kw (5 hp) | 150 mm (6 in.) |
| Pumps 5.6 kW (7-1/2 hp) to 18.7 kW (25 hp) | 250 mm (10 in.) |
| Pumps 22.4 kW (30 hp) to 44.8 kW (60 hp) | 300 mm (12 in.) |
| Pumps 56.0 kW (75 hp) to 93.3 kW (125 hp) | 400 mm (16 in.) |
| Pumps 112 kW (150 hp) and larger | 600 mm (24 in.) |
- .1 Base for horizontally split pumps shall include supports for base elbows for the discharge and suction connections. Vertically split pumps shall include support for base elbow for suction connection. Bolt and grout base elbows to the pump base.
- .2 Mount the base on Type SPNM isolators. Where the base is 'T' shaped or other than rectangular, locate the isolators under the projections as well as the main body of the base.
- .3 Pour bases on roofing felt and elevate a minimum of 50 mm (2 in.) with mounting adjustment bolts after the pumps are grouted to the base.
- .4 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 (1 in.) and all mountings shall have 6 mm (1/4 in.) thick neoprene vibration isolation pads at the bottom.
- .9 Base mounted pumps less than 3.73 kW (5 hp), except where located on slab-on-grade, bolt and grout each pump to a Type CB inertia base.
- .1 Mount the base on Type EP isolators.
- .2 Minimum base thickness shall be 150 mm (6 in.).
- .10 Base mounted pumps On Slab On Grade: Bolt and grout each pump to a Type CB base. The minimum base thickness shall be:
- | | |
|--------------------------------------------|-----------------|
| Pumps up to 3.73 kw (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.) |

Vibration and Noise Control

- .1 Mount the base on Type MEP isolators. Where the base is 'T' shaped or other than rectangular, locate the isolators under the projections as well as the main body of the base. The isolators shall be in accordance with the manufacturer's instructions for the size and weight distribution of the pump supported.
- .11 Vertical in-line pumps floor mounted 6.5 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 6.5 kW (10 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 (1 in.) and all mountings shall have 6 mm (1/4 in.) thick neoprene vibration isolation pads at the bottom.
- .12 Vertical in-line pumps floor mounted 4.9 kW (7-1/2 hp) and smaller and 6.5 kW (10 hp) and larger where located on slab-on-grade, shall be supported on Type MEP isolation. Refer to Mechanical Standard Details.
- .13 Vertical in-line pumps ceiling hung shall be supported by Type SPNH spring isolators. Refer to Mechanical Standard Details.
- .14 Floor mounted air compressors shall be bolted and grouted to Type CB inertia base supported by Type SPNM isolators. Spring deflection shall be 50 mm (2 in.) minimum. Resilient pipe hangers shall be as specified for piping in Mechanical Rooms.
- .15 Fan coil units or heat pumps suspended from overhead structure shall be hung on Type SPNH spring isolators. Unless otherwise specified in the Vibration and Isolation Schedule, the static deflection of the isolators shall be 50 mm (2 in.).
- .16 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.
- .17 Expansion tanks, dearators, heat exchangers and water heaters without pumps or motors which are floor mounted shall be supported on Type MEP isolators. Suspended units shall be supported by Type DDNH isolators. Where piping on isolators is connected to these units, the connection shall be made with a neoprene flexible connector.
- .18 Diesel generator exhaust pipe shall have Type SPNH hangers for the entire length. Hangers shall have a minimum of 38 mm (1-1/2 in.) deflection.
- .19 Cooling tower shall be mounted 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.

Vibration and Noise Control

- .20 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.
- .21 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.
- .22 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.
- .23 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.
- .24 Flexible piping connectors shall be installed to connect piping of diameter 50 mm (2 in.) or greater to reciprocating or rotating equipment.
- .25 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.
- .26 No rigid connections between equipment and the building structure shall be made that degrades the specified noise and vibration control system.
- .27 Any conflicts with other trades which result in rigid contact with the equipment or piping due to inadequate space or other unforeseen conditions should be brought to the Consultant's attention prior to installation. If not brought to the attention of the Consultant prior to installation corrective work necessitated by conflicts shall be at the Contractor's expense.
- .28 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.
- .29 Where pipes rise in a vertical chase and are supported from a structure with type SPNH or DDNH isolators and require lateral bracing, neoprene riser guides shall be mounted around the pipe to limit lateral movement and to prevent direct contact with the supporting structure.
- .30 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. Flexible duct connectors shall not be used outside the Mechanical Room unless expressly shown on the Drawings. Flexible connectors shall be in accordance with Section 23 31 13.00 – DUCTWORK AND SPECIALTIES.
- .31 Kitchen exhaust ducts shall be supported on SPNH and/or SPNM isolators as appropriate. Neoprene riser guides shall be used if lateral restraint is required in shafts.

Vibration and Noise Control

- .32 After installation, manufacturer shall verify that the vibration isolation systems are installed and operating properly, and shall submit a certificate so stating. Verify that the isolators are adjusted, with springs perpendicular to bases or housings, adjustment bolts are tightened up on equipment mountings, and hangers are not cocked. In addition, the manufacturer shall certify that Type RTIC isolation curbs are assembled and installed properly.

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 gauges used.
- .2 Silencers shall have outside dimensions that match the connecting duct size unless indicated otherwise.
- .3 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 E477-06a and so certified when submitted for approval. The aero-acoustic laboratory must be NVLAP accredited for the ASTM E477-06a test standard. A copy of the accreditation certificate must be included with the submittals. Data from non-NVLAP accredited test facilities will not be accepted. Shop Drawings submitted without proper certifications will be rejected.
- .4 The certification of the pressure drop, insertion loss and generated noise data shall be based upon tests of the same silencer for all measurements.
- .5 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 Acoustic Plenum

- .1 Acoustic plenum shall be supplied and installed where shown. All acoustic panels, doors, windows, steel supports, etc. shall be co-ordinated to provide an integral noise barrier.
- .2 Where panels are required between two fan plenums and similar locations, they shall be similar to the wall and roof panels except they shall be perforated on both sides with a central baffle to prevent air crossover and no transmission loss is required.
- .3 Make all connections in a way to ensure the integrity of the acoustic performance. Provide flanged or collar openings for ducts, pipes, fan, etc constructed of 1.6129 mm (1/16 in.) thick (16 G.S. gauge) galvanized steel.
- .4 Acoustic transmission loss data shall be the results of tests in accordance with ASTM E90-90 or its latest version. Absorption coefficients shall be the results of tests in accordance with ASTM C-423-90 or its latest version. Copies of test data to substantiate the acoustic performance of the panels, published by the Illinois Institute of Technology (formerly Riverbank Acoustical Laboratory) or other acceptable laboratory, shall be furnished by the panel manufacturer.
- .5 Acoustic plenums shall not be used as intake and exhaust air plenums that are directly connected to an exterior louvre and where water may infiltrate the plenum.

Vibration and Noise Control

3.5 Acoustical Lining Of Ducts

- .1 Other ductwork shall be acoustically lined where shown on the Drawings.
- .2 The acoustical liner shall be fixed to the duct with a minimum of 50% coverage of a fire-resistant adhesive. Where the duct width exceeds 300 mm (12 in.) or the height 600 mm (24 in.), the liner shall be additionally secured with mechanical fastening on maximum 450 mm (18 in.) centers on all sides. Mechanical fasteners that pierce the duct are unacceptable. Mechanical fasteners shall be in accordance with Section 21 07 00.00 – MECHANICAL INSULATION. All ends of the liner shall be coated with a fire resistant cementing material to prevent delamination, leakage or erosion. All joints shall be firmly butted and ends coated with an adhesive to ensure that the lining is smooth across all joints.
- .3 Where acoustical duct lining is installed, the dimensions of the sheet metal shall be increased 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.

END OF SECTION

Pipe and Ductwork Identification

PART 1 - GENERAL**1.1 Work Included**

- .1 Conform to Section 21 05 00.00 – 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 00.00 – PAINTING AND COATING.

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 and ANSI A131-1981.
- .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.

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.
- .4 Pipe identification markers for insulated or non-insulated pipe sizes less than 150 mm (6 in.) circumference shall be pre-coiled and shall cover the pipe in its entirety and be joined using adhesive along the longitudinal joint. In addition to the adhesive the marking system shall be banded with clear plastic tie-wraps on each end.
- .5 Pipe identification markers for insulated or non-insulated pipe sizes equal to and greater than 150 mm (6 in.) circumference shall be strapped 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 shall not be accepted.
- .8 All electric traced piping shall have additional identification to show it is traced.

Pipe and Ductwork Identification

- .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 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 Nameplates for systems such as thermostatic controls, are covered in the Articles specifying the equipment.
- .3 Every piece of equipment shall have a nameplate.

1.2 Submittals

- .1 Submit samples of nameplates before installation.

PART 2 - PRODUCTS

2.1 Materials

- .1 The nameplates shall be a minimum of 2 mm (3/32 in.) thick laminated phenolic plastic. 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 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Submittals

- .1 Submit samples of charts and numbering system before installation.

PART 2 - PRODUCTS

2.1 Materials

- .1 Tags shall be square colour coded phenolic 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 Roof drains used for restricting or controlling the flow of water from the roof or acting as an overflow shall be affixed with an identification label "Control Flow Roof Drain – Do Not Remove Restriction Device".

Valve Tags and Charts

- .7 Charts shall be set in metal picture frames with a clear acrylic front and fastened securely where directed by Consultant or Owner.
- .8 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 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 Submit Drawings showing size, type and location of all access doors, for review, before installation.

PART 2 - PRODUCTS**2.1 Materials**

- .1 Access doors shall be Acudor, or Mifab Manufacturing Inc.
- .2 Doors in solid walls shall be with a 14 U.S. gauge, prime painted steel door panel, rust resistant concealed hinges, flanged frame, and screwdriver operated lock. Acudor Model UF 5000 or Mifab Model UA.
- .3 Doors in plaster partitions or ceilings shall be with a 16 US gauge, prime painted steel recessed door panel with metal lath for the acceptance of plaster finish, concealed hinges, metal lath frame, and screwdriver operated lock. Acudor model AP 5010 or Mifab Model CAD-PL.
- .4 Doors in drywall partitions or ceilings shall be 16 US gauge, prime painted steel recessed door panel for the acceptance of a drywall insert, concealed hinges, drywall bead frame, and screwdriver operated lock. Acudor model DW 5015 or Mifab Model CAD-DW.
- .5 Doors in drywall partitions or ceilings shall be 14 US gauge, prime painted steel flush door panel, concealed hinges, drywall bead frame, and screwdriver operated lock. Acudor model DW 5040 or Mifab Model MDW.
- .6 Access doors in fire rated walls or ceilings shall be 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 Doors in tiled walls or ceilings shall be 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 Minimum size of doors shall be 300 mm x 450 mm (12 in. x 18 in.). Wherever possible 600 mm x 600 mm (24 in. x 24 in.) doors shall be used.

PART 3 - EXECUTION**3.1 Installation**

- .1 All parts of the installation requiring periodic maintenance shall be accessible. Wherever valves, dampers 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 Wall mounted plumbing fixtures with back water connection shall have an adjacent access door.
- .3 Wherever possible, items requiring access shall be located in easily accessible areas (i.e. exposed or T-bar ceilings).
- .4 Group items in order to minimize the number of access doors required.
- .5 Each access door shall be installed to provide complete access to equipment for maintenance and servicing.
- .6 Make any changes to locations of access doors as directed by the Consultant.
- .7 The final installed locations of all access doors shall be shown on the As-Built Record Drawings.

END OF SECTION

Excavation and Backfill for Mechanical Work

PART 1 - GENERAL**1.1 Work Included**

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 This Section governs requirements for all excavating and backfilling Work required for the installation of buried storm drains, sanitary sewers, gas lines, water lines, and appurtenances associated with such services. Excavation and backfill includes all work within building footprint (plan), and extends to a point 1500 mm (5 ft. 0 in.) [3000 mm (10 ft. 0 in.)] [1000 mm (3 ft. 0 in.)] beyond face of building foundation line.
- .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. (under separate Contract).
- .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.

PART 2 - PRODUCTS**2.1 Soils**

- .1 To the requirements for Granulars "A", "B" (Type 1), "M" and "Select Subgrade Material"; Ontario Provincial Standard Specifications (OPSS), Form No. 1010 for Granulars "A", "B", "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 (¼ in.), containing not 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 A179-93 for masonry sand is also acceptable.

Excavation and Backfill for Mechanical Work

PART 3 - EXECUTION**3.1 Installation**

- .1 All excavation and backfilling for all services shall be in accordance with Division 31, (the Site Work Division (Section 31 00 00.00 – EXCAVATION/EARTHWORKS)).
- .2 Refer to Section 31 23 00 (the Site Work Division (Section 31 00 00.00 – EXCAVATION/EARTHWORKS)) 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 Section 31 23 33.00, (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 separate Section, (in the Earth Work Division (Section 31 00 00.00 – EXCAVATION/EARTHWORKS)) 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 Drawings 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.
 - .2 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.
 - .3 Backfill up to top of subgrade.
 - .4 Backfill the remainder of trench or excavation up to top of subgrade or bottom of floor slabs ongrade.

END OF SECTION

Sleeves and Escutcheons

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 21 05 00.00 – 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 Division 15. All other firestopping and smoke seals of mechanical services are specified under [07860 – FIRESTOPPING AND SMOKE SEALS]

PART 2 - PRODUCTS

2.1 Materials

- .1 Sleeves passing through stud partitions shall be 0.75 mm (0.0299 in. - 22 G.S.G.) steel.
- .2 Sleeves passing through concrete or masonry partitions 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 Sleeves passing through floors in kitchens, laundries, mechanical rooms, garages, pipe spaces or other similar areas except slab on grade, shall extend 50 mm (2 in.) above the surrounding housekeeping pad or floor and shall be Schedule 40 steel pipe.
- .5 Sleeves passing through floors with a waterproof membrane and not located within a housekeeping pad shall have a flashing collar, 50 mm (2 in.) wide at the membrane level. Flashing collar shall be continuously welded to sleeve. Sleeves shall extend 50 mm (2 in.) above the finished floor and shall be Schedule 40 steel pipe.
- .6 Sleeves for pipes passing through exterior foundation walls shall be pre-manufactured molded non-metallic HDPE equal to PSI-Thunderline Model CS 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 carbon steel bolts with zinc dichromate and corrosion inhibiting coating equal to PSI-Thunderline Link-Seal Model C wall seal.
 - .2 A reinforced concrete bridge shall be installed between the wall and the adjacent undisturbed soil.
- .7 Firestopping and smoke seal systems shall be in accordance with CAN4-S115 – Standard Method of Fire Tests for Firestop Systems, CAN/ULC-S101 – Standard Methods for Fire Endurance Tests of Building Construction and Materials, ASTM E119 – Standard Test Methods for Fire Tests of Building and Construction Materials, and ASTM E814 – Standard Test for Fire Tests of Through-Penetration Firestop Stops.

Sleeves and Escutcheons

- .1 Unless noted otherwise "F" and "T" ratings are shown on the drawings.
- .2 Systems shall be asbestos free and maintain an effective barrier against flame, smoke, and gases in accordance with CAN4-S115 and shall not exceed opening sizes for which they are intended.
- .3 Firestopping and smoke seals at openings around mechanical services shall be an elastomeric seal for sound and vibration control.
- .4 Fire resistance rating of firestopping assembly shall not be less than the fire resistance rating of surrounding floor or wall assembly.
- .5 Service penetration assemblies shall be ULC certified in accordance with CAN4-S115 and listed in ULC Guide No. 40 U19.
- .6 Service penetration firestop components shall be ULC certified in accordance with CAN4-S115 and listed in ULC Guide No. 40 U19.13 and ULC Guide No. 40 U19.15.
- .8 Firestopping and smoke seals shall be by Hilti, Tremco/Royal Quickstop, or 3M.
- .9 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 15450 - FIXTURES AND TRIM.
- .10 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.
- .11 Cover exposed duct sleeves in finished areas with 1.42 mm (0.0561 in. - 18 G.S.G.) galvanized sheet steel in the form of duct collars. Fix in position with non-ferrous metal screws.
- .12 Counter flashing for roof penetrations shall be commercial quality galvanized sheet steel to ASTM A653/A653M-02, 0.70 mm (0.0276 in. - 24 G.S.G.) 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 Consultant.
- .3 Provide sleeves for all service penetrations through walls, partitions, floor slabs, plenums and similar barriers.

Sleeves and Escutcheons

- .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 21 07 00.00 – MECHANICAL 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 fire rated insulation as specified in Section 21 07 00.00 – MECHANICAL INSULATION and caulk around the edges with smoke and acoustic sealant.
- .6 Firestopping and smoke seal material and components shall be installed in accordance with the ULC certification and manufacturers instructions. Examine the sizes and conditions of the cavities to be filled to determine the correct thicknesses and installation of materials. All substrates and surfaces in contact with firestopping materials shall be dry and prepared in accordance with the Manufacturers instructions at appropriate ambient conditions.
- .7 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.
- .8 Provide escutcheons at all penetrations of piping into finished areas, and at insulated pipes, make the escutcheons large enough to fit around the insulation.
- .9 Counter flash vertical duct penetrations through roof at intersection of roof curb and duct.

END OF SECTION

Cutting and Patching

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 Openings required for mechanical services for new construction shall be in accordance with Section 21 05 83.00 – 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. Carry out cutting and patching work in accordance with requirements of Section 01 60 00.00 – PROJECT FORMS.
- .4 Cutting and Patching shall be in accordance with Section 01 60 00.00 – 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 00.00 – 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 Section 01 60 00.00 – PROJECT FORMS in a timely manner to avoid unnecessary cutting. All openings shall be shown on Drawings and submitted to the Consultant for review. No holes through structure shall be permitted prior to review by the Consultant.
- .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 structure elements requiring cutting and patching and x-ray the structure to obtain Consultant'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 avoid electrical conduit.
 - .1 Cut holes through slabs 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.

Cutting and Patching

- .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.
- .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 Consultant before cutting or core drilling any openings or holes.
- .5 Patch all openings after services have been installed to match the surrounding finishes.

END OF SECTION

Mechanical Insulation

PART 1 - GENERAL**1.1 Work Included**

- .1 Conform to Section 21 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 Provide shop drawings with technical data on all types of insulation to be installed.
- .3 Provide two samples of each type of insulation indicating where each is to be used and a sample of a typical vapour barrier dam. 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 Consultant.

PART 2 - PRODUCTS**2.1 Materials**

- .1 Fibreglass insulation shall be Owens-Corning, Certainteed, Manson, Johns Manville, Knauf or Fibrex.
 - .1 Duct insulation shall be rigid board vapour seal 48 kg/cu.m. (3 lbs/cu.ft.) density duct insulation with factory applied vapour barrier. Flexible duct insulation shall be 24 kg/cu.m. (1-1/2 lbs/cu.ft.) type with vapour barrier.
 - .2 Pipe insulation shall be preformed sectional fibreglass or mineral fibre insulation with factory applied all service jacket.
 - .3 Insulation for linear radiant heating panels shall be 12 kg/cu.m. (3/4 lb.cu.ft.) density fibreglass batt insulation with foil back.
- .2 Flexible elastomeric insulation for ducts exterior to the building shall be Armacell with Tuffcoat 25 surface or Nomaco K-Flex with R-374 protective coating.
- .3 Extruded polystyrene insulation for ducts exterior to the building shall be Dow Weathermate Styrofoam insulation board.
- .4 Mineral Fibre Board Thermal insulation for ducts exterior to the building shall be Roxul RXL 80 125 kg/cu.m. (8 lbs/cu.ft.) density board insulation with factory applied reinforced foil vapour barrier.
- .5 Foamglass insulation shall be Pittsburgh-Corning.
- .6 Flexible elastomeric insulation shall be Armacell or Nomaco with adhesive applied to both surfaces to be joined. Flexible elastomeric insulation shall not be used on pipes that are electrically traced.
- .7 Insulation jacket for services and ductwork exterior to the building, and for indoor components such as valves, pump, meters, etc. shall be Childers or Armacell field applied U.V. protected mesh reinforced mastic.
 - .1 Mastic shall be equal to Childers VI-CRYL CP-10/11 weather barrier coating. Finish shall be white.
 - .2 Sealant for areas where mastic meets adjoining insulated or uninsulated surfaces or dissimilar weather proofing materials shall be equal to Childers CP-76.

Mechanical Insulation

- .3 Glass fibre reinforcing mesh for thickness control and strength at joint interfaces in field applied mastic on exterior ductwork insulation shall be equal to Childers CHIL-GLAS # 10.
- .8 High temperature insulation shall be 232 kg/ cu.m. (14.5 lbs/cu.ft.) Johns Manville Thermo-12 Gold molded, asbestos free, non-combustible, abuse-resistant pipe and block insulation composed of hydrous calcium silicate meeting ASTM C533, Type I for operating temperatures up to 649 Deg. C. (1200 Deg. F.).
- .1 Tie Wire shall be 16 gauge (0.045mm) stainless steel with twisted endons on maximum 300mm (12 in.) centres.
- .9 High temperature insulation shall be Roxul ProRox PS 980 molded, non-combustible, mineral wool fibre pipe insulation.
- .10 Corner beads and channels at floor line shall be 0.4 mm (28 ga.) galvanized sheet metal.
- .11 Fire retardant lagging coating shall be Chil-Seal CP-50 by Childers Products Company or Monsey Bakor equivalent.
- .12 Vapour barrier dam shall be Chil-perm CP30 with fibreglass cloth reinforcing.
- .13 All cements and adhesives shall be as recommended by the manufacturer of the insulation. Insulation, insulation jacket, canvas and adhesive shall be fire retardant with a flame spread rating not to exceed 25 and a smoke developed rating not to exceed 50 when tested in accordance with CAN/ULC-S102-M.
- .14 P.V.C. fitted jackets and covers shall have a flame spread rating not to exceed 25 and a smoke developed rating not to exceed 50 when tested in accordance with CAN/ULC-S102-M.
- .15 Aluminum Jacket shall be 0.51mm (24 B&S Gauge - 0.0201 in) thick sheet, embossed finish, with longitudinal slip joints and 50mm (2 in.) laps, die shaped fitting covers with factory applied moisture barrier.
- .16 Fire resistant duct insulation shall be Royal Quickstop Quickwrap, 3M Fire Barrier Duct Wrap, CL4Fire, or Unifrax Corporation FyreWrap to meet the requirements of NFPA 96. Product shall meet flame spread rating of 25 and smoke developed rating of 50. Insulation product shall be complete with all manufacturers 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.

PART 3 - EXECUTION**3.1 Installation**

- .1 Install insulation in accordance with the manufacturer's printed installation instructions unless noted otherwise.
- .2 Insulation thicknesses and conductivities shall meet or exceed the minimum standards set out in ASHRAE 90.1 (refer to Table 1 following) and as specified herein for the services covered.

Mechanical Insulation

- .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.
- .5 Recover all insulation, where exposed to view and not concealed in ceiling spaces or pipe spaces with 6 oz. canvas pasted on. Apply two coats of fire retardant lagging finish.
- .6 Where approved by the Consultant, as an alternative to the above, recover all piping insulation with a PVC jacket and preformed PVC elbows and fittings sealed with adhesive. PVC shall not be used on steam, medium and high temperature hot water piping or piping services that will be painted.
- .7 Cover all piping insulation external to the building and where specifically shown with field applied mesh reinforced mastic.
- .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 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
 - .8 and exterior ductwork
- .9 Terminate insulation on pipes passing through fire rated walls or floors, and fit tight to the fire stop material.
- .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 Hot Services

Mechanical Insulation

- .1 Heating water services, heating glycol, low pressure steam and condensate piping shall have glass fibre preformed pipe insulation. Refer to Table 1 for required insulation thicknesses.
 - .2 On hot services, insulate valves, fittings, couplings, unions, flanges and all other appurtenances through which water or steam passes, using mitred sections of preformed insulation of a thickness equal to the adjoining pipe insulation, and securely wire in place. Over mitred section, apply one coat of field applied mesh reinforced mastic. Finish services with a vapour barrier using two full brush coats of vapour seal adhesive.
 - .3 Apply glass fibre or mineral fibre preformed vapour barrier jacket pipe insulation to domestic hot water piping. Refer to Table 1 following for required insulation thickness. Apply with all joints butted firmly together, and bond securely, sealing flaps by pasting down to give a smooth finish.
 - .4 Apply 50 mm (2 in.) thick mineral fiber tank wrap insulation (wired on) to the following:
 - .1 All domestic hot water tanks
 - .2 Heating water tanks
 - .3 Shell and tube heat exchangers
 - .4 Condensate receivers
 - .5 Continuous and intermittent blow down tanks
 - .6 Steam generator drum heads
 - .7 Deaerator heaters.Recover with canvas. Provide removable sections at access doors/manholes and all components requiring servicing.
 - .5 Insulate all hot gas piping in conditioned spaces with preformed glassfibre insulation. Cover exterior piping with field applied mesh reinforced mastic.
- .14 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 75 mm (3 in.) and largerProvide foamglass, Thermo-12 or calcium silicate insulation inserts the full length of shields at all hangers and supports.

Mechanical Insulation

- .2 For domestic cold water piping less than 75 mm (3 in.) where hangers on cold water lines penetrate vapour barrier make sure the penetration is properly sealed with insulation and vapour barrier continued up hanger a further 75 mm (3 in.).
- .3 Where sheet metal shields are used refer to Section 21 05 29.00 – HANGERS AND SUPPORTS.
- .4 Apply 12 mm (1/2 in.) thick, preformed glass fibre pipe insulation with vapour barrier jacket or 12 mm (1/2 in.) thick flexible elastomeric insulation to all domestic cold water and chilled drinking water piping. Insulate the first 4500 mm (15 ft.) of the standpipe and/or sprinkler main.
- .5 On cold water service valves, water meters, drain valves, vent connections, thermometer wells, pressure gauges and other irregular shaped objects, apply flexible elastomeric sheet insulation, thickness to suit service, cut and mitre as necessary, and attach with adhesive and stainless steel banding. Bond and seal edges of insulation to the adjacent surfaces and finish with field applied mesh reinforced mastic.
- .6 Apply 50 mm (2 in.) thick rigid glass fibre insulation tank wrap by wiring or banding onto all chilled water storage tanks. Apply vapour barrier of foil faced flame resistant Kraft paper or aluminum foil, and recover with canvas. Apply insulation to legs/supports. Provide removable sections at access doors/manholes and all components requiring servicing. As an alternative to the above, provide 50 mm (2 in.) thick Flexible elastomeric sheet insulation.
- .7 The following cold service piping shall have glass fibre dual temperature pipe insulation:
 - .1 Chilled water
 - .2 Dual temperature glycol
 - .3 Spray coils
 - .4 Dual temperature water piping
 - .5 Dual temperature condenser water piping.
 - .6 Chemical feed piping for evaporative fluid cooler basin.Refer to the Table 1 for required insulation thicknesses.
- .8 Piping in air handling or air conditioning units. Insulate with 25 mm (1 in.) thick flexible elastomeric insulation and cover with field applied mesh reinforced mastic.
- .9 Insulate refrigerant suction lines with 12 mm (1/2 in.) flexible elastomeric insulation. Cover exterior piping with field applied mesh reinforced mastic.
- .15 Chilled water, spray coil and domestic pumps. Adhere 25 mm (1 in.) thick flexible elastomeric insulation.
- .16 Pipe serving chilled water pumps, spray water pumps and domestic water pumps located inside air handling or air conditioning units shall be covered with 25 mm (1 in.) thick flexible elastomeric insulation.

Mechanical Insulation

.17 Drainage Piping

- .1 Cover cast iron bell and spigot drainage pipe 75 mm (3 in.) and smaller with 12 mm (1/2 in.) preformed glass fibre pipe insulation, and finish with vapour barrier jacket. Cover the bell and spigot joint with a 12 mm (1/2 in.) thick flexible elastomeric insulation band that overlaps the fibreglass insulation 300 mm (12 in.) beyond joint in each direction. Seal band to the fibreglass insulation. Apply 25 mm (1 in.) thick insulation for all larger pipes.
- .2 Storm Drainage piping to be insulated:
 - .1 Roof drain sump
 - .2 All horizontal or sloping storm piping
 - .3 All elbows connecting the horizontal storm drainage piping to the vertical leaders
 - .4 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.
- .3 Sanitary drainage piping to be insulated:
 - .1 Sanitary drainage pipes from urinals
 - .2 Direct and indirect drains from drinking fountains
 - .3 Floor drains from air conditioning apparatus
 - .4 Carrying chilled condensate to closest branch or main.
 - .5 All piping passing through high humidity area
 - .6 Sanitary drainage pipe from barrier free lavatories

.18 Electrically Traced Piping

- .1 Insulated for the entire length of the piping. Insulation type shall be as specified for the service being traced. For services not specifically designated insulate as specified for heating water. The minimum thickness of insulation shall be:
 - .1 25 mm (1 in.) for up to 150 mm (6 in.) pipe
 - .2 38 mm (1-1/2 in.) for 200 mm (8 in.) pipe
 - .3 250 mm (10 in.), 50 mm (2 in.) for pipes larger than 250 mm (10 in.) in size.Thickness of insulation over fittings, valves and other appurtenances shall match the pipe insulation.

.19 Ductwork and Equipment

- .1 Ductwork and equipment internal to the building within conditioned spaces shall have 25 mm (1 in.) thick rigid glass fibre duct insulation with vapour barrier. In concealed spaces and on round duct smaller than 600 mm (24 in.) insulation may be 38mm (1-1/2 in.) flexible type with vapour barrier. Flexible duct connections do not require insulation except where a factory applied insulation has been specified with the flexible duct connection.

Mechanical Insulation

- .2 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.
- .3 On exposed insulation in mechanical rooms, increase thickness as necessary to give 12 mm (1/2 in.) thickness over flanges and angles. 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.
- .4 Insulation Contractor to 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.
- .20 The following ductwork and equipment shall be insulated:
 - .1 Apparatus casings
 - .2 Outside and mixed air plenums
 - .3 Outside and mixed air ductwork, including ducts to and from independent ERVs
 - .4 Heating and cooling coil sections of ductwork and plenums
 - .5 Casings of supply fans in equipment rooms
 - .6 Supply ductwork in equipment rooms.
 - .7 Exhaust and relief air ductwork. Plenums and/or casings from 1500 mm (60 in.) upstream of shut-off dampers to connection to exterior wall or roof
 - .8 Exhaust, relief and supply and return air ductwork, plenums and/or casings through non-air conditioned or unheated internal space. Use 50 mm (2 in.) thickness.
 - .9 For non-LEED projects, all supply ductwork from fans to VAV box for variable volume systems and all supply ductwork on constant volume systems.
 - .10 Silencers and fan capacity monitors. Insulate to suit the service and location.
- .21 Apply 2 layers of 50mm (2 in.) flexible elastomeric insulation on all ductwork which is external to the building. Exterior insulation shall be coated with factory applied coating. Provide sloped extruded polystyrene insulation support on top of ductwork to maintain slope at a minimum of 5%. All flanges shall be covered by a minimum of 12mm (1/2 in.).
- .22 As an alternative to the above, apply 2 layers of 50 mm (2 in.) thick rigid extruded polystyrene board insulation. Insulation on top of ductwork shall slope a minimum of 5% and all flanges shall be covered by a minimum of 12mm (1/2 in.). Install field applied mesh reinforced mastic jacket on all insulated ductwork which is external to the building in accordance with the manufacturers recommended installation. The mastic shall be trowelled, sprayed, or wet brushed to a smooth even finish. There shall be no voids or holidays.

Mechanical Insulation

- .23 Site fabricated breaching. Up to and including connection to chimney stack, insulate with 100 mm (4 in.) thick mineral fibre intermediate service board secured with pins and covered with expanded metal lath. Apply final finish consisting of two layers of cement, reinforced with canvas and trowelled smooth, to effect a uniform finish. Apply insulation to permit expansion and contraction of breaching without damage to the insulation. Insulate all breaching, except for double walled insulated gas vents, from all boilers and other equipment up to the chimney stack.
- .24 Plate type heat exchangers. Enclose hot surfaces in a removable galvanized steel box using 25 mm (1 in.) thick rigid insulation board. 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. Construction shall be similar to built-up air plenums. For cold surfaces use 25 mm (1 in.) thick Flexible elastomeric insulation, installed in sections with all joints sealed, using an installation method similar to that used on chillers. Insulate plate heat exchangers when both services are insulated. Insulate shell and tube heat exchangers when the service in the shell is insulated.
- .25 Fire resistant duct insulation shall be applied directly onto the ductwork and plenums in strict accordance with the manufacturer's instructions and Listing. Tested to ULC Standard for Internal Grease Duct Testing and ISO standard 6944 as a gypsum shaft alternative per NFPA 96 guidelines.

Mechanical Insulation

.26 TABLE 1: MINIMUM PIPE INSULATION THICKNESS/PERFORMANCE (BASED ON ASHRAE 90.1 AND MODEL NATIONAL ENERGY CODE FOR BUILDINGS)

MINIMUM PIPE INSULATION – MM (IN.)

Fluid Design Operating Temp. range deg. C. (deg. F.)	Insulation Conductivity		Nominal Pipe Diameter – mm (in.)					
	Conductivity [W(m-K)] [h-cu.ft. – deg. F. (Btu- in.)]	Mean Rating Temp deg. C. (deg. F.)	Runouts ^b Up to 32 (1-1/4)	Less than 25 (1)	25-32 (1 to 1- 1/4)	38-75 (1-1/2 to 3)	100- 150 (4- 6)	200 (8) and up
<u>Heating Systems (Steam, Steam Condensate, Heating Glycol and Heating Water)</u>								
Above 177	0.049	121	87	114	125	125	125	125
Above (350)	(0.34)	(250)	(3.5)	(4.5)	(5.0)	(5.0)	(5.0)	(5.0)
122-177	0.045	93	50	75	100	114	114	114
(251-350)	(0.32)	(200)	(2.0)	(3.0)	(4.0)	(4.5)	(4.5)	(4.5)
94-121	0.043	66	38	65	65	65	75	75
(201-250)	(0.30)	(150)	(1.5)	(2.5)	(2.5)	(2.5)	(3.0)	(3.0)
61-93	0.042	52	25	38	38	50	50	50
(141-200)	(0.29)	(125)	(1.0)	(1.5)	(1.5)	(2.0)	(2.0)	(2.0)
41-60	0.040	38	25	25	25	38	38	38
(105-140)	(0.28)	(100)	(1.0)	(1.0)	(1.0)	(1.5)	(1.5)	(1.5)
<u>Domestic and Service Hot Water Systems ^c</u>								
41-60	0.040	38	25	25	25	38	38	38
(105 -140)	(0.28)	(100)	(1.0)	(1.0)	(1.0)	(1.5)	(1.5)	(1.5)
<u>Cooling Systems (Chilled Water, Chilled Glycol, Brine and Refrigerant)</u>								
5-13	0.039	24	25	25	25	25	25	25
(40-60)	(0.27)	(75)	(1.0)	(1.0)	(1.0)	(1.0)	(1.0)	(1.0)
Below 4.4	0.039	10	25	25	38	38	38	38
Below (40)	(0.27)	(50)	(1.0)	(1.0)	(1.5)	(1.5)	(1.5)	(1.5)

^A PIPING INSTALLED EXTERIOR TO THE BUILDING SHALL MEET THE MINIMUM INSULATION REQUIREMENTS OF HEATING SYSTEMS WITH A FLUID DESIGN OPERATING TEMPERATURE ABOVE 177 DEG. C. (350 DEG. F.).

^B RUNOUTS TO INDIVIDUAL TERMINAL UNITS NOT EXCEEDING 3.7 M (12 FT.) IN LENGTH LOCATED WITHIN PARTITIONS WITHIN CONDITIONED SPACES.

^C APPLIES TO RECIRCULATING SECTIONS OF SERVICE OR DOMESTIC HOT WATER SYSTEMS AND FIRST 2.4 M (8 FT.) FROM STORAGE TANK FOR NON-RECIRCULATING SYSTEMS

END OF SECTION

Cleaning and Protection

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 Conform to Section 23 08 00 – Commissioning Requirements - Mechanical

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 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 manufacturers' 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 workmanship shall be equal to the manufacturers original.
- .8 All cleaning and protective measures shall be in accordance with the SMACNA – IAQ Guidelines for Occupied Buildings under Construction. .

END OF SECTION

Operating and Maintenance Instructions

PART 1 - GENERAL**1.1 Work Included**

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 Comply with all requirements of Section 21 05 02.00 – RECORD DRAWINGS.
- .3 Comply with all requirements of Section 21 05 03.00 – SHOP DRAWINGS.
- .4 Comply with all requirements of Section 21 08 00.00 – 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 DVD.
- .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 Volume One shall contain the master index of all systems, the name of the Contractor, Mechanical Sub-Contractors and the date of substantial performance for the Contract.
- .5 Volume One shall contain a section with all necessary warranty information.
- .6 Each binder shall have a complete index for all volumes.
- .7 Each binder shall be no more than half filled.
- .8 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.
- .9 There shall be a separate section for all Insurance Certificates, Test Certificates, Verification Forms and Test Forms.
- .10 All relevant information relating to a system or product shall be contained within one binder.
- .11 The manual sections shall follow the specification sections.
- .12 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.

2.2 Data for Manuals

- .1 Equipment data shall contain:

Operating and Maintenance Instructions

- .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 Sub-Contractor manuals are required for:
 - .1 BAS
 - .2 Water treatment
 - .3 Sprinkler system
 - .4 Water 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

2.3 Operating Instructions

- .1 Instruct the Owner's representative in all aspects of the operation and maintenance of systems and equipment.

Operating and Maintenance Instructions

- .2 Comply with all requirements of Section 21 08 00.00 – COMMISSIONING, for duration of tests.
- .3 Instruct the Owner for a minimum of five (5) working days.
- .4 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 Consultant and/or the Owner.
- .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, Consultant, etc.), system or equipment involved and signature of the Owner'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 Owner'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 Steam generators and associated equipment
 - .4 Automatic controls and instrumentation
 - .5 Water treatment and cleaning
 - .6 Life safety and fire protection
 - .7 Noise and vibration
 - .8 Condenser water distribution system
 - .9 Chilled water distribution systems
 - .10 Heating water distribution systems
 - .11 Steam distribution systems and condensate
 - .12 Air handling distribution and components
 - .13 Miscellaneous ventilation systems
 - .14 Diesel generator fuel supply and ventilation
 - .15 Humidification systems
 - .16 Medical gases
 - .17 Storm, sanitary and domestic water pumping and distribution system

Operating and Maintenance Instructions

2.4 Trial Usage

- .1 The Owner 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 Owner 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 workmanship of any kind.

PART 3 - EXECUTION

3.1 Not Used

END OF SECTION

Siamese Connections

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Materials

- .1 Siamese connection: C.F.H. National Fire Equipment or Impaction Firequip Inc., 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 Siamese: C.F.H. Model 229 Flush type with working as specified below, cast into face plate.
- .3 Siamese shall bear the following working as applicable.
 - Standpipe fire department connection
 - Sprinklers fire department connection
 - Or
 - 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 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 Sprinkler system shall conform to applicable N.F.P.A. Standards 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 Consultant.

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
Penthouse Areas, Ground Floor Lobby, Ground Floor Retail	Ordinary Group 1	4.9 (0.12)	279 (3000)	Wet Type

Sprinkler Systems

Basement storage, Electrical , Pool and Mechanical rooms	Ordinary Group 1	4.9 (0.12)	279 (3000)	Wet Type
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Pool and Change Rooms	Light (HC-1)	4.1 (0.10)	139.5 (1500)	Wet Type.
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- .2 Where quick response sprinkler heads are used in the design, the area of protection shall not be reduced. Quick response heads shall be provided where required in accordance to NFPA 13.
- .3 Where systems are hydraulically designed obtain water flow data of street mains. The estimated static pressure at the street is 317.2 kPa (46psi). The estimated residual pressure at the street with a flow of 144.4 L/s (2288 USGPM) is 165.5 kPa (24psi). Submit all calculations and data on approved forms with Shop Drawings. Refer to the attached "Hydrant Water test Summary report" dated 7th July, 2017 for additional details.
- .4 Shop Drawings: Submit sprinkler drawing layouts in accordance with Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS showing all component parts complete with Shop Drawings of all pumps, starters, valves and accessories to I.A.O. (F.M.) and to the Consultant 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 Work. The Contractor's design Engineer shall provide periodic review in accordance with all applicable requirements of their licence 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.
- .5 Submit hydraulic calculations in approved formats.
- .6 Samples: Submit samples of all hangers for review.
- .7 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 21 08 03.00 – 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 Owner to ensure a thorough understanding of the equipment and its operation.
 - .2 At the completion of the installation submit a complete set of CADD Record Drawings as outlined in Section 21 05 02.00 – Record Drawings. Record Drawings shall be complete including all valve tag numbers and symbols.

Sprinkler Systems

.8 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

1.5 Qualifications

- .1 The installation company shall be a member of the Canadian Sprinkler Association and regularly engaged in this work.
- .2 Acceptable sprinkler companies are:
 - .1 Simplex Grinnell Fire Protection
 - .2 Vipond Sprinklers
 - .3 Paul & Douglas Sprinkler
 - .4 Viking Fire Protection
 - .5 Forest City Fire Protection

PART 2 - PRODUCTS

2.1 Materials

- .1 General:
 - .1 All components used in the sprinkler system shall be U.L.C. listed. UL or FM listed equipment not bearing a U.L.C. 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 1206 kPa (175 psi) working pressure shall be as follows:
 - .1 Pipe, black steel, Schedule 40, A.S.T.M. A53.
 - .2 Fittings for a minimum of 1206 kPa (175 psi) working pressure, 1035 kPa (150 psi) malleable iron ASME B16.3, 860 kPa (125 psi) cast iron ASME B16.4, butt welding schedule 40 ASME B16.25, or roll grooved Victaulic, Gruvlok or Tyco.
 - .3 Dry pipe and fittings for all projects shall be galvanized.
 - .4 Pipes and fittings installed within the Aquatic Hall, Change room, Pool washroom, pool storage rooms and pool mechanical rooms shall be galvanized.
 - .5 All valves shall be U.L.C. listed.
 - .6 Gate valves 50 mm (2 in.) and smaller, all bronze O.S. & Y screwed, 1207 kPa (175 psi) working pressure. Crane No. 459.
 - .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. Victaulic Series 728 Firelock.

Sprinkler Systems

- .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. Milwaukee Valve BB-SCS02.
- .9 Gate valves 65 mm (2-1/2 in.) and larger iron body bronze mounted, O.S. and Y flanged or grooved ends. Crane No. 467.
- .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. Victaulic Series 705 W Firelock, Gruvlok GN7722-3D, or Tyco BFV-1.
- .12 Check valves 50 mm (2 in.) and smaller, all bronze replaceable seat, screwed ends. Crane No. 137.
- .13 Check valves 65 mm (2-1/2 in.) and larger iron body, bronze mounted, flanged or grooved ends. Crane No. 375, Victaulic Series 717 Firelock, Gruvlok 78FP or Tyco CV-1F.
- .14 All grooved products including couplings, fittings and valves shall be of one manufacturer.
- .15 Fittings with grooved connections at all legs of the fitting or couplings, shall be equal to Victaulic 920, Tyco/Central Figure 730, or Gruvlok Figure 7045 Clamp-T will be accepted. 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.
- .3 Alternative pipe downstream of alarm check valve, (galvanized) Schedule 10 to ASTM-A795 minimum roll grooved ends for 1200 kPa (175 psi) working pressure.
- .4 No grooved fittings or products shall be used except for those specified. All grooved products shall be of one manufacturer.
- .5 Pipe valves and fittings over 1206 kPa (175 psi) working pressure shall be as follows:
 - .1 Pipe, black steel, schedule 40, A.S.T.M. A53 (up to 2070 kPa (300 psi)).
 - .2 Fittings, 2070 kPa (300 psi) malleable iron ASME B16.3, 1720 kPa (250 psi) cast iron ASME B16.4, or butt welding schedule 40 ASME B16.25.
 - .3 Dry pipe and fittings for all F.M. projects shall be galvanized.
 - .4 Gate valves 50 mm (2 in.) and smaller all bronze, rising stem, screwed Class 200, Crane No. 459 U.L. listed and to local authorities approval.
 - .5 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. Equal to Victaulic Series 728 Firelock,
 - .6 Gate valves 65 mm (2-1/2 in.) and larger, steel body, flanged or welded, Exalloy stellite trim, O.S. & Y equal to Class 1930 kPa (150 to 280 psi) Crane No. 47XUF or Kitz 150SCL and Class 300 above 1930 kPa (280 psi) Crane No. 33XUF or Kitz 300 SCL, and to local authorities approval.

Sprinkler Systems

- .7 Check valves 50 mm (2 in.) and smaller all bronze, swing check, class 200, to local authorities approval.
- .8 Check valves 65 mm (2-1/2 in.) and larger, steel body, flanged or welded Exalloy trim, equal to Class 1930 kPa (150 to 280 psi) Crane 147X or Kitz 150SCO, and Class 300 above 1930 kPa (280 psi) Crane 159X or Kitz 300SCO, and to local authorities approval.
- .9 Express riser shall be welded pipe and fittings.
- .6 Alternative pipe downstream of alarm check valve, (galvanized) Schedule 10 to ASTM-A795 minimum roll grooved ends for up to 2070 kPa (300 psi) working pressure.
- .7 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.
- .8 Sight glasses shall be 1207 kPa (175 psi) working pressure.
- .9 Hangers, hanger rods and inserts in all parking and ramp areas shall meet the requirements of CAN/CSA-S413-94 and shall be of corrosion resistant material or shall have an effective, durable, corrosion resistant coating.
- .10 Provide approved type backflow prevention complete with supervised valves, on glycol loops.
- .11 The pressure reducing valves on the sprinkler down-feed riser shall be hydraulically operated globe valve with U.L.C. label rated at 1206 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.
- .12 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.
- .13 Alarm flow switches shall be U.L.C. approved and equal to Potter VSR-F. Wiring to annunciator panel shall be by the Electrical Division – Division 16.
- .14 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 – Division 16. Plug in type switches are not acceptable. Switches shall be equal to Potter OSYSU.
- .15 Alarm check valve shall be complete with all appurtenances including contacts for wiring to the building fire alarm system for low pressure and flow, water gong mounted where shown or directed, electric alarm bell mounted where shown or directed, and all valve, gauges, fittings and drains. Victaulic Series 751 Firelock, Tyco AV-1-175/AV-1-300, or Viking Model J-1.
- .16 Dry pipe valve shall be complete with all appurtenances as noted above with the addition of compressed air connection. Victaulic Series 756 Firelock, Tyco/Grinnell F3061, Tyco/Central Sprinkler DPV-1, or Viking Model F-1.

Sprinkler Systems

- .17 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).
- .18 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 of 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.
- .19 Pressure switches shall be U.L.C. 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.
- .20 Pressure gauges shall be 6 mm (1/4 in.) NPT, (3-1/2 in) dial, 1207 kPa (175 psi) working pressure.
- .21 Sprinkler zone control cabinets shall be recessed type, 1.19 mm (0.0478 in. – 18 M.S.G.) 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 M.S.G.) 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.
- .22 Sprinkler heads shall be the automatic spray type, U.L.C. listed and as approved by I.A.O. or F.M. 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.
- .23 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/Central TY3131, Victaulic V2704.
- .24 Sprinkler heads in finished or unfinished areas with acoustic or gypsum wall board ceiling indicated as light or ordinary hazard shall be quick response, standard coverage, chrome plated heads, pendent with chrome plated escutcheon. Reliable Model F1FR, Viking Microfast Model M, Tyco/Central TY3231, Victaulic V2708.
- .25 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/Central TY3331, Victaulic V2710.
- .26 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/Central TY3332, Victaulic V3802.

Sprinkler Systems

- .27 Sprinkler heads in secured or institutional finished areas with gypsum wall board ceiling and/or walls indicated as light hazard or ordinary hazard shall be quick response, standard coverage, tamper resistant chrome plated heads, pendent or horizontal sidewall as applicable with chrome plated escutcheon and retaining flange. Reliable Model XL, Viking HQR-2, Tyco/Central TFP MAX.
- .28 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 G4A, Viking Mirage, Tyco/Central RFII, Victaulic V3802.
- .29 Window sprinkler heads shall be Tyco/Central Sprinkler Model WS horizontal or pendent vertical sidewall and installed to comply with Architectural Details.
- .30 Sprinklers located in pool areas, pool chemical storage areas, and pool mechanical room areas shall be complete with the manufacturer's applied, approved waxed coating.
- .31 Provide extended coverage sprinkler heads only as required by N.F.P.A. to satisfy general sprinkler head layouts as shown without reducing the area of protection.
- .32 Unless otherwise specified, hangers shall conform to the requirements of N.F.P.A. 13.
- .33 Connection between fire protection system and the domestic water system shall have a double check valve assembly conforming to CSA B 64.5 and with U.L.C. listing and components. For all 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 backflow preventer assembly conforming to CSA B 64.4 and with U.L.C. listing and components. All valves shall be supervised, and shall be of one of the manufacturers listed under the Pipes, Valves and Fittings Section.
- .34 Fire department connections shall be in accordance with Section 21 11 19.00 – SIAMESE CONNECTIONS.
- .35 Site main shall be ductile iron (cement lined ductile iron) (J.M. Blue Brute plastic pipe with C.I.M.J. fittings.)

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 Owner's Insurers and the Consultant 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 I.A.O. or F.M. 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.

Sprinkler Systems

- .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.
- .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 installation of additional sprinkler heads.
- .9 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.
- .10 Provide all alarm 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.
- .11 In all office areas, any additional sprinkler heads added to the floor because of increased requirements, shall be piped directly from the loop main.

3.2 Electrical

- .1 Perform electrical wiring to tracing from dedicated power source. Wiring shall be in accordance to requirements specified in Electrical Division.
- .2 Electrically trace drum drips and quick opening devices on dry pipe, and insulate in accordance with the requirements specified in the Insulation and Electric Tracing Sections.

3.3 Testing of System

- .1 All testing shall be executed in accordance with the latest regulations of N.F.P.A 13 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:
- .5 Main drain test connections
 - .1 On-floor test connections.
 - .2 System, main drain or sectional drain connections.

END OF SECTION

Portable Fire Extinguishers

PART 1 - GENERAL**1.1 Work Included**

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Related Work Specified Elsewhere

- .1 Finish painting for prime painted cabinets – under Section 09 90 00.00 – PAINTING AND COATING.

PART 2 - PRODUCTS**2.1 Materials**

- .1 Portable fire extinguishers shall be rated and identified in accordance with CAN/ULC-S508 "Rating and Fire Testing of Fire Extinguishers". All ratings identified below shall be considered as a minimum.
- .2 Portable fire extinguishers in Mechanical and Electrical Rooms shown as "FE-3" shall be 6A80BC rating, 4.53 kg (10 lbs.) multi-purpose dry chemical powder type and ULC labelled.
- .3 Portable fire extinguishers in kitchens shall be 1-A:K rating, 6 L (1.59 USgal.) wet chemical type, stainless steel, and ULC labelled.
- .4 Portable fire extinguishers in general areas shown as "FE-1" shall be minimum 3A40BC rating, 2.26 kg (5 lbs.) multi-purpose dry chemical powder type and ULC labelled (ammonium phosphate).
- .5 Portable fire extinguishers in pool areas (FEC-2, FE-2) shall be a minimum 3A40BC, 2.26 kg (5lbs.) multi-purpose dry chemical powder type and ULC labelled. Extinguisher shall be corrosion resistant. Extinguisher to have a zinc chromate plated steel shell, epoxy powder paint finish, stainless steel hose band and nozzle retainer, nickel plated brass valve, stainless steel handles, pull pins, levers and siphon tube.
- .6 Extinguishers in non-finished areas not accessible to the general public shall be mounted on wall brackets.
- .7 Portable fire extinguisher cabinets in finished areas shown as Type "FEC-1" shall be recessed type flush mounted, 1.19 mm (0.0478 in. – 18 M.S.G.) thick steel tub with black enamel interior and maximum inside dimensions of 254 mm x 762 mm x 203 mm (10 in. x 30 in. x 8 in.) deep. Front shall be adjustable with black enamel trim, 1.2 mm (0.05 in. – 18 U.S.G.) thick 304 stainless steel No. 4 vertical grain satin finish door. Glass shall be 5mm (3/16 in.) clear. Latch shall be concealed. National Fire Equipment Model CTE300-20.

Portable Fire Extinguishers

- .8 Portable fire extinguishers cabinets in pool areas shown as Type "FEC-2" shall be recessed type with 6mm (1/4 in.) return frame, 0.76 mm (0.0299 in. – 22 M.S.G.) thick 316 stainless steel tub and maximum inside dimensions of 203 mm x 432 mm x 127 mm (8 in x 17 in x 5 in) deep. Front shall be adjustable, 1.57 mm (0.0618 in. – 16 M.S.G.) thick, 316 stainless steel door. Glass shall be 5mm (3/16 in.) clear. Hinge shall be fully concealed. Door latch shall be flush 316 stainless steel type with no visible mounting screws. All exterior metal shall be #4 satin finish stainless steel. National Fire Equipment Model CE-950-3 all 316 stainless steel.

PART 3 - EXECUTION**3.1 Installation**

- .1 Spacing of extinguishers shall conform to the authority having jurisdiction. Maximum spacing for ordinary hazard shall be 9 m (30 ft.) for 10 BC extinguisher and 15 m (50 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 general offices shall be 25 m (75 ft.).

END OF SECTION

Fire Booster Pump Systems

PART 1 - GENERAL**1.1 Work Included**

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Related Work Specified Elsewhere

- .1 Electrical hard wire supply [and connections to electrical components] – under Electrical Division.

PART 2 - PRODUCTS**2.1 Materials**

- .1 U.L.C. listed and labelled, F.M. and approved fire booster pump systems shall be Armstrong, ITT, Grundfos or Aurora packaged unit completely factory assembled and tested requiring only pipe connections and power supply. Fire booster systems shall comply with authority having jurisdiction.
- .2 Quantity: one diesel engine driven
- .3 Design: Pumps shall furnish not less than 150 percent of rated capacity at not less than 65 percent of total rated head
- .4 Maximum shutoff head: The shutoff head shall not exceed 140 percent of rated head.
- .5 Operating Conditions:
 - .1 Capacity 500 GPM
 - .2 Rated Pressure: 40 PSI
 - .3 Total discharge head (TDH): 92.4 Ft
 - .4 Voltage (120V/12V)
- .6 Pump Type:
 - .1 A-C Fire Pump Model 8100 series, Centrifugal, Horizontally split case, Drive shaft coupled, Base Mounted, CIBF
- .7 Pump Materials:
 - .1 Casing: Cast iron
 - .2 Impeller: Bronze
 - .3 Shaft: Steel
 - .4 Stuffing Box Packing: Teflon Impregnated Yarn
 - .5 Shaft Sleeve: Bronze
 - .6 Seal Tubing: Brass

Fire Booster Pump Systems

- .7 Connections: Flanged class 125, ASME B16.1
- .8 Bearings: Steel
- .8 Provide fire pump accessories in accordance with NFPA 20 including but not limited to:
 - .1 One automatic air release valve
 - .2 One pump discharge gauge, range 0-300 with shutoff cock
 - .3 One compound pump suction gauge, range -30-0-200 with shutoff cock
 - .4 Common rigid structural steel baseplate (elevated as required) for each pump and its associated drive
 - .5 Drive Shaft, with OSHA approved guard
 - .6 One manufactures nameplate for pump, stating:
 - .1 Pump capacity
 - .2 Total head
 - .3 Pump RPM
 - .4 Pump, Driver and Controller Manufacturer's model and serial number
 - .5 Casing working pressure
 - .6 Acceptable manufacture's A-C Fire Pump
 - .7 Pump Design and Construction: Pump shall be UL Listed and FM Approved
- .9 Jockey (Pressure maintenance) Pump:
 - .1 Quantity: one
 - .2 Configuration: Vertical
 - .3 Type: Centrifugal or multistage diffuser, direct drive by electric motor
 - .4 Materials:
 - .1 Casing: Cast iron and stainless steel
 - .2 Shaft: Steel
 - .3 Trim and impeller: stainless steel
 - .5 Operating Conditions:
 - .1 Capacity: 5 GPM
 - .2 Total head (TDH): 50 PSIG
 - .3 Maximum Shutoff Head: 65 PSIG
 - .4 Speed: 3500 RPM Maximum
 - .5 Voltage: 120/1/60
 - .6 Provide accessories including but not necessarily limited to:

Fire Booster Pump Systems

- .1 a. Common structural steel baseplate for pump and drive elevated as required
 - .2 b. Motor: TEFC, 1.15 service factor, Nema design B, 120/1/60
 - .7 7. Manufacturer's nameplate stating:
 - .1 Pump capacity
 - .2 Total head
 - .3 Manufacture's model number and serial number
 - .8 8. Acceptable manufactures: Goulds (A Xylem Brand)
- .10 Diesel Engine Drive:
 - .1 Quantity: One
 - .2 Type: direct drive, designed for operation on diesel fuel for fire pump service, in
 - .3 accordance with NFPA 20
 - .4 Horse Power Rating: Not less than 110 percent of maximum brake horsepower (after derating for temperature and elevation in accordance with NFPA 20, required to drive the pump at rated speed.
 - .5 Engine Manufacturer: Clarke
 - .11 Provide accessories for each drive including but not limited to the following:
 - .1 Adjustable governor capable of regulating speed within range of 10 percent between shutoff and maximum load conditions of pumps.
 - .2 Overspeed shutdown device
 - .1 Designed to stop engine at 20 percent above rated speed
 - .2 Position: Supervised so automatic controller will show overspeed trouble signal until shutdown device is manually reset
 - .3 Manual reset
 - .3 c. Speed Switch:
 - .1 Function: Signal engine running and crank termination.
 - .2 Source of Power: Source other than engine generator or alternator.
 - .4 Instrument Panel including but not limited to
 - .1 Tachometer
 - .2 Oil pressure gauge
 - .3 Water temperature gauge
 - .4 Hour meter
 - .5 Ammeter
 - .5 In line fuel filter.

Fire Booster Pump Systems

- .6 Oil pressure safety switch.
 - .7 Air cleaner.
 - .8 Engine driven oil pump.
 - .9 .Enclosed control wiring.
 - .10 Electric starter with voltage regulator.
 - .11 Two heavy duty 12 volt batteries,with corrosion resistant battery rack and cables as required; charged from engine generator or alternator and automatic trickle charger
 - .12 Residential grade engine exhaust silencer with spark arrestor, flexible exhaust connection and ventilated thimble (as required) A flexible connector with threaded connections shall be provided at the engine. Flexible sections shall be stainless steel suitable for diesel-engines exhaust gas at 1000 degree F minimum
 - .13 Horizontal factory painted double wall carbon steel ULC S601 labeled fuel storage tank, level gauge, low level fuel switch, fuel leak detector switch, vent with flame arrestor, and necessary connections for fill, outlet and fuel return. The fuel tank shall have a capacity at least equal to 1 gal per horsepower plus 5 percent volume for expansion and 5 percent volume for sump per NFPA 20 r. Fuel tank piping shall be carbon steel with lockable valve in supply line, there shall be no shutoff valve in the return fuel piping.
 - .14 Fuel oil level system.
- .12 Diesel Fire Pump Controller:
- .1 The Fire Pump Controller shall meet the requirements of NFPA 20.
 - .2 The controller shall have twin battery chargers meeting NFPA 20 requirements. The battery chargers shall have reverse polarity protection/indication and be capable of recharging a completely discharged battery within 24 hours. The chargers shall auto detect the input voltage of 120 VAC and shall be able to be programmed for either 120 VDC or 24 VDC output
 - .3 A solid state pressure transducer shall be installed in a bulkhead in the enclosure bottom so that all plumbing connections are made external to the controller. The controller piping and pressure system shall be rated for pressures up to 600 psig within +/- 1.5 % accuracy.
- .13 Jockey Pump Controller
- .1 Function: Cycling jockey pump to maintain system pressure of (TBD) psig; pump shall start at (TBD) and shut off at (TBD).
 - .2 Jockey pump controller
 - .3 controller
 - .4 The jockey pump controller shall be of the Full Voltage Starting type

Fire Booster Pump Systems

- .5 The controller shall be rated NEMA 2
- .6 The jockey pump shall have as a minimum but not limited to the following alarms:
 - .7 a. Power Failure
 - .8 b. Phase Reversal
 - .9 c. Pump Running
- .14 The jockey pump shall have as a minimum but not limited to the following standard features:
 - .1 Horsepower rated disconnect switch, fuse block and fuses
 - .2 Horsepower rated motor contactor and overload relay
 - .3 Minimum run timer to prevent short cycling of pump
 - .4 HAND-OFF-AUTO HMI interface to allow manual operation of the pump.
 - .5 0-300 psi pressure switch suitable for freshwater applications.

PART 3 - EXECUTION**3.1 Installation**

- .1 Booster Pump installation shall conform to applicable N.F.P.A. Standards and to all local authorities' requirements.
- .2 Mount the entire assembly on a structural steel framework. Provide a pressure relief valve piped to drain in pump discharge.

END OF SECTION

Water Meter

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Materials

- .1 Water meter shall be Neptune Compound acceptable to local authorities.

PART 3 - EXECUTION

3.1 Installation

- .1 Install water meter in accordance with manufacturer's instructions and to the satisfaction of the local authority, complete with valved by-pass.
- .2 Water meter will be supplied by the local authorities. Include for the cost of supply and installation of accessories and incidental components necessary for a complete and functioning meter installation, including valved by-pass.

END OF SECTION

Cleanouts

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

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-UR-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 Consultant 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

Pipes, Valves and Fittings (Plumbing System)

PART 1 - GENERAL**1.1 Work Included**

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

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 city and domestic water, above grade, 75 mm (3 in.) and smaller, less than 1380 kPa (200 psi) working pressure:
 - .1 Pipe: Copper Tubing, Type “L”, Hard Drawn, ASTM B88. Fittings: wrought copper solder joint pressure fittings, ANSI/ASME B16.22 or cast copper alloy solder joint pressure fittings, ANSI/ASME B16.18.
 - .2 Joints made with 95-5 tin antimony, 96-6 tin silver, or 96-4 tin silver solder, ASTM B32.
 - .3 Grooved end copper fittings conforming to ASTM B75 /B75M-11.
 - .4 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 EHP gasket, rated for -35 deg. C. to 121 deg. C. (-30 deg. F. to 250 deg. F. Victaulic 607.
 - .2 Copper tubing standard coupling complete with EPDM flush seal gaskets rated for -35 deg. C. to 110 deg. C. (-30 deg. F. to 230 deg. F.) Victaulic 606.
 - .5 Butterfly valves, bubble-tight service up to 2065 kPa (300 psi) with bronze body Victaulic 608.
 - .6 Gate valves, 860 kPa (125 psi) WSP or 1380 kPa (200 psi) non-shock WOG with bronze body, rising stem screwed. Crane #428, Jenkins #810J, Toyo 293 or Kitz 24, for threaded ends or Crane #1334, Jenkins #813J, Toyo 299 or Kitz 44 for solder ends.
 - .7 Globe valves, 860 kPa (125 psi) WSP or 1380 kPa (200 psi) non-shock WOG with bronze body, solder ends or with screwed to solder adapter and composition disc for water service. Crane #1310, Jenkins #106BPJ, Toyo 222 or Kitz 10.
 - .8 Check valves 860 kPa (125 psi) WSP or 1380 kPa (200 psi) non-shock WOG with bronze body, swing check, solder ends. Crane #1342, Jenkins #4093J, Toyo 237 or Kitz 23.

Pipes, Valves and Fittings (Plumbing System)

- .9 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.
- .10 Strainers shall be Bronze Y body equal to Colton Industries Model 125YTB, Mueller 351M.
- .11 Drain valves and blow-off valves shall be 4137 kPa (600 psi) WG 19 mm (3/4 in.) ball valves with bronze body or forged brass body, solid ball, male threaded garden hose end, brass cap and chain equal to Watts B-6000, Toyo 5046, Kitz 58CC or Apollo 78-100.
- .12 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 U.L.C. vacuum breaker.
- .3 All city and domestic water above grade 100 mm (4 in.) and larger, less than 1380 kPa (200 psi) working pressure.
 - .1 Pipe: Copper Tubing, Type "L", Hard Drawn, ASTM B88. Fittings: wrought copper solder joint pressure fittings, ANSI/ASME B16.22 or cast copper alloy solder joint pressure fittings, ANSI/ASME B16.18
 - .2 Joints made with 96-6 tin silver, or 96-4 tin silver solder, ASTM B32.
 - .3 Grooved end copper fittings conforming to ASTM B75.
 - .4 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 EHP gasket, rated for -35 deg. C. to 121 deg. C. (-30 deg. F. to 250 deg. F. Victaulic 607.
 - .2 Copper tubing standard coupling complete with EPDM flush seal gaskets rated for -35 deg. C. to 110 deg. C. (-30 deg. F. to 230 deg. F.) Victaulic 606.
 - .5 Butterfly valves, bubble-tight service up to 2065 kPa (300 psi), with bronze body. Victaulic 608.
 - .6 Joint shall be Victaulic where exposed and screwed or flanged where concealed.
 - .7 Stainless steel pipe may be used as an alternative material on sizes 100 mm (4 in.) and over if acceptable to Local Authorities.
 - .8 Gate valves, 860 kPa (125 psi) WSP or 1380 kPa (200 psi) non-shock WOG with iron body, bronze mounted, outside screw and yoke, and flanged ends, Crane #465 1/2, Jenkins #454J, Toyo 421 or Kitz 72.
 - .9 Globe valves, 860 kPa (125 psi) WSP or 1380 kPa (200 psi) non-shock iron body, bronze mounted, outside screw and yoke, flanged ends and composition disc for water service. Crane #351, Jenkins #2342J, Toyo 400A or Kitz 76.
 - .10 Check valves 860 kPa (125 psi) WSP or 1380 kPa (200 psi) non-shock WOG with iron body, bronze mounted, swing check, flanged ends. Crane #373, Jenkins #587J, Toyo 435A or Kitz 78.

Pipes, Valves and Fittings (Plumbing System)

- .11 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, or Mueller Sure Check #72-HHH-3-H.
- .12 Strainers shall be flanged cast iron Y body equal to Colton Industries Model 125YFI or Mueller #758.
- .13 Drain valves and blow-off valves shall be 4137 kPa (600 psi) WG 19 mm (3/4 in.) ball valves with bronze or forged brass body, solid ball, virgin Teflon seat and packing, male threaded hose end, brass cap and chain. Equal to Watts B-6000, Toyo 5046, Kitz 58CC or Apollo 78-100.
- .4 All city and domestic water below grade 50 mm (2 in.) and smaller:
 - .1 Soft copper Type K conforming to ASTM B88-83.
 - .2 Minimum number of joints using 95-5 tin-antimony or tin-silver solder.
 - .3 Gate valves, bronze body, non-rising stem, extension sleeve and box to grade, to local authorities approval.
- .5 All city and domestic water below grade 65 mm (2-1/2 in.) and larger:
 - .1 Copper pipes Type L with wrought or cast couplings and fittings conforming to ASTM B88-83 etc.
 - .2 Joints made with silver solder.
 - .3 Alternate for buried pipe; cast or ductile iron.
 - .4 Gate valves, AWWA iron body, non-rising stem, extension sleeve and box to grade, to local authorities approval.
- .6 Storm and sanitary drains and vents above grade shall be cast iron or copper pipe installed as in regulations, except where copper pipe is used, joints to be made with 95-5 solder. ABS and PVC pipes are not acceptable.
- .7 Vent stack covers shall be equal to Thaler Metal Industries SJ-24/SJ-25 and shall be 1100-OT alloy aluminum with vandal proof removable cap and EPDM base seal, pvc coated deck flange or bituminous deck flange as required to suit roof membrane.
- .8 Buried storm and sanitary inside the building shall be SDR 28 rigid for 100mm (4 in.) to 150mm (6 in.), SDR 35 for 200mm (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 CAN/CSA B182.2 with assembled with PVC pipe lubricant.
- .9 All embedded pipe and materials in parking structures and ramps shall meet the requirements of CAN/CSA S413-94 for corrosion resistant materials or shall have a corrosion resistant coating.
- .10 Sump and sewage pump discharge shall be Schedule 40 galvanized steel pipe with galvanized malleable iron fittings or Type "L" copper.
- .11 Field tile shall be vitrified clay pipe or No-Co-Rode pipe.

Pipes, Valves and Fittings (Plumbing System)

- .12 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 iron body, one piece or split alloy steel shaft, top and bottom bearings, bronze disc or 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.
 - .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 shall be equal to Keystone Model 222-784, Dezurik Model BOS-CL, Challenger Model 20-CN4E, Bray Series 31, Apollo 143 Series, Kitz 61 Series, Centreline 200 or Crane 44.
 - .7 Butterfly valves for grooved end systems shall be Victaulic 608.
- .13 Back-flow preventers for connection to wall hydrants, hose bibs, hot water heating systems, and similar uses, shall be Watts No. 9 or 909 or Hersey-Beeco with C.S.A. listing.
- .14 Double check valve backflow preventers shall be complete with OS&Y gate valves, replaceable seats, spring loaded check valves, serviceable in-line equal to Zurn-Wilkens Model 950. Maximum pressure drop shall be 34 kPa (5 psi) at 31.5 L/s (500 g/m).
- .15 Ball valves 50 mm (2 in.) and smaller shall be 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. B-6000, Toyo 5044A/5049A, Kitz 58/59 or Apollo 70-100/200. Stem extensions shall be provided on all ball valves. Ball valves may be substituted for gate valves only.
- .16 Except where special feature 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. Valves shall be manufactured by Crane, Jenkins, Toyo or Kitz. Butterfly valves shall be by Keystone, DeZurik, Bray, Challenger, Centerline, Crane, Apollo, Kitz or Victaulic. Non-slam check valves shall be Pro-Quip, Duo CHEK II, Centerline, Mueller or Victaulic. Ball valves shall be Apollo, Watts, Crane, Jenkins, Toyo or Kitz. Valves shall be equal to the model numbers specified.
- .17 Pressure reducing valves 65 mm (2-1/2 in.) and larger shall be equal to Cla-Val 90-01 with capacity shown and a pressure drop not exceeding 70 kPa (10 psi) under full flow. Valve shall maintain downstream pressure within a range of plus or minus 35 kPa (5 psi). Required outlet pressure, inlet pressure and flow rate as shown. Alternate manufacturers will not be accepted.
 - .1 This valve shall maintain a constant downstream pressure regardless of fluctuations in demand and shall also prevent a pressure rise when demand is zero.

Pipes, Valves and Fittings (Plumbing System)

- .2 Valve shall be single-seated, hydraulically operated, pilot controlled diaphragm type globe valve. Valve stem shall be top and bottom guided and shall be actuated by a resilient diaphragm. Valve body and cover shall be cast iron, flanged. Trim shall be bronze type. Valve seat shall be replaceable. There shall be no external packing glands.
- .3 Pilot control shall be a direct acting, adjustable, spring-loaded valve with bronze body and stainless steel trim.
- .4 Main valve, pilot control valve and all trim shall be factory-assembled into one unit.
- .5 Valve shall be Class 125 for low pressure systems less than 1380 kPa working pressure and Class 250 for high pressure systems greater than 1380 kPa (200 psi) working pressure.
- .6 Pressure reducing valves 50 mm (2 in.) and smaller shall be Cash Acme, or Watts to Watts UB5 bronze body, screwed. Rating of valve shall be 2070 kPa (300 psi) at 71 deg. C. (160 deg. F.).
- .7 See drawing for capacities and operating pressures.
- .18 Combination pressure reducing and check valve shall be Cla-Val 790-01-D and shall be as specified for the pressure reducing valve, but with an integral check valve.
- .19 Backwater valves shall be Mainline "Adapt-a-valve complete with removable seat and gate (Cassette) allowing for full servicing, extendable cassette, 3" valve with 4" pipe extensions and 3/4" cassette extension.
- .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 Z-1700, Mifab WHB, Watts SS Series. Piston type shall not be acceptable.
- .21 Gate valves in sanitary drains shall be equal to Seguro rubber sealed, cast iron, Class 150, ASA B16.10, with ASA B16.1 flanged ends, with OS&Y rising stem operation.
- .22 Exterior site sewers shall be PVC non-pressure, SDR 28, asbestos cement, or concrete of class and type to suit depth of trench and bedding. PVC non-pressure sewer piping shall be Ipex or Canron for sizes 100 mm (4 in.) to 150 mm (6 in.) conforming to CSA B182.1 ASTM D 3034. For sizes 200 mm (8 in.) to 375 mm (15 in.) shall be Canron conforming to CSA B182.2 and ASTM D3034. For size 450 mm (18 in.) to 1200 mm (48 in.) shall be Ipex or Canron conforming to CSA B182.4 and ASTM F794. Sewers shall be laid in accordance with manufacturers instructions and in accordance with Sub-section 3.5 of Regulation 815/84 the O.W.R.A. (Ontario Plumbing Code).
- .23 Exterior site PVC pressure piping shall be Ipex or Canron Blue-Brute conforming to AWWA-C900 and CSA B 137.3 standards laid in accordance with the manufacturers instructions and in accordance with Sub-section 3.5 of Regulation 815/84 of the O.W.R.A. (Ontario Plumbing Code).
- .24 Thermostatic mixing valves

Pipes, Valves and Fittings (Plumbing System)

- .1 Thermostatic mixing valves shall be Lawler Series High-Low Water Mixer 804 combination thermostatic and pressure balanced water controller, 38mm (1-1/2 in.) inlet and 50 mm (2 in.) outlet, liquid filled motor. 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.

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 Gate 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 Back-flow preventers shall be installed for connections to wall hydrants, hose bibs, hot water heating systems, as shown on drawings, and any other connection to potable water systems in which backflow may occur, shall be Watts No. 9 or 909 or Hersey-Beeco with CSA listing. Where hose bibs and wall hydrants are provided with an approved vacuum breaker the back-flow preventer is not required. An approved double check valve device may be used in lieu of a back-flow preventer where approved by CSA.
- .7 Check valves shall be installed as shown and where required to prevent backflow.
- .8 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.
 - .1 Bedding types shall be Class A or Class B as detailed Standard Drawings for concrete, vitrified clay or asbestos cement pipes or the manufacturer's equivalent with minimum load bearing factors of 2.8 and 1.9 respectively.
- .9 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 Installation manual of the Ontario Concrete Pipe Association.
 - .2 Design data of the American Concrete Pipe Association as distributed by the Ontario Concrete Pipe Association.

Pipes, Valves and Fittings (Plumbing System)

- .3 Cast iron soil pipe and fittings handbook of the cast iron soil pipe institute.
- .4 Sewer pipe manual of Cannon.
- .5 Sewer Design & Construction of the Water Pollution Control Federation.
- .6 The Blue Brute and Ring Tite PVC gravity sewer pipe installation Guide by Manville.
- .10 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.
- .11 PC4 jointing material shall not be used on underground 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.
- .12 Connections between copper and steel pipe shall be made with brass or bronze fittings where other type of connection is not specified in regulations.
- .13 All piping shall run parallel with closest wall.
- .14 Piping in walk-in pipe spaces shall be installed as close to one wall as possible.
- .15 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 PD1-WH201.
- .16 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.
- .17 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.
- .18 Provide all mechanical piping and fitting within the cistern. Rainwater cistern floating device shall intake water 150mm below the water surface and shall ensure that the foot valve is always submerged.
- .19 Provide a thermostatic mixing valve on discharge of domestic hot water systems.

END OF SECTION

Packaged Booster Systems

PART 1 - GENERAL**1.1 Work Included**

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

PART 2 - PRODUCTS**2.1 Materials**

- .1 Packaged booster system shall be manufactured by Armstrong, Grundfos-Paco, ITT, or Taco Industries, completely factory assembled, tested and calibrated unit requiring connection of piping and power supply only.
- .2 Pumps shall be vertical in-line, centrifugal type, complete with gate valves, pressure reducing valves, check valves, pressure gauges, thermal bleed circuits piped to drains, wiring, conduit and interconnecting piping, neatly arranged and firmly supported by the framework of the unit.
- .3 The control panel shall incorporate the following features:
 - .1 E.E.M.A.C. 3R sprinkler proof enclosure
 - .2 Main disconnect switch
 - .3 Fused circuit or circuit breaker for each motor
 - .4 Magnetic starters with overloads
 - .5 Current sensing device
 - .6 Selector switch for each pump
 - .7 Control circuit transformer
 - .8 Time delay relay or minimum run timer as applicable
 - .9 Low limit pressure switch
 - .10 Low pressure alarm light
 - .11 High pressure cut-out switch
 - .12 Electrical alternation
 - .13 Power on indicating light
 - .14 Overload indicating light
 - .15 Panel mounted gauges
 - .16 Amp meters for each pump
- .4 All components shall be assembled on a fabricated steel baseplate with structural steel framework, adequately ribbed and braced to ensure rigidity. Rubber mounts shall be provide to isolate all pipework from the baseplate assembly.

Packaged Booster Systems

Overall dimensions of the package shall be such as to permit passage through standard door frames of sizes scheduled on Architectural Drawings.

- .5 Electric motors shall be of one of the manufacturers specified in Section 21 05 13.00 – ELECTRIC MOTORS; valves shall be of one of the manufacturers specified in Section 22 11 13.00 – PIPES, VALVES AND FITTINGS (PLUMBING SYSTEMS). No substitutes permitted. All pipe and fittings shall be copper and bronze or stainless steel.
- .6 Combination pilot operated check and pressure reducing valve assembly shall be mounted on the pump package. Pressure reducing valve shall be Cla-Val 90-01D complete with resilient synthetic rubber disk, stainless steel seat, and stainless steel stem guided at both the top and the bottom of the valve. The body shall be of bronze construction. The pressure reducing pilot control shall be a direct-acting, adjustable, spring-loaded, normally open, diaphragm valve to permit flow when controlled pressure is less than the spring setting. The pilot system shall include an opening speed control on all valves. The pilot control shall have a second downstream sensing port which can be utilized to install a pressure gauge. A full range of spring settings shall be available in ranges of 0 to 450 psi.
- .7 All other pipe, valves, and fittings shall conform to Section 22 11 13.00 – PIPES, VALVES AND FITTINGS (PLUMBING SYSTEMS). Failure to comply with all requirements in this section will cause rejection of the entire packaged booster system.
- .8 Pump capacity shall be as shown in the Pump schedule.

PART 3 - EXECUTION**3.1 Installation**

- .1 Adjust packaged unit to match actual field working conditions.

END OF SECTION

Circulators

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Materials

- .1 Circulators shall be Armstrong, Taco, Grundfos or ITT Industries in the line type with flanged inlet and outlet, mechanical seal and suitable for 125 psig working pressure.
- .2 For domestic water systems pump shall be all bronze with brass impeller.
- .3 For 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 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

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 S.S. screws, 100 mm (4") throat on strainer. Drain shall be complete with trap primer connection. J.R. Smith 2005ASS, Zurn ZXSS-415-B5, Mifab F1000C-5-3, Watts FD-1100-C-5-3.
- .2 Floor drains in quarry or mosaic tiled areas shall be similar to floor drains in finished areas but with 127 mm x 127 mm (5" x 5") square nickel bronze strainer. J.R. Smith 2005B, Zurn ZN-415-Y5, Mifab F1100C-S5-1, Watts FD-100- C-L5-1.
- .3 Floor drains in quarry or mosaic tiled areas and stainless steel top shall be similar to floor drains in finished areas but with 127 mm x 127 mm (5" x 5") square stainless steel strainer with No. 4 satin finish. J.R. Smith 2005BSS, Zurn ZN-415-Y5, Mifab F1000C-S5-3, Watts FD-1100- C-L5-3.
- .4 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 2005A-A6-3591 NB, Zurn ZN-415-BF, Mifab F1100C-EG-1, Watts FD-100-C-EG-1.
- .5 Floor drains in Safety Sheet Vinyl Flooring Areas shall be similar to floor drains in finished areas but with 2 piece flashing clamp collar. JR Smith 2051, Zurn ZN-415-R9, Mifab F1100C-FC9-1, Watts FD-100-C-FC9-1.
- .6 Hub drains shall be similar to floor drains in finished areas but with cast iron hub. J.R. Smith 2005-2645, Zurn ZN-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. J.R. Smith 2320, Zurn Z-536, 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 2320-3591, Zurn Z-536-FO, Mifab 1320C-4-G-50, Watts FD320-4-G-50.

Floor Drains

- .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 SQ4-1753-F, Zurn ZN-211-R9, Watts FD-200-FC9-1.
- .4 Elevator pit drains shall be vertical wall or angled pit drain type, coated cast iron body, flashing clamp, integral backwater valve and cast iron secured grate. J.R. Smith 7000-C, Zurn Z-629-C, Mifab BV1210, Watts BV-600.
- .5 Electronic automatic trap seal primer system shall have 12 mm (1/2 in.) connection be complete with integral ball valve, backflow preventer and vacuum breaker. The unit shall be pre-piped with a copper manifold and distribution system suitable for the number of drains served. Electrical components to require a single point power connection at 120V. Unit shall include a manual override switch and 24 hour timer with relay and adjustable delay. All components shall be factory assembled and installed into a coated steel box with access door for recessed [surface] mounted installation. Mifab MI 100-UA series, Zurn Z1020 series or PPP PT or MPB-500 series.

2.4 Installation

- .1 Provide floor drains in air plenums on the suction and discharge side of fans with deep seal traps.
- .2 Provide a trap seal primer for all floor drain traps. Trap primer shall be installed at the nearest cold water served fixture or faucet, except drinking fountains. Provide access to primer for repair or replacement. Provide a globe valve on the water supply for regulation and shut-off.
- .3 Provide a running trap and cleanout for each pit drain.

PART 3 - EXECUTION**3.1 Not Used****END OF SECTION**

Submersible Pumps

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Materials

- .1 Sump pumps shall be Barnes, Armstrong, Scarboro Pumps, Goulds, Grundfos or Myers similar to Armstrong Series 5300. Impeller shall be open type. Shaft shall be corrosion resistant steel. Screen shall have large free area. Control shall be by water pressure operated switch, integral with the pump. Unit shall be complete with 6 m (20 ft.) waterproof cable
- .2 Submersible sump pumps shall be Leader (Barnes), Flygt or Hydromatic non-clog submersible pump.
- .3 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.
- .4 There shall be two float-operated switching mechanisms. 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.
- .5 There shall be a high water alarm switch complete with transformer and bell, auxiliary contacts for wiring to the building system.
- .6 All controls shall be mounted in a E.E.M.A.C. 3R (sprinkler proof) control panel and shall be complete with all starters, fused disconnect, power wiring, control wiring, hand-off-auto switch, pilot light for each pump, transformer and power 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.
- .7 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.
- .8 All pits (including sand settling pits and inspection pits) shall be complete with a prime painted (galvanized) steel cover plate that shall be sufficiently strong or rigid to support a service man without deflection. An inspection cover shall be provided in the cover plate. Minimum thickness shall be 6 mm (1/4 in.).
- .9 A prime painted (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.

Submersible Pumps

- .10 The size of the cover plate and frame shall be determined from the pit size shown on the Drawings.
- .11 All openings in cover plate and frame shall be gasketed for sanitary pumps.
- .12 Provide galvanized steel ladder rungs at 300 mm (12 in.) on centres for full depth of pit. Provide intermediate safety platforms on all pits over 3000 mm (10 ft.).
- .13 Obtain flow tests to determine actual flow rates before ordering pumps.
- .14 Pump capacity shall be as shown in the Pump Schedule.

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 the concrete section 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.

END OF SECTION

Domestic Water Storage Tanks and Heaters

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Materials

- .1 Tank shall be Clemmer, Reco, PVI, or Niles Steel welded steel tank lined with Precrete or Alcrete. Flanged connections shall also be lined. Screwed connection shall be Everdur. Tanks shall be designed for 860 kPa (125 psig) working pressure and shall be complete with manhole, heater flanges and tapping's for cold water, hot water recirculation, drain , relief valve, temperature controller and thermometer. Vertical tanks shall be complete with legs and floor flanges. Horizontal tanks shall be complete with saddles.
- .2 Heating element shall have seamless hard drawn copper tubes expanded into bronze tube sheets.
- .3 Connecting piping shall be installed to allow removal of heating element after disconnecting only two flanged pipe connections.
- .4 Controls for heating medium provided under Section 23 09 00.00 – BUILDING AUTOMATION SYSTEM (BAS).
- .5 Tank shall be complete with A.S.M.E. temperature pressure relief valve; valve shall be piped to drain.
- .6 Tank and heater shall be as shown on Drawings.
- .7 Tank and heater shall be as shown on Storage Tank and Heater Schedule.

PART 3 - EXECUTION

3.1 Not Used

END OF SECTION

Fixtures and Trim

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 Refer to Laboratory Furniture and Fittings section for supply, installation, connection requirements for laboratory systems.

1.2 Submittals

- .1 Submit Shop Drawings and/or catalogue cuts of all items supplied in accordance with requirements of Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

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 The flow rates of fittings that supply water to a fixture shall not exceed the maximum flow rates listed in Part 7 of the O.B.C. under the Water Efficiency section.
- .3 Fixtures shall be American Standard, Crane, Eljer or Kohler, equivalent to the fixtures specified. Fixtures shall be white.
- .4 Fittings and trim shall be American Standard, Crane, Kohler, Sloan, Chicago Faucets, Symmons, or Delta/Cambridge except where specified otherwise. All exposed valves, fittings, escutcheons, trim, etc., at each fixture shall be polished chrome plated brass, unless specified otherwise.
- .5 Fittings and trim shall be American Standard, Crane, Delta/Cambridge, Kohler, Sloan, Chicago Faucets, Symmons, or Moen equivalent to the trim specified. All exposed valves, fittings, escutcheons, trim, etc., at each fixture shall be polished chrome plated brass unless specified otherwise.
- .6 Carriers shall be furnished for all wall hung water closets, urinals, and lavatories. Carriers shall be in conformance with Section 22 42 46.00 – FIXTURE CARRIERS.

2.2 Water Closets and Urinals

- .1 All tanks of water closets shall be internally lined with anti-sweat insulation except pressure assist water closets.
- .2 All flush valves shall have non-syphon by-pass and factory set rate of flow.

Fixtures and Trim

- .3 Water closets shown as type 'WC-1 – Wall hung flush valve' shall be vitreous china with EverClean antimicrobial surface which inhibits the growth of stain and odor causing bacteria mold and mildew, elongated bowl, white finish, wall hung, siphon jet flush action, operates in the range of 4.2 L to 6 L (1.1 US Gal to 1.6 US Gal) per flush, condensate channel, 305 mm x 254 mm (12" x 10") water surface, siphon jet flush action, condensate channel, elongated bowl, 54 mm (2-1/8") fully glazed internal trapway, 38 mm (1-1/2") dia. Top spud. American Standard AFWall Millennium Flowise Elongated #3351.101.020.020 HET Toilet.
- .1 Flush valves for WC unit above shall be for Top Spud Toilet, polished chrome finish, 4.8 L (1.28 US Gal) factory set flow, quiet action 'PERMEX' diaphragm type with dual filter by-pass, infrared sensor located on a 125 mm x 125 mm (4-15/16" x 4-15/16") stainless steel plate, solenoid operated flush controller circuitry, Courtesy Flush electronic over-ride button, V.P. Smooth design stop cap on bak-check angle stop (screwdriver operated), flush tube for 292 mm (11-1/2") rough-in, high pressure vacuum breaker, sensor located above the toilet, 5 VA Power Required per unit. Provide 4" (102 mm) square electrical box for mounting sensor plate. Sloan #EL-154, Box Mount Hard Wired Transformer, 120 VAC/ 24 VAC, 50 VA. Will operate up to 10 'Optima' flush valve units. Royal Optima 111-1.28 ES-SCP
- .2 Seats for above shall be elongated heavy-duty solid plastic toilet seat, less cover, with stainless steel stainless steel check hinge and stainless steel posts, washers, and nuts. Centoco #500STSCC.
- .3 Carrier for WC unit above shall be mounted on concrete floor, all epoxy coated cast iron fitting, adjustable ABS slide nipple with integral test cap and neoprene bowl gasket, wasted plated hardware, chrome cap nuts, tiling frame, 102 mm (4") no hub waste, 51 mm (2") no hub vent, 158.8 kg (350 lbs) static load. 305 mm (12") finished metal stud wall to back of pipe space. Watts #ISCA-101-M11 single horizontal Adjustable Toilet Carrier.
- .4 Drain coupling for WC unit above shall be no-hub, type 304 AISI stainless steel band, type 304 AISI stainless steel eyelet, elastomeric compound gasket meeting the requirements of ASTM C-564, type 304 AISI stainless steel shield; painted red for easy identification, Tested to maintain 15 psi maximum line pressure at 80 inch lb min to 100 inch lb maximum torque bolt tightness, Tested by IAPMO to comply to FM 1680-1989 Standard (except for markings) and CSA B602-2010 Standard (up to 10"). They are tested and certified to ASTM C1540-2011 Standard. Per OSHPD Code Application Notice 5-311.9 revised 6/29/2011, signed by Paul Coleman; Section I (a) states that: "the use of couplings that have been tested to conform to the performance requirements of FM approvals, Approval Standard 1680, Class I, by FM Approvals or by a nationally recognized independent testing agency" are acceptable. Champion MI-X Series #MI-XHUB Drain Coupling.

Fixtures and Trim

- .4 Water closets shown as type 'WC-2 – Wall hung flush valve (Barrier Free Design)' shall be vitreous china with EverClean antimicrobial surface which inhibits the growth of stain and odor causing bacteria mold and mildew, elongated bowl, white finish, wall hung, siphon jet flush action, operates in the range of 4.2 L to 6 L (1.1 US Gal to 1.6 US Gal) per flush, condensate channel, 305 mm x 254 mm (12" x 10") water surface, siphon jet flush action, condensate channel, elongated bowl, 54 mm (2-1/8") fully glazed internal trapway, 38 mm (1-1/2") dia. Top spud. Mount fixture 16"(406mm) above finished floor to rim of toilet (or as required to meet local codes). American Standard AFWall Millennium Flowise Elongated #3351.101.020 HET Toilet
- .1 Flush valve for WC unit above shall for Top Spud Toilet, polished chrome finish, 4.8 L (1.28 US Gal) factory set flow, quiet action 'PERMEX' diaphragm type with dual filter by-pass, infrared sensor located on a 125 mm x 125 mm (4-15/16" x 4-15/16") stainless steel plate, solenoid operated flush controller circuitry, Courtesy Flush electronic over-ride button, extended seat bumper on, V.P. Smooth design stop cap on bak-check angle stop (screwdriver operated), flush tube for 292 mm (11-1/2") rough-in, high pressure vacuum breaker, sensor located above the toilet, 5 VA Power Required per unit. Sensor to clear toilet seat cover. Provide 4" (102 mm) square electrical box for mounting sensor plate. Sloan #EL-154, Box Mount Hard Wired Transformer, 120 VAC/ 24 VAC, 50 VA. Will operate up to 10 'Optima' flush valve units. Sloan Royal Optima #Royal Optima 111-1.28 ES-S-CP-YG, Exposed Flushometer
- .2 Seat for WC unit above shall be extra heavy duty, for elongated bowl, open front, solid plastic, with cover, stainless steel self-sustaining check hinges, metal flat washers stainless steel posts and nuts. Centoco #820STSS.001 Toilet Seat
- .3 Carrier for WC unit above shall be mounted on concrete floor, all epoxy coated cast iron fitting, adjustable ABS slide nipple with integral test cap and neoprene bowl gasket, wasted plated hardware, chrome cap nuts, tiling frame, 102 mm (4") no hub waste, 51 mm (2") no hub vent, 158.8 kg (350 lbs) static load. 305 mm (12") finished metal stud wall to back of pipe space. Watts #ISCA-101-M11 single horizontal Adjustable Toilet Carrier
- .4 Drain Coupling for WC unit above shall be no-hub, type 304 AISI stainless steel band, type 304 AISI stainless steel eyelet, elastomeric compound gasket meeting the requirements of ASTM C-564, type 304 AISI stainless steel shield; painted red for easy identification, Tested to maintain 15 psi maximum line pressure at 80 inch lb min to 100 inch lb maximum torque bolt tightness, Tested by IAPMO to comply to FM 1680-1989 Standard (except for markings) and CSA B602-2010 Standard (up to 10"). They are tested and certified to ASTM C1540-2011 Standard. Per OSHPD Code Application Notice 5-311.9 revised 6/29/2011, signed by Paul Coleman; Section I (a) states that: "the use of couplings that have been tested to conform to the performance requirements of FM approvals, Approval Standard 1680, Class I, by FM Approvals or by a nationally recognized independent testing agency" are acceptable. Champion MI-X Series #MI-XHUB Drain Coupling

Fixtures and Trim

- .5 Urinals shown as type 'U-1 – Wall hung flush valve' shall be vitreous china, operates in the range of 0.5 L to 3.8 L (0.125 US Gal to 1.0 US Gal) per flush, wall hung, extended sides for privacy, washdown action, Washbrook Flowise, flushing rim, 19 mm (3/4") dia. Top spud, elongated rim, integral P-trap, outlet connection 51 mm (2"), 2 wall hangers, #7301242-100 chrome plated, non-metallic strainer, white finish. American Standard Washbrook Flowise #6590.001.020 Urinal.
- .1 Flush valve for urinal unit above shall be for Top Spud urinal, polished chrome finish, 0.5 L (0.125 US Gal) factory set flow, quiet action 'PERMEX' diaphragm type with dual filter by-pass, infrared sensor, solenoid operated flush controller circuitry, V.P. Smooth design stop cap on bak-cheek angle stop (screwdriver operated), flush tube for 292 mm (11-1/2") rough-in, high pressure vacuum breaker, located above the urinal, 5 VA Power Required per unit. Provide 4" (102 mm) square electrical box for mounting sensor plate. Sloan #EL-154, Box Mount Hard Wired Transformer, 120 VAC/ 24 VAC, 50 VA. Sloan Royal Optima #Royal Optima 186-0.125 ES-S-CP, Exposed Flushometer
- .2 Carrier for urinal unit above shall be mounted on concrete floor, epoxy coated top and bottom universal steel hanger plates, heavy gauge epoxy coated steel offset uprights with welded feet supports. For one unit: 102 mm (4") for two to six units in a row: 152 mm (6") finished metal stud wall to back of pipe space. Watts #WUCO Urinal Wall Access Cleanout, two (2) piece expandable plug with 102 mm (4") diameter stainless steel access cover, secured with vandal proof stainless steel screw. Watts #CA-321 Fixture Carrier
- .3 Drain Coupling for urinal unit above shall be no-hub, type 304 AISI stainless steel band, type 304 AISI stainless steel eyelet, elastomeric compound gasket meeting the requirements of ASTM C-564, type 304 AISI stainless steel shield; painted red for easy identification, Tested to maintain 15 psi maximum line pressure at 80 inch lb min to 100 inch lb maximum torque bolt tightness, Tested by IAPMO to comply to FM 1680-1989 Standard (except for markings) and CSA B602-2010 Standard (up to 10"). They are tested and certified to ASTM C1540-2011 Standard. Per OSHPD Code Application Notice 5-311.9 revised 6/29/2011, signed by Paul Coleman; Section I (a) states that: "the use of couplings that have been tested to conform to the performance requirements of FM approvals, Approval Standard 1680, Class I, by FM Approvals or by a nationally recognized independent testing agency" are acceptable. Champion MI-X Series #MI-XHUB Drain Coupling\

2.3 Lavatories

- .1 Lavatories shown as type 'L-1 – Counter mounted (Barrier free design & general use, hard-wired electronic 'no touch' faucet, recessed box)' shall be 3 holes, 4" (102 mm) center, 533 mm x 445 mm x 175 mm (21" x 17-1/2" x 6-7/8") high, oval, vitreous china, white finish, Self-rimming / Drop-in, side rear overflow, faucet ledge. Provide basin rim sealant. American Standard Cadet Universal Access #9494.001.020 basin

Fixtures and Trim

- .1 Faucet for lavatory unit above shall be polished chrome finish, cast brass, vandal resistant 1.9 LPM (0.5 GPM) multi-laminar spray head outlet, infrared sensor with screw adjustable range, under counter filtered solenoid valve with serviceable strainer filter, module control assembly housed in splash proof junction box, 24VAC 50/60Hz, vandal proof box, 12" (305 mm) sq. Recessed metal box with 13"(330 mm) sq. V.P. S.S face, located in wall under basin. Flexible copper supply, lead free, below deck SL-BDT-LF Thermostatic Mixing Valve, nickel plated bronze body, temperature adjusting spindle, 10 mm (3/8") inlet and outlet FNPT connection, integral checks, offer temperature range between 95 C (203 F) and 46 C (114.8 F). Set valve temperature at 46 C (114.8 F). Provide tee, adaptors and flex. copper tubing to suit installation. 15 VA power required per unit. Sloan #EL-154, Box Mount Hard Wired Transformer, 120 VAC/ 24 VAC, 50 VA. Sloan Optima #ETF-600-LT-CP-VPB-SL-BDT-LF Electronic Faucet
 - .2 Drain for lavatory unit above shall be cast brass one piece top, 17 GA. (1.5 mm) tubular 32 mm (1-1/4") tailpiece. McGuire #155A Open Grid Drain
 - .3 Trap for lavatory unit above shall be heavy cast brass adjustable body, with slip nut, 32 mm (1-1/4") size, shallow wall flange and seamless tubular wall bend. McGuire #8872C P-Trap
- .2 Lavatories shown as type 'L-2 – Wall Hung (Barrier free design)' shall be 3 holes, 4" (102 mm) center, 540 mm x 520 mm x 165 mm (21-1/4" x 20-1/2" x 6-1/2") high, vitreous china, white finish, for carrier with concealed arms, rear overflow, recessed self-draining faucet ledge, semi-pedestal P-trap cover. American Standard Murro with Everclean #0954.004EC.020/0062.000EC.020 basin
- .1 Faucet for lavatory unit above shall be polished chrome finish, cast brass, vandal resistant 1.9 LPM (0.5 GPM) multi-laminar spray head outlet, infrared sensor with screw adjustable range, under counter filtered solenoid valve with serviceable strainer filter, module control assembly housed in splash proof junction box, 24VAC 50/60Hz, vandal proof box, 12" (305 mm) sq. Recessed metal box with 13"(330 mm) sq. V.P. S.S face, located in wall under basin. Flexible copper supply, lead free, below deck SL-BDT-LF Thermostatic Mixing Valve, nickel plated bronze body, temperature adjusting spindle, 10 mm (3/8") inlet and outlet FNPT connection, integral checks, offer temperature range between 95 C (203 F) and 46 C (114.8 F). Set valve temperature at 46 C (114.8 F). Provide tee, adaptors and flex. copper tubing to suit installation. 15 VA power required per unit. Sloan #EL-154, Box Mount Hard Wired Transformer, 120 VAC/ 24 VAC, 50 VA. Sloan Optima #ETF-600-LT-CP-VPB-SL-BDT-LF Electronic Faucet
 - .2 Drain for lavatory unit above shall be cast brass one piece top, 17 GA. (1.5 mm) tubular 32 mm (1-1/4") tailpiece. McGuire #155A Open Grid Drain
 - .3 Trap for lavatory unit above shall be heavy cast brass adjustable body, with slip nut, 32 mm (1-1/4") size, shallow wall flange and seamless tubular wall bend. McGuire #8872C P-Trap

Fixtures and Trim

- .4 Carrier for lavatory unit above shall be concealed arms, wall flanges to attach to backing plate secured in wall with locking device and levelling screws, heavy gauge steel uprights with integral welded feet. For one unit: 102 mm (4") for two to six units in a row: 152 mm (6") finished metal stud wall to back of pipe space. Watts #WCA-411 Basin Carrier

2.4 General Sink Units

- .1 Sinks shown as S-1/S-2 shall be 3 holes, 8" (203 mm) center, 508 mm (20") wide x 521 mm (20-1/2") long x 203 mm (8") high deep, counter mounted, backledge, grade 18-10 18 GA. (1.2 mm) type 304 stainless steel, self-rimming, satin finish rim and bowls, mounting kit provided, fully undercoated to reduce condensation and resonance, factory applied rim seal, 3-1/2" (89 mm) crumb cup waste assembly with 1-1/2" (38 mm) tailpiece. Franke Commercial #LBS6808P-1/3 Single Bowl Countertop Mount Sink
- .1 Faucets for sink unit above shall be chrome plated finish, ECAST construction lead free (equal or less than 0.25%) ECAST brass construction, volume control and hot water limit stop ceramic cartridge, 5.7 LPM (1.5 GPM) vandal resistant pressure compensating Softflo aerator outlet, 241 mm (9-1/2") projection cast brass spout, lever handle. McGuire #LFH165LKN3 Faucet Supplies, chrome plated finish polished brass, heavy duty angle stops, 10 mm (3/8") I.P.S. Inlet x 76 mm (3") long rigid horizontal nipples, V.P. Loose keys, escutcheon and flexible copper risers. Chicago Faucets #431-E34VPABCP Single Handle Faucet
- .2 Trap for sink unit above shall be heavy cast brass adjustable body, with slip nut, 38 mm (1-1/2") size, box flange and seamless tubular wall bend. McGuire #8912CB P-Trap

2.5 Showers

- .1 Shower valves shown as 'SH-1' shall be chrome plated finish, Consisting of: Pressure Balancing shower trim and valve 171 mm (6-3/4") dia wall trim faceplate with on/off and temperature control single lever handle, integral service stops and adjustable hot limit safety stop. Adjustable Low-Flow Showerhead with ball joint, 5.7 LPM (1.5 GPM) max flow rate (@ 80 PSI), pressure compensating flow control, wall mount shower arm and wall flange. Chicago Faucets #SH-PB1-03-000 Pressure Balancing Complete Shower kit
- .1 Floor Drain for shower unit above shall be epoxy coated cast iron drain body, Type 304 stainless steel 82 mm (3-3/4") wide x (specify) long waterLine shower channel, reversible cast stainless steel collar with dual O-ring seals and weepholes. Provide P-Trap, same material as the connecting pipe drain. Blucher #BWC-100 Floor Drain
- .2 Shower valves shown as 'SH-2' shall be chrome plated finish, 171 mm (6-3/4") dia trim face plate, on/off and temperature control single lever handle, integral service stops, adjustable hot limit safety stop. Chicago Faucets #624-LCP Adjustable Hand Shower, 5.7 LPM (1.5 GPM) flow rate @ 80 psi, pressure compensating flow control device.

Fixtures and Trim

- .1 Grab bar for shower unit above shall be chrome plated finish stainless steel construction, 38 mm (1-1/2") dia x 914 mm (36") high bar, adjustable bracket for personal shower, locking wall flanges, includes mounting hardware. Chicago Faucets #9800-036CP hand shower Grab bar/Slide Bar combination
- .2 Hand shower for shower unit above shall be Chicago Faucets #24-59NF Hand Shower Metal Hose 1501 mm (59.1") long. Chicago Faucets #E24JKCP Hand Shower In-Line Vacuum Breaker, installed between supply outlet and shower hose, maximum hot water temperature of 60 °C (140 °F), maximum working pressure of 861.25 kPa PSI. Hand shower wall supply, chrome plated finish, 13 mm (1/2") NPT female thread inlet, 13 mm (1/2") hose connection. Chicago Faucets #622-001CP
- .3 Floor drain for shower unit above shall be epoxy coated cast iron drain body, Type 304 stainless steel 82 mm (3-3/4") wide x (specify) long waterLine shower channel, reversible cast stainless steel collar with dual O-ring seals and weepholes. Provide extra floor drain at entrance of shower area. Provide P-Trap, same material as the connecting pipe drain. Blucher #BWC-100 Floor Drain
- .3 Shower units shown as SH-3 shall be one station, column shall be heavy gage, type 304 stainless steel with satin finish. Anchor plate is cold rolled steel with a rust preventative coating and provides a secure mounting for Pylon. Solid brass, triple chrome-plated with adjustable spray pattern from a coarse stream to a fine mist, punched for valve by others (specify punching), 2.5 GPM (9.5 LPM) flow restrictor, Acorn furnishes all exposed tamper-resistant fasteners necessary to complete the on-site shower assembly; however, concealed wall fasteners or anchor shields are not furnished, All valves have replaceable cartridges which contain all wearing parts. Inlet size is for 3/4" NPT pipe connection. Acorn Shower-Ware 919-F1.4 Pylon Showers One to Four Station Model

2.6 Utility Sink Units

- .1 Janitor sinks shown as JS-1 shall be 610 mm (24") wide x 610 mm (24") long x 305 mm (12") high deep, floor mounted, terrazzo composed of pearl gray marble chips and Portland cement ground smooth, sealed to resist stain finish, one piece stainless steel cast integral on all sides, without tiling flange, cast brass drain with stainless steel strainer, 3"(75 mm) outlet. Complete with drain gasket. Stern Williams #SB-900 square Service / Mop Sink
- .1 Faucets for janitor sink unit above shall be Rough Chrome Finish, solid brass exposed body, ceramic 1/4 turn operating cartridge, unrestricted hose end outlet, 203 mm (8") projection spout with atmospheric vacuum breaker and bucket hook, 60 mm (2-3/8") metal vandal proof lever handles with blue and red index buttons, wall brace support. Chicago Faucets #897-RCF Wall Mounted two handles Faucet
- .2 Hose and Wall Hook for janitor sink unit above shall be 36" (914 mm) long hose with 3/4" (19 mm) chrome coupling, stainless steel wall bracket. Stern Williams T-35 Hose and Wall Hook
- .3 Mop Hanger for janitor sink unit above shall be stainless steel #4 finish, 24" (610 mm) long with 3 rubber spring loaded clips. Stern Williams #T-40 Mop Hanger

Fixtures and Trim

- .4 P-Trap for janitor sink unit above shall be same material as the connecting pipe drain.

2.7 Miscellaneous

- .1 Drinking fountains shown as DF-1 shall be sensor, touchless activation with auto 20-second shut off (bottle filler), bi-level, 8 GPH of 50 °F drinking water at 90 °F ambient and 80 °F inlet water, light gray granite vinyl clad steel cooler cabinet, galvanized structural steel cooler chassis frame provides structural integrity, laminar flow provides minimal back splash, lead-free design, easy-touch front and side pushbar controls (cooler), Flexi-Guard safety bubbler utilizes an infused anti-microbial pliable polyester elastomer to prevent mouth injuries, real drain system eliminates standing water, stainless steel bottle filler wrapper with ABS plastic alcove, quick fill rate of 1.1 gpm, Innovative Green Ticker counts bottles saved from waste, 1-1/2" (38 mm) p-trap. Compressor: hermetically-sealed, reciprocating type, single phase. Sealed-in lifetime lubrication, condenser: fan cooled, copper tube with aluminum fins, fan motor is permanently lubricated, cooling unit: combination tube-tank type, self cleansing, continuous copper tubing with stainless steel tank, fully insulated with eps foam which meets UL requirements for self-extinguishing material, Chilling Capacity of 8GPH, Voltage Requirement: 115V at 60 Hz, current of 5.0 Amps, power consumption: 370W, refrigerant control: refrigerant R134a is controlled by accurately calibrated capillary tube, temperature control: easily accessible enclosed adjustable thermostat is factory preset, WaterSentry Plus 3000-gallon capacity filtration system, NSF/ANSI 42 & 53 certified, LED Visual Filter Monitor shall automatically detect new filter and reset visual filter monitor while diagnosing system issues and relay related messages, Green Spec Listed. Integrated silver ion anti-microbial protection in key areas. Provide electrical duplex box with GFI. Elkay EZH2O Bottle Filling Station Versatile Bi-Level Filtered LZ Cooler #LZSTL8WSLP wall hung water cooler
- .1 Drinking fountain supply for the drinking fountain unit above shall be chrome plated finish polished brass, straight stops, 10 mm (3/8") I.P.S. Inlet, V.P. Loose keys, low lead. McGuire #LFHST11LK drinking fountain supplies
- .2 Carrier for drinking fountain unit above shall be mounted on concrete floor, universal steel hangar support plates with integral mounting brackets, heavy gauge steel uprights with integral welded feet. For one unit: 114 mm (4-1/2") finished metal stud wall to back of pipe space. Watts #CA-431-1-Q double carrier
- .2 Eyewash units shown as EW-1 shall be lead-free brass and stainless steel design, vandal-resistant temperature adjustment, stainless steel sliding piston control device allow cold flow through both the fixed and variable bypass, 13 mm (1/2") N.P.T. Outlet, positive hot water shut-off, liquid-filled thermostatic motor control mechanism, 29 °C (84.2 °F) factory set temperature, standard 69.8 °F (21 °C) - 89.6 °F (32 °C) temperature range, 26 LPM (6.9 GPM) flow capacity at 30 psi (207 kPa) pressure drop across the valve, 7.57 LPM (2.0 GPM) min. Flow rate, 18 LPM (4.8 GPM) bypass flowrate at 30 psid. (See 911E/F) Provide shut-offs at emergency mixing valve. Lawler #911E/F, Emergency Thermostatic Mixing Valve for Eyewash or Eye/Face Wash

Fixtures and Trim

- .3 Eyewash units shown as EW-2 shall be Wall Mounted, eye wash, 11 1/2" (292 mm) diameter, orange ABS plastic bowl, two (2) GS-Plus spray heads with fliptop dust cover and filter, powder coated cast aluminum flag handle activation, 1/2" (13mm) IPS chrome plated brass stay-open ball valve with Teflon seal, heavy duty cast aluminum wall bracket with corrosion resistant powder coated finish, 1-1/4" (32 mm) NPT female outlet - Unit is third party certified by IAPMO to meet ANSI Z358.1-2014, the Uniform Plumbing Code cUPC and the National Plumbing Code of Canada.
- .1 Thermostatic mixing valve for eyewash unit above shall be lead-free brass and stainless steel design, vandal-resistant temperature adjustment, stainless steel sliding piston control device allow cold flow through both the fixed and variable bypass, 13 mm (1/2") N.P.T. Outlet, positive hot water shut-off, liquid-filled thermostatic motor control mechanism, 29 °C (84.2 °F) factory set temperature, standard 69.8 °F (21 °C) - 89.6 °F (32 °C) temperature range, 26 LPM (6.9 GPM) flow capacity at 30 psi (207 kPa) pressure drop across the valve, 7.57 LPM (2.0 GPM) min. Flow rate, 18 LPM (4.8 GPM) bypass flowrate at 30 psid. (See 911E/F) Provide shut-offs at emergency mixing valve. Lawler #911E/F, Emergency Thermostatic Mixing Valve for Eyewash or Eye/Face Wash
- .2 Trap for eyewash unit above shall be heavy cast brass adjustable body, with slip nut, 32 mm (1-1/4") size, shallow wall flange and seamless tubular wall bend. McGuire #8872C P-Trap
- .4 Emergency shower unit shown as EWSH-4 shall be pedestal mounted, combination shower and eye wash, 11 1/2" (292 mm) diameter, orange ABS plastic bowl, two (2) GS-Plus spray heads with fliptop dust cover and filter, powder coated cast aluminum flag handle activation, 10" (254 mm) diameter orange ABS plastic shower head, 1/2" (13 mm) IPS chrome plated brass stay-open ball valve with Teflon seal, 1" (25 mm) IPS chrome plated brass stay-open ball valve with Teflon seals, stainless steel actuating arm and 29" (737 mm) stainless steel pull rod, schedule 40 galvanized steel furnished with orange polyethylene covers on vertical piping, shower flow rate at 20 GPM (76 LPM), 1-1/4" (32 mm) NPT female outlet - Unit is third party certified by IAPMO to meet ANSI Z358.1-2014, the Uniform Plumbing Code cUPC and the National Plumbing Code of Canada. Guardian #G1902P -FC20
- .1 Thermostatic mixing valve for shower unit above shall be lead-free brass and stainless steel design, vandal-resistant temperature adjustment, stainless steel sliding piston control device allow cold flow through both the fixed and variable bypass, 32 mm (1-1/4") N.P.T. Outlet, positive hot water shut-off, temperature gauge, liquid-filled thermostatic motor control mechanism, 29 °C (84.2 °F) factory set temperature, standard 69.8 °F (21 °C) - 89.6 °F (32 °C) temperature range, 94 LPM (24.8 GPM) flow capacity at 30 psi (207 kPa) pressure drop across the valve, 37.85 LPM (10.0 GPM) min. Flow rate, 79 LPM (20.9 GPM) bypass flowrate at 30 psid. (See 911E) Provide shut-offs at emergency mixing valve. Lawler #911E, emergency eyewash and drench shower combination Emergency Thermostatic Mixing Valve
- .2 Floor drain for shower unit above shall be epoxy coated cast iron, anchor flange, 5" (127 mm) adjustable round nickel bronze strainer, reversible clamping collar with primary & secondary weepholes. Provide p-trap for drain. Watts #FD-100-C-A Floor Drain

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 Engineer's Representative Consultant, 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 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 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

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 All fixture carriers with integral cast iron fittings shall be certified to CSA B70 as required by authority having jurisdiction.

2.2 Water Closet Carriers

- .1 Carriers for water closets shown as (WC-1, WC-2) shall be as described herein. Refer to Drawings for installation arrangement.
- .2 Carriers for water closets with single adjustable horizontal discharge shall be 100 mm (4") all coated cast iron fittings, rear anchor bolt factory assembled, face plate with rear anchor support, heavy duty legs, adjustable short cast iron nipple, plated hardware, cap nuts, test plug and protection cap. Watts #ISCA-101-M11 single horizontal Adjustable Toilet Carrier
- .3 Carriers for wheelchair use shown as (WC-2) shall be mounted 400 mm (16") above finished floor to rim of toilet.

2.3 Urinal Carriers

- .1 Carriers for wall hung urinals shown as (U1) mounted on concrete floor, epoxy coated top and bottom universal steel hanger plates, heavy gauge epoxy coated steel offset uprights with welded feet supports. For one unit: 102 mm (4") for two to six units in a row: 152 mm (6") finished metal stud wall to back of pipe space. Watts #CA-321 Fixture Carrier

2.4 Lavatory Carriers

- .1 Carriers for wall-hung lavatories shown as (L-2) shall be concealed arms, wall flanges to attach to backing plate secured in wall with locking device and levelling screws, heavy gauge steel uprights with integral welded feet. For one unit: 102 mm (4") for two to six units in a row: 152 mm (6") finished metal stud wall to back of pipe space. Watts #WCA-411 Basin Carrier

Fixture Carriers

2.5 Miscellaneous Carriers

- .1 Carriers for Drinking fountains shown as (DF-1) shall be mounted on concrete floor, universal steel hangar support plates with integral mounting brackets, heavy gauge steel uprights with integral welded feet. For one unit: 114 mm (4-1/2") finished metal stud wall to back of pipe space. Watts #CA-431-1-Q double carrier

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

PART 1 - GENERAL**1.1 Work Included**

- .1 Conform to the Section 13 11 13 and as supplemented below.
- .2 Conform to the Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .3 The supplier of the pool equipment shall be responsible for the design and installation of the equipment, materials, and labour for pool re-circulation systems as required by Provincial and local Building Codes including Ministry of Labour, Health, and Safety at Work and as specified herein.
- .4 The installing contractor shall have a minimum of five (5) years experience in pool construction, with at least five (5) 25m pools constructed in this period of time. A reference list must be supplied with the tender documents.

1.2 System Performance

- .1 The Contractor shall be responsible for achieving the design flow rates for the filtration system listed under the pump capacities on the drawings.

1.3 QUALITY ASSURANCE

- .1 In accordance with Section 13 11 13.

1.4 Construction Site Visits

- .1 A qualified representative of the pool equipment supplier shall visit the site after the installation of such equipment has been completed, and shall, for a period five (5) non-consecutive working days, assist and instruct the Owner's representative in the operation of such equipment.
- .2 As part of this service the representative shall, after the installation of such equipment, but prior to the filling of the pool, visit the site with the pool mechanical contractor, and a representative of the Owner to verify the correct installation of each piece of equipment.
- .3 During the start-up instruction, each item of equipment of each type of equipment and all controls shall be operated in the presence of the Owner's representative to ensure his understanding of the equipment function, the function of individual working parts and the location of all valves and controls.
- .4 The Owner reserves the right to set the period or periods during which instructions shall be given. There will be an initial period of approximately two consecutive working days required for start-up instruction. The remaining days of instruction is to be on an "on call" basis at the request of the Owner.
- .5 Provide a 550 x 860 mm schematic chart, glazed with plexi-glass and framed with metal (suitable for wall mounting). Each schematic will clearly show the total recirculation system for the respective pool, including but not limited to, pool fittings, lines and sizes, valves and valve numbers, filters, auxiliary feeders, heaters and controllers.

Swimming Pool and Whirlpool Equipment

1.5 Supervision During Construction

- .1 The swimming pool equipment supplier shall name its local dealer/distributor that shall be available on call during the construction period. This person shall be technically competent in the mechanics of the swimming pool equipment and will guide and direct the mechanical contractor in the proper installation of the equipment. The supplier will also be fully cognizant of the overall system and shall be in position to provide warranty and service after completion.
- .2 Prior to the initial filling of the pools, the swimming pool equipment supplier shall perform detailed testing of the source water and instruct the mechanical contractor and Owner's representative on the procedures and chemical required to initially balance the water.

1.6 Start-Up and Commissioning

- .1 The swimming pool equipment supplier shall provide a minimum of five (5) days for start-up and commissioning of the swimming pools.
- .2 Conform to Section 21 08 00.00 – COMMISSIONING.

1.7 Service and Maintenance Manuals

- .1 The supplier of the pool system shall provide three (3) copies of service manuals pertaining to all components of the section.

PART 2 - PRODUCTS**2.1 Operating and Maintenance**

- .1 Provide operating and maintenance manuals and instructions in accordance with Section 21 08 03.00 – OPERATING AND MAINTENANCE INSTRUCTIONS.
- .2 The pool mechanical equipment supplier shall provide, but shall not be limited to, the following operating and maintenance instructions.
- .3 Three (3) complete and comprehensive identical sets of Operation and Maintenance Manuals for equipment related to each swimming pool re-circulation system: Each set shall be in a hard cover, loose leaf binder and shall contain the following:
 - .1 A reduced size photocopy of each wall chart.
 - .2 A reduced size photocopy of the total equipment room pool equipment schematic.
 - .3 Manufacturer's recommended maintenance schedules.
 - .4 Complete parts list, pump curves, show drawings and equipment design data.

2.2 Shop Drawings

- .1 Provide shop drawings in accordance with Section 21 05 03.00 – SHOP DRAWINGS.
- .2 The shop drawings shall include, but shall not be limited to, the following:
 - .1 Mechanical drawings that shall clearly show size, locations, clearances (maintenance), materials of all piping, circuits, valves, pumps, filters, controls and accessories.

Swimming Pool and Whirlpool Equipment

2.3 Pipes, Valves and Fittings

- .1 Pool piping shall consist of P.V.C. (Poly-Vinyl Chloride) with Schedule 80 used for above grade applications and Schedule 40 for below grade applications (ASTM D -1785, CSA - B137.3) listed.
- .2 PVC solvent weld fittings shall be Schedule 80, ASTM D-2467, for above grade applications and Schedule 40, ASTM D-2466, for below grade applications. Fittings must be CSA -C137 listed.
- .3 Solvent weld ASA 15016 PVC flanges shall be utilized for connection to equipment and valves with line sizes exceeding 50 mm (2 in.).
- .4 All valves 50 mm (2 in.) or smaller shall be Schedule 80 PVC full throat ball-type with Teflon seats.
- .5 All valves 65 mm (2 ½ in.) to 100mm (4 in.) shall be Schedule 80 PVC wafer type with EPDM seats and lever handles.
- .6 All valves 150 mm (6 in.) and larger shall be Schedule 80 PVC wafer type with EPDM seats and worm gear manual operator.
- .7 Piping and equipment provided under this Section shall be complete with all necessary supports and hangers required for a safe and workmanlike installation. Refer to Section 21 05 29.00 – HANGERS AND SUPPORTS for pipe hanger requirements.
- .8 Pool contractor shall connect to domestic cold water piping at isolating valve installed by mechanical contractor. Pool contractor shall provide backflow prevention on supply piping to pool equipment. Backflow preventer shall be equal to WATTS model number 009, complete with a strainer.

2.4 Starters and Wiring

- .1 Conform to the Section 21 05 14.00 – WIRING AND STARTERS.
- .2 Provide starters for all equipment supplied under this section.
- .3 All control wiring to ensure complete and proper operation of the pool systems including, but not limited to, water locking of pumps, flow and pressure switches, solenoid valves, shall be the responsibility of this Contractor.
- .4 Provide a water feature pump control panel in the Lifeguard Office as detailed on the drawings to start/stop each pump and enable/disable the feature pumps. Provide a 15 minute timer located on the pool deck adjacent to the hydro-massage bench for timed operation of the jets when the pump is enable through the control panel.
- .5 Provide, install and wire audible and visual alarms and an emergency stop button to deactivate all re-circulating pumps. It shall be clearly labelled and located beside the emergency telephone. When used it will activate an audible and visual signal located by the emergency stop.
- .6 Provide an emergency sign containing the words "IN THE EVENT OF AN EMERGENCY PUSH EMERGENCY STOP BUTTON AND USE EMERGENCY PHONE, AUDIBLE AND VISUAL SIGNAL WILL ACTIVATE" in letters at least 25 mm high with a 5 mm stroke above each emergency stop button.

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2.5 Butterfly Valves

- .1 Butterfly valve(s) shall be of PVC construction and shall come complete with a replaceable EPDM diaphragm. The valve(s) shall have flanged connections and a travel stop on the adjustment shaft.

2.6 Main Drains

- .1 Main drain outlets shall be 'A' wide, 'B' wide and 'C' deep with cyclac frame. Grate openings shall not exceed 6 mm (1/4 in.) in width, providing an open flow area of not less than 'D'. The grate shall be flush with the top surface and fit close to the frame. Each grate shall be secured to the frame with six (6) stainless steel screws. The frame and grate shall be equal to Neptune Benson model as per chart below:

.2

Pool	'A'		'B'		'C'		'D'		Neptune Benson Model No.
	(mm)	(in.)	(mm)	(in.)	(mm)	(in.)	(sq.cm.)	(sq.in.)	
25m	457	18	457	18			1216	183.06	Superflow – 18"x18"
Leisure	457	18	457	18			1216	183.06	Superflow – 18"x18"
Hot tub	457	18	457	18			1216	183.06	Superflow – 18"x18"

2.7 Variable Orifice Eyeball Inlet Fittings

- .1 Variable orifice "eyeball" inlet fittings shall be provided consisting of a cyclac body, retainer ring, directional ball type nozzle, variable orifice inserts and construction shield. The body shall have a 38 mm (1-1/2 in.) solvent weld connection and be provided with an integrally molded "knock-out" membrane to facilitate line pressure testing.
- .2 A 32 mm (1¼ in.) NPT connection is provided for a winterizing plug.
- .3 The directional ball shall be secured to the body with a retainer ring with four 18-8 stainless steel screws and have an adjustable range of 45° from the centre line in any direction.
- .4 The direction ball shall have a 25 mm (1 in.) diameter orifice. Two additional orifice inserts shall be included: one 12 mm (1/2 in.) diameter orifice and one 19 mm (3/4 in.) diameter orifice. The inserts shall be secured to the directional ball by two 18-8 stainless steel screws.
- .5 The construction shield shall snap-lock over the face of the inlet and remain in place during placement of concrete.
- .6 The variable orifice "eyeball" inlet(s) shall be Sta-Rite model number 8429 or equal.

2.8 Floor Return Inlet Fittings

- .1 Angled floor returns installed on entry ramps shall be chrome plated bronze body 100 mm (4 in.) x 140 mm (5-1/2 in.) with drilled orifices providing return water at 60° degrees. Inlets shall be Atlantis model number 6630 or equal.

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- .2 Non-angled floor inlet fittings shall consist of a cyclac body with 38 mm (1-1/2 in.) solvent weld connection and be provided with an integrally molded "knock-out" membrane to facilitate line pressure testing. Inlets shall be Sta-Rite model number 8417 or equal.

2.9 Non-Adjustable Inlet Fittings

- .1 Non-adjustable water level control inlet fitting(s) shall be provided consisting of a molded ABS grate and construction shield. The body shall have a 38mm (1-1/2 in.) solvent weld connection and be provided with an integrally molded "knock-out" membrane to facilitate line pressure testing.
- .2 The grate, having an open flow area of 14.58 sq. cm (2.26 sq. in.) shall be secured to the body with four 18-8 stainless steel screws.
- .3 The construction shield shall snap-lock over face of inlet and remain in place during placement of concrete.

2.10 Hydro Therapy Fittings

- .1 The Hydrotherapy Jet fitting(s) shall be Hayward or Jacuzzi consisting of a cyclac body, 10.5 mm (0.415 in.) nozzle, 19 mm (3/4 in.) directional ball and suitable for concrete installations.
- .2 The Hydrotherapy Jet fitting(s) body shall have a 38 mm (1-1/2 in.) connection at the water inlet and a 12 mm (1/2 in.) connection at the air inlet.
- .3 The Hydrotherapy Jet fitting(s) directional ball shall be secured to the body with a threaded ring and shall have an adjustment of 45 deg off centre in any direction.
- .4 The Hydrotherapy Jet shall produce an air draw of 4.23 S.C.M.H. (150 SCFH) with a motive operating flow of 1.26 lps (20 U.S. G.P.M.) at a head pressure of 96 kPa (14 P.S.I.G.).
- .5 Supply and install fourteen (14) hydrotherapy jets in the Leisure Pool equal to Hayward SP1433S.

2.11 Floor Bubbler

- .1 The floor bubbler shall consist 100mm (4 in.) diameter headers supply from an air pump each with typical 12 mm (1/2 in.) diameter risers with 7 mm (9/32 in.) diameter x 25 mm (1 in.) long plug at the top. Headers are to be spaced at 300 mm (12 in.).
- .2 Rough in 12 mm (1/2 in.) diameter risers 25 mm (1 in) above finished floor elevation. When project is completed cut the pipe flush and install 7 mm (9/32 in.) diameter 25 mm (1 in.) long plug.

2.12 Regenerative Air Blower

- .1 The regenerative blower shall be a non-positive displacement, high volume air pump.
- .2 The radial blades shall be positioned between two (2) channels to produce a continuous flow.
- .3 The unit shall be capable of supplying air to overcome the depth of water at the bubbler unit and create a frothy plume.

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- .4 It shall be complete with anti-siphon and check valves to protect the system when not operating.
- .5 The regenerative air blowers shall be as shown on the Pump Schedule.

2.13 Pool Pumps

- .1 Conform to the Section 23 21 23.00 – CENTRIFUGAL PUMPS, with the following modifications:
 - .1 Pump casing shall be bronze, impeller shall be bronze, shaft shall be stainless steel or steel with bronze sleeves.
- .2 All materials of the pump construction shall be considered non-corrosive in standard pool operation.
- .3 Provide pumps in accordance with the Pump Schedule.

2.14 Vacuum Release System

- .1 Vacuum safety release system shall be equal to Vac-Alert model no. VA-2000 SVRS unit.

2.15 Hair and Lint Strainers

- .1 Hair and lint strainers shall consist of a PVC body, cover with “O” ring seal, clear lid and a stainless steel strainer basket and “T” bolt lockdown.
- .2 The strainer body shall have flanged connections and mounted directly to the pump body by means of bolts, flange and gasket seal. The strainer body shall have a removable drain plug for winterizing. The strainer basket shall be securely positioned below the suction inlet of the trap, with access for inspection cleaning through a removable trap body. The strainer basket shall have perforations, which in total area is equal to 6 times the open area of the suction pipe into the trap body inlet.
- .3 Hair and lint strainer shall be equal to Nemato NSS Series or Mermade Full Outlet.

2.16 Ultraviolet Light System

- .1 Each pool system shall be provided with a complete, functional and serviceable ultraviolet light (UV) treatment system to kill bacteria, and to continuously remove chloramines in the pool water. Supply, installation and commissioning of the UV treatment system shall be completed by the pool specialty subcontractor.
- .2 All UV equipment must be NSF 50 approved.
- .3 The UV lamp shall be a high intensity, medium-pressure UV arc tube modified to emit a continuous UV spectrum from 220 nm to 400 nm into the water. Full output must be available from 0 to 200 degrees. The lamp shall be UL approved with one electrical lead at each end.
- .4 The UV chamber shall be pressure rated for continuous operation at 1034 kPa (150 psi) tested to 1551 kPa (225 psi) and constructed of type 316L stainless steel with flanged connections for installation into the full-flow pool piping as shown in the project drawings. The stainless steel cylinder shall be provided by the UV system manufacturer and shall be suited to the lamp size, configuration and flow according to the manufacturer.

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- .5 The UV system controls shall include a UV intensity meter with 4-20mA output for connection to the BAS or other monitoring system, and shall be operated by a hand/off/auto switch. The controls and switch enclosure shall be manufactured from 304 stainless steel.
- .6 The UV system shall be fitted with an automatic cleaning mechanism. It shall consist of a single SS yoke with Teflon bosses and replaceable molded viton wiper rings which travel the full length of the quartz sleeve. The frequency of the wiper cycle shall be adjustable from 15 to 720 minutes and set for job conditions. The mechanism shall be driven by a two-pole bi-directional electric motor and acme lead screw. Reed type limit switches shall control the length of travel. The wiper rings in the "parked" position shall not be over the lamp.
- .7 The Lap Pool UV system shall be sized for the recirculation rate of 39 L/s (615 GPM), Hanovia - UV Swim U-200-6D (208 volts, 1 phase, 60 hertz), or approved equal.
- .8 The Leisure Pool UV system shall be sized for the recirculation rate of 27 L/s (420 GPM), Hanovia - UV Swim U-200-6D (208 volts, 1 phase, 60 hertz), or approved equal.
- .9 The Hot tub Pool UV system shall be sized for the recirculation rate of 11 L/s (171 GPM), Hanovia - UV Swim U-150-4C (208 volts, 1 phase, 60 hertz), or approved equal.

2.17 Surge Tanks

- .1 Surge tanks shall be cast in concrete and waterproofed. All penetrations of the surge tanks shall include a waterstop flange made of a PVC ring twice the nominal pipe diameter welded to a pipe section or coupling fitting, with a sanded surface able to prevent water leaks around each penetration.
- .2 All pipe penetrations into the surge tank shall include flanged ends inside surge tank on ALL penetrations to permit bolting of valves etc. to each penetration, and to facilitate pressure testing during and after construction, including main drains, pump suction(s), gutter lines, drain line, overflow/vent lines, level sensor(s) and make-up water connections. The 25 m (82 ft.) Pool surge tank shall provide at least 3,900 U.S.gal. of usable surge capacity. The Leisure Pool surge tank shall provide at least 2,600 U.S.gal. of usable surge capacity. Usable surge capacity shall be the surge tank volume, measured between 300 mm (12 in.) above the highest pump suction opening inside the surge tank and the bottom of the overflow fitting on the surge tank. Surge tank shall be constructed with an access cover, as shown on the plans.
- .3 Overflow fitting shall be 100 mm (4") nominal pipe size, and shall be adjustable to permit fine adjustment of maximum water level in surge tank, to within 38 mm (1-1/2 in.) of bottom of floor slab of storage room above surge tank.
- .4 Pump suction piping inside the surge tank shall enter horizontally through the sidewall of the surge tank, and then turn down with an elbow fitting. This pipe shall be supported and fixed by mounting a flanged end of the pipe to the floor with stainless steel hardware, to prevent movement or stress on the piping. Provide details on hardware and mounting details for approval by the architect. The pipe within 300 mm (12 in.) of the floor will then be drilled to provide several openings, within 300 mm (12 in.) of the surge tank floor, all around the piping, to provide minimum two times (2X) the open area of the pipe cross section area. Provide drawing showing hole pattern and details for acceptance by the Consultant

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- .5 Gutter drain piping inside the surge tank shall be shall enter horizontally through the sidewall of the surge tank, and then turn down with an elbow fitting. This pipe shall be supported and fixed by mounting a flanged end of the pipe to the floor with stainless steel hardware, to prevent movement or stress on the piping. Provide details on hardware and mounting details for approval by the architect. The pipe within 600 mm (24 in.) of the floor will then be drilled to provide several openings, within 600 mm (24 in.) of the surge tank floor, all around the piping, to provide minimum three times (3X) the open area of the pipe cross section area. Provide drawing showing hole pattern and details for acceptance by the Consultant.
- .6 Main drain piping shall be connected directly to the pump suction header, and shall bypass the surge tank.
- .7 Level sensor shall include two (2) level sensors that shall provide the following functions:
 - .1 The upper sensor shall be mounted 100 mm (4 in.) above the minimum normal operating level of the surge tank, or 400 mm (16 in.) above the highest pump suction opening in the surge tank. When the water level inside the surge tank drops below this level, a solenoid valve in the cold water make-up line shall open, adding cold water into the pool system, as indicated on the drawings.
 - .2 The lower sensor shall be mounted 100 mm (4 in.) below the upper sensor. When the water level in the surge tank drops below the lower sensor, it shall cause all pumps drawing water from the surge tank to stop until the level in the surge tank rises to operating level again.
 - .3 The level control system for the surge tank shall be LEVII-K-2100 as supplied by Levolor Controls, or approved equal.
- .8 Surge tank access doors shall have inside open dimensions of minimum 750 mm x 750 mm (30 in. x 30 in.) to match inside dimensions of opening through floor slab. The installed access door shall be flush with the finished floor, of aluminum construction, and must be sufficiently strong or rigid to support a service man without deflection. The access door shall be fixed in place with tamper-proof hardware requiring a tool to remove. The frame of the access door shall be set into the concrete floor of the room above the surge tank in such a way that it is flush with the floor finish and presents no tripping or stubbing hazard. Access doors shall be "Just Set" ALUMINUM TERRAZZO DOOR model # AEL3030S, or approved equal.
- .9 Provide stainless steel ladder rungs 300 mm (12 in.) on centre for full depth of tank below the access door.

2.18 Balance Tanks (Hot Tub)

- .1 Balance tank walls shall be seamless with no joints. The tank shall be made on a one-piece horizontal rotating mandrel with a top dished head and a flat bottom. The bottom knuckle of the tank shall be continuous and smooth with no joints.
- .2 The inner corrosion resistant liner shall be hand contact molded by a trained certified molder and shall be constructed to ASTM Specification C582.
- .3 The structural portion of the tank shall be contact molded in accordance with ASTM Specification D4097. The tank shall be provided with four hold-down lugs and two lifting lugs and shall be designed to withstand 7.01 m (23 ft.) of static head.

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- .4 The balance tank will be fitted with flanged through the wall PVC lines as shown on the drawings. Gutter return inlet shall be located/designed to prevent unnecessary cycling/stressing of the float valve assembly.
- .5 The balance tank will contain one (1) 250 mm (10 in.) dual arm modulating float valves with flanged couplings to secure each with bolts to the through the wall flanged fittings.
- .6 Each float arm will have a 200 mm (8 in.) float on an extended rod of 50 mm (2 in.) stainless steel.
- .7 The access opening shall be of clear lexan to allow for visible inspection.
- .8 The Hot tub shall have one 850 mm (34 in.) diameter balance tanks, each with an overall height of 2,515 mm (99 in.) and 1,060 litre (280 USgal.) surge capacity. The balance tanks shall be equal to Nemato Inc. with capacity 320 GAL.

2.19 Pool Filter Systems

- .1 The filter system specified under this section shall be of a pressurized design and shall consist of Non-Corrosive Horizontal Hi-Rate Permanent Media Filter equal to Nemato Composites Inc.
- .2 The filter system shall be of the horizontal or vertical type requiring one grade of filter media and shall have a maximum flow of 7.95 litres/second per square meter of filter area (12 U.S.gallons/minute per square foot).
- .3 The filter system shall consist of horizontal filter tank(s), internal overhead distribution system, internal lower collection system, gauge panel with 0-400 kPa (2-60 PSIG) gauges, internal automatic air relief, external air relief with a manually adjusted shut off valve, integrally molded 303 mm x 406 mm (12 in. x 16 in.) manhole, integrally molded drain/dump port, FRP support, all of which shall be fabricated in a fully assembled state by the original equipment manufacturer, then disassembled for shipping to prevent damage to internal parts.
- .4 Each filter tank shall be manufactured in a 2 step process comprised of contact molding of the dished heads and filament winding of the body. The head shall be welded to the body using adhesive F epoxy. The material used in manufacturing the filter shall be E glass and isophthalic resin that shall be suitable for a maximum working pressure of 345 kPa (50 PSIG). The body and dished heads shall vary in thickness to provide durability at the points of maximum stress and the thickness shall be determined through ASTM and ASME tank standards.
- .5 Filter tanks shall pass a hydrostatic pressure test of 517.5 kPa (75 PSIG), and shall comply with all governing Pressure Vessel Code requirements. All hydrostatic pressure tests must be verified at the place of manufacture by a Professional Engineer and must be accompanied by a certificate to that effect signed by such a professional engineer.
- .6 A 303 mm x 406 mm (12 in. X 16 in.) integrally molded manhole complete with flange, internally mounted FRP cover, gasket bolts and yokes, shall be located at a 45 degree angle in the body of the filter tank. All gasket contact points on the manhole port of the body and manhole cover shall have a smooth gel coat finish to provide a continuous watertight seal. Cover shall be internally mounted to effect a pressure-assisted seal. Tanks with externally mounted manhole covers shall not be considered equal and shall not be approved.

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- .7 An integrally molded combination media dump port and drain complete with an ABS media retainer shall be located in the filter tank(s) body.
- .8 Influent and effluent connections shall be integrally molded. A continuous, water tight exterior seal at the influent and effluent ports of the filter tank shall be provided with the use of integrally molded flanged connections on the influent and effluent distribution connections. Support brackets shall be provided for the upper distribution and lower collection headers on the interior of the dished head opposite to the influent and effluent flanged connections. The filter tank shall be mounted on a FRP support.
- .9 Internal filter tank equipment shall include an upper distribution system and lower collection system, hydraulically balanced to prevent turbulence and/or displacement of the filter media during service operation or backwash. Standard pipe arrangements or an internal valve system will not be acceptable.
- .10 The upper distribution system shall include hydraulic distribution lenses, injection molded ABS plastic, located over the filter bed. They shall be joined to the influent connection by means of a 75 mm (3 in.) Schedule 80 PVC header, 32 mm (1-1/4 in.) nipples and elbows.
- .11 The lower collection system shall consist of a 75 mm (3 in.) Schedule 80 PVC header and 38 mm (1-1/2 in.) molded ABS plastic laterals designed to retain filter media with minimum head loss. The internal collection system shall be designed to promote media bed circulation during backwash.
- .12 The back wash piping system shall include sight glass.
- .13 Filter media shall consist of uniformly graded silica sand which shall be free of limestone or clay. The media shall be # 20, effective size range .45 – .55 mm with a uniformity coefficient of 1.6 maximum. The filter will require a filter bed depth which shall extend to an approximate level of 305 mm (12 in.) below the top of the hydraulic distribution lenses.
- .14 The pressure gauge panel shall consist of two (2), 100 mm (4 in.) diameter gauges scaled from 0-400 kPa (0-60 PSIG). The pressure gauges shall be mounted in a PVC panel with a printed system name plate. The pressure gauges shall be connected to influent and effluent pressure points with air relief cocks, compression fittings and semi rigid PVC tubing.
- .15 A manual shall be provided with each filter and include, according to ANSI/NSF Standard 50-1992; drawings, illustrations, operating instructions, charts, installation instructions, design head loss curve, and parts list to permit proper installation, operation and maintenance.
- .16 Filters lacking such manuals will not be considered equal and shall not be accepted.
- .17 Data plates shall be permanent, easy to read and securely attached to the filter tank at a readily accessible location. Data plates shall contain the following:
 - .1 Manufacturers name and address
 - .2 Filter model number
 - .3 Filter serial number
 - .4 Effective filter area in sq. m. (sq. ft.)
 - .5 Required clearance (h x w x l) for service and maintenance
 - .6 Filtration and backwash design flow rate in lps (USGPM)

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- .7 Maximum working pressure
- .8 Suitability for buried installation
- .9 Steps of operation
- .10 Filtration rate in lpm/sq.m. (USGPM/sq. ft.)
- .11 Media specification if different from media specified in ANSI/NSF Standard 50-1992
- .12 Suitability for swimming pool and/or spa application
- .18 Filters lacking such data plates will not be considered equal and shall not be accepted.
- .19 The Hi-Rate filter shall be provided with 150 mm (6 in.) dia. PVC-EPDM butterfly valves and face piping that shall be pre-assembled by the original equipment manufacturer. Piping shall consist of Schedule 80 PVC pipe and fittings with ASA 150Lb. PVC flanges.
- .20 The horizontal Hi-rate sand filters specified under this section shall come complete with two (2) one-piece fiberglass saddle supports that shall be bonded to the filter with fiberglass laminate.
- .21 The Saddles shall provide for a 75 mm (3 in.) filter tank clearance for easy removal of the drain/dump port and shall have two (2) anchoring holes per saddle for 12 mm (1/2 in.) anchor bolts.
- .22 The filter plant for the 25m Lap Pool shall consist of two (2) Fluidra Model 42210-050-E, 1080 mm (42 in.) dia. x 2,210 mm (87 in.) horizontal Non-Corrosive Hi-Rate Permanent Media Filters with a total effective filter area of 1.95 sq.m. (21.0 sq.ft.) of filter area each. The filter system will have a capacity of filtering 559,003 litres (147,673 US gallons) in 4 hours or less.
 - .1 The stacking frame shall be equal to Fluidra model # 20937.
- .23 The filter plant for the Leisure Pool shall consist of two (2) Fluidra Model 42175-050-E, 1080 mm (42 in.) dia. x 1,727 mm (68 in.) horizontal Non-Corrosive Hi-Rate Permanent Media Filters with a total effective filter area of 1.46 sq.m. (15.7 sq.ft.) of filter area each. The filter system will have a capacity of filtering 191,000 litres (50,457 US gallons) in 2 hours or less.
 - .1 The stacking frame shall be equal to Fluidra model # 20937.
- .24 The filter plant for the Hot tub shall consist of one(1) Fluidra Model 34135-050-E, 864 mm (34 in.) dia. x 1,854 mm (73 in.) horizontal Non-Corrosive Hi-Rate Permanent Media Filters with a total effective filter area of 1.26 sq.m. (13.5 sq.ft.) of filter area each. The filter system will have a capacity of filtering 19,400 litres (5,125 US gallons) in 0.5 hours or less.
 - .1 The stacking frame shall be equal to Fluidra model # 20940.

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2.20 Meters and Instruments

- .1 A flow meter shall be provided for each pump. Meters shall be self-powered analog display flow meters equal to Signet with PVC saddle installation, scaled to provide operation in mid-scale. Install in straight run of pipe at least 15 pipe diameters upstream from any joints or elbows. Flow meters shall be made from PVDF with Viton seals. Units shall be battery powered and complete with all mounting hardware required and suitable for PVC pipe based on the schedules below.

Pump	Pipe Size		Flow Rate	
	(mm)	(in)	(lps)	(USgpm)
25m Pool Circulation	150	6	0 - 39	0 – 622
Leisure Pool Circulation	100	4	0 - 22	0 – 346

- .2 The pool make-up water meters shall be of a frost proof design and shall be of brass construction with NPT connections. The size shall be 65 mm (2-1/2 in.) equal to Neptune Trident for the Lap Pool and 50 mm (2 in.) for the Leisure Pool. Two meters are required.
- .3 The in-line pool thermometers shall be of aluminum construction, with a length of 225mm (9”), vari-angle, c/w brass well and dual scale. Thermometer shall be equal to Winters 9IT-102.

2.21 Automatic Water Level Controller

- .1 The controller shall be designed specifically for the purpose of maintaining the water level of a pool. A NEMA 12 class enclosure, with standard 3-prong AC plug, shall house the electronics. The front cover shall be transparent. The controller shall include a 24 volt 19 mm (3/4 in.) 2-way solenoid valve that fails closed.
- .2 Light indicators shall display information from the level sensors. There shall be an indicator that displays when the solenoid valve is open and filling is taking place. The level sensors shall be encased in a chamber that is separate from the electronic module.
- .3 Two separate sensors shall indicate that the water level is higher than the ideal and when filling should take place. Each level sensor shall be of the magnetic float type and be made of Kynar or an equally chemical resistant material. Typical control resolution shall be .031 in. or less.
- .4 The level sensors shall be adjustable by the positioning of the chamber and height adjustment of the sensors within the chamber. In the event of a power failure, no programming or reentering of values shall be required. A visual alarm shall be triggered on high water level. The high level sensor shall signal the solenoid valve to close should the ideal level sensor fail. The manufacturer shall supply a complete instruction booklet covering the installation and operation of the controller.

2.22 Heat Exchangers

- .1 Heat exchanger(s) shall be as specified in Section 23 57 19.13 – PLATE HEAT EXCHANGER and Section 23 31 16.00 – POOL DEHUMIDIFICATION UNIT.
- .2 The BAS Contractor shall provide the heating water control valves. The pool contractor shall provide piping between the heat exchangers and pool recirculation systems.

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2.23 Pool Water Chemistry Control Systems

- .1 Warranty - Quality Assurance
- .2 The Pool Controller shall carry a 60 month (5 year) warranty from the date of product start-up, against all defects in material and workmanship. All components in the system include electronics, flowcell assembly, sensors, and cabinets.
- .3 Manufacturer's Representative shall perform initial Start-up of Water Chemistry Controller, train customer on-site and perform on-site warranty repairs.
- .4 Product shall be UL listing 1563 approved. This listing is specifically for pool water chemistry controllers.

2.24 Controller

- .1 The integrated water treatment control system shall be a BECSys5 controller as manufactured by BECS Technology.
- .2 The controller shall have 120 VAC; <1A fused input and shall come in a NEMA 4X polycarbonate enclosure. The controller shall come with 4 integral 3 A solid-state relay outputs that shall allow assignment of master alarm and pump control. The controller shall carry UL 508, (CSA) C22.2 Number 205- M1983, FCC part 15 sub part B product certifications.

2.25 Controller Functions

- .1 Water Chemistry Control:
 - .1 Continuously monitor and control pH, ORP and Cl/Br ppm
 - .2 Selectable control of sanitizer through ORP and/or amperometric ppm
 - .3 Selectable on/off feed or time based proportional feed
 - .4 Time based proportional feed cycle time will vary based upon variance of measurement to set point
 - .5 Proportional band of 0 to 2.0 pH units, 0 to 100 mV, 0 to 2 ppm with increased offset from set point causing increased feed system operation
 - .6 The controller shall regulate the output of the chemical feed system from 10% to 100% of capacity
 - .7 Sanitizer min/ max residual selectable for non-primary control method (i.e. ORP control can have min/ max amperometric ppm value)
 - .8 Feed duration alarm circuit shall disable appropriate feed and activate alarm circuit
 - .9 Sensor failure
 - .10 Chemical feed malfunction
 - .11 Low chemical feed inventory (optional)
 - .12 Overfeed time (programmable from 0 to 18 hrs, 1 minute resolution)
 - .13 Visual Hi/ Lo pH, ORP and ppm alarms
 - .14 Hi/ Lo pH alarm shall disable sanitizer chemical feed based on pH feed direction (programmable)

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- .2 Flow Monitoring:
 - .1 Paddlewheel flow sensor
 - .2 Flow rate, gpm/ lpm
 - .3 Flow volume totalizer
- .3 Heater Control:
 - .1 Temperature control, heater on/ off
 - .2 Energy saving mode, on/ off set time and secondary temperature set point
- .4 Control Displays
 - .1 The display shall be a backlit LCD with 12x40 alpha/ numeric, graphical characters that will continuously display information related to the following:
 - .1 pH: 0.0 to 14.0, 0.1 or 0.01 resolution (programmable)
 - .2 ORP: -1000 to 1000 mV, 1 mV resolution
 - .3 PPM: 0 to 20 ppm 0.1 or 0.01 resolution (programmable)
 - .4 Temperature: 32-212°F, 1°F resolution; 0-100°C, 1°C resolution
 - .5 Flow rate: 0-8800 gpm, 0.1 gpm resolution; 0-33265 liter/min, 0.1 liter resolution
 - .6 Flow volume: 999 trillion gallons, 1 gallon resolution; 999 trillion liters, 1 liter resolution
 - .7 Chemical Inventory: programmable range 0.1 ft., 0.1 m
 - .8 Heater set point & alternate heater set point (4 Event 28 day timer)
 - .9 Alternate ORP control set point (4 Event 28 day timer)
 - .10 Cl/ Br booster ORP and/or ppm feed points with a separate trigger set points
 - .11 Ozone ORP and/or ppm set points
 - .12 Dechlorination ORP or ppm set point
 - .13 Superchlorination ORP or ppm set point
 - .14 Display of Ca hardness & alkalinity
 - .15 Langelier & Ryznar index calculated
 - .16 Smart menus w/ integrated help
- .5 Feed Mode:
 - .1 The controller shall have auto/ manual off/ manual on, which will provide on/off or proportional feed modes.
- .6 Data Logging:
 - .1 The controller shall have 512K battery backed-up RAM for input level recording and events. Seven input level recordings for 10 to 56 days depending on sample rate (2 to 10 minutes):
 - .1 pH, ORP, ppm, Temperature
 - .2 Flow Rate

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- .3 Two chemical inventory levels
- .2 1100 events over a maximum of 14 days recording all alarms, menu changes and operational cycles related to the following parameters:
 - .1 pH, ORP & ppm Hi/ Lo w/ interlocked failsafe
 - .2 Temperature Hi/ Lo w/ heater failsafe
 - .3 System Lo flow & sample stream No flow
 - .4 Chemical inventory level
 - .5 Battery Low
- .7 Safety Systems:
 - .1 The controller shall have three security password levels with six for operators, two for managers and one for the distributor. The controller shall also have programmable alarms (some disabling chemical feed) for pH, ORP, free chlorine ppm, temperature, no and low flow and chemical overfeed. All alarm conditions shall activate a master alarm relay.
- .8 Alarm Indicators:
 - .1 The controller shall have a flashing LED alarm indicator with an auto polling LCD display of Hi/ Lo out of range, overfeed, low system flow and sample stream no flow.
- .9 Remote Operation:
 - .1 The controller shall come with a 33,600 bps data modem for communication via telephone, pager for selectable alarms or fax alarm data conditions via auto dialer. Up to eight phone numbers can be selected for paging or fax. The controller manufacturer shall provide BECSys for Windows™ based remote operation software with graphical display, for interactive connection and direct connect capability to a PC with the controller. Operational data logs, graphs and event calendars shall be included with the software.
- .10 Sensors:
 - .1 The controller shall have four (4) standard sensors and three (3) optional sensors.
- .11 Standard Sensors:
 - .1 Potentiometric (pH and ORP): The standard pH and ORP sensors shall have an ABS body with 1/2 in. NPT process connection. The standard pH and ORP sensor shall contain 32 milliliters (1.08 oz) of electrolyte gel. Inorganic electrolyte shall be used to avoid breakdown in the presence of strong oxidants. Each potentiometric sensor shall have a porous Teflon liquid junction to provide a stable, low impedance reference contact, and to prevent fouling and clogging of the liquid junction. The pH sensor range shall be 0 - 14. The ORP sensor range shall be 0 - 1000 mV. Each potentiometric sensor shall have a silver/silver chloride (Ag/AgCl) reference element. The pH element shall be a General Purpose Glass Membrane. The ORP element shall be 1 mm diameter platinum wire. The environmental characteristics for the potentiometric sensors shall be: temperature range 0 – 80 deg. C (32 – 176 deg. F), pressure range 0 – 689 kPa (0 - 100 psig).

Swimming Pool and Whirlpool Equipment

- .2 Temperature: The standard temperature sensor will be a 2 wire, 100 ohm resistive temperature detector (RTD) with a 0.00385 Alpha.
 - .3 Pressure: Each flowcell shall be equipped with a pressure-sensing device. The pressure sensor shall consist of a compound pressure/vacuum gauge manufactured in stainless steel, 65 mm (2-1/2 in.) diameter, liquid filled with an operating pressure range of 414 kPa (0 to 60 psig) and vacuum of 0 to -30 in./ Hg.
- .12 Optional Sensors:
- .1 Flow Rate Sensor: The controller shall provide an optional measurement of pool circulation flow rate utilizing a frequency output paddle wheel flow sensor with a 7.62 m (25 ft). cable and saddle.
 - .2 Amperometric Sensor: The optional Free Chlorine sensor shall be an amperometric probe system with a measuring range of 0.05 to 20 mg/l with a fully selectable scale and a temperature range of 2.22 deg. C – 44 deg. C (36 deg. F – 113 deg. F). The amperometric probe shall come with a PVC body, replaceable PTFE membrane and electrolyte, gold cathode and silver/ silver chloride anode.
 - .3 Liquid Level Sensor: The controller shall provide an optional measurement of two liquid levels for chemical inventory. The sensor shall be field-calibratable allowing for site modifications within an operating range from 914 mm to 4572 mm (3 ft to 15 ft).
- .13 Flowcell Assembly:
- .1 The flowcell shall have a machined PVC body with tapped ports for the ORP sensor, pH sensor, pressure sensor, optional temperature sensor, sample stream influent and effluent and a testing stream. The flow cell shall have a clear acrylic face for easy viewing of the sensors. The flowcell design shall provide precise sample flow rate and water velocity regulation past the probes while providing hydro-mechanical cleaning of the free chlorine sensor. The flowcell shall come complete with PVC 1/2 in. isolation ball valves, PVC ¼ in. wet test valve and reed flow switch.

2.26 Pool Chlorine System

- .1 The chlorine feed system specified under this section shall be capable of feeding liquid chlorine into the recirculation system of the swimming pool for the purpose of maintaining a chlorine residual at a preset limit. The specified system shall work in concert with an automatic water chemistry control device, which shall govern the feeding of chlorine.
- .2 Chlorine Feed System
 - .1 The bulk chlorine system shall incorporate a complete system, including two bulk tanks, liquid chlorine feed pumps, tank refill panel, and external mounted refill station.
 - .2 The bulk liquid chlorine tanks shall be rotationally molded polyethylene with a sealed threaded lid cap. It shall be fitted with bulk tank fittings for filling, venting, and feed tubing connection to the chemical feed pumps.
 - .3 Each bulk liquid chlorine tank shall be 1220 mm (48 in.) diameter with a height of 2133 mm (7 ft.) and have a capacity of 1893 litres (500 U.S.gal.).

Swimming Pool and Whirlpool Equipment

- .4 The system shall incorporate an internal level, which will indicate when the tank is full to both the tank refill panel and the external refill panel.
- .3 The chlorine tank refill panel shall be a NEMA-4 enclosure, and shall have an indicator light for high level, an audible alarm test button, a secondary external audible alarm connection, and an indicator light for high level. It shall be complete and CSA approved.
- .4 The external refill station shall be a NEMA-4 recessed lockable panel with filling instructions on the inside panel door. It shall be fitted with a chlorine bulk fill fitting, high-level indicator light, and vent tube from the bulk chlorine tank(s). It shall be mounted in an external wall above the height of the bulk chlorine tank(s).
- .5 All piping to and from the bulk tank(s) shall be schedule 40 PVC and installed as per the manufacturers recommended instructions and supplied by the chlorine supplier.
- .6 Tank shall have 65 mm (2-1/2 in.) fill line and 50 mm (2 in.) vent line. The pool contractor shall install piping from the fill station to the tank.
- .7 Wiring from power source to chlorine fill station and the fill station to chlorine tank level controller by this Contractor.
- .8 The chemical feed pump shall be electronic with dual function control by changing stroke length and stroke frequency complete with a Tyrill or PVC pump head, PVC fittings, Teflon-faced diaphragm, Hyphalon valve seats, ceramic valve balls, PVC 12 mm (1/2 in.) X 1.2 m (4 in.) section tubing, polyethylene 11.1 mm (7/16 in.) X 2.4 m (8 in.) discharge tubing and anti-siphon valve assembly.
- .9 The 25 m Lap Pool chemical feed pump shall have total capacity of 112 litres per day (30 gallons per day) at a maximum pressure of 551.6 kPa (80 P.S.I.) with an electrical requirement of 115 volts, 60 hertz.
- .10 The Leisure Pool chemical feed pump shall have total capacity of 39 litres per day (10.3 gallons per day) at a maximum pressure of 551.6 kPa (80 P.S.I.) with an electrical requirement of 115 volts, 60 hertz.
- .11 The Hot tub chemical feed pump shall have total capacity of 4 litres per day (1.1 gallons per day) at a maximum pressure of 551.6 kPa (80 P.S.I.) with an electrical requirement of 115 volts, 60 hertz.
- .12 The chlorine feed pump shall be connected to a pump auto-flush through a foot valve flush kit. The auto flush shall consist of a non-corrosive solenoid valve with internal programmable repeat cycle timer, manual flush by-pass valve, tubing adapters and mounting bracket.
- .13 Chemical Feed pumps shall be LMI 73 Series B complete with wall mounted bracket, and remote automatic fresh water flush controller LMI 30344.

2.27 Carbon Dioxide Feed Systems

- .1 The CO₂ pH control system shall consist of a flow control unit, complete with diffuser/injector fitting with integral check valve for the system.
- .2 The flow control unit shall include a remote on/off control (120 VAC solenoid), a rate adjusting flow meter scaled from 0 – 0.85 cubic meters per hour (0 – 30 standard cubic feet per hour) and have a pressure rating of 689 kPa (100 psi). The CO₂ gas feed is cycled on and off as needed, to maintain the desired pH set point.

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- .3 The diffuser/ injector fitting shall be 1/2 in. NPT. Unit shall cause CO₂ to be totally diffused and made to go fully into solution without evidence of CO₂ bubbling at any point where water is open to atmosphere. Unit must be equipped with a check valve to prevent the flow of water into the feed unit.
- .4 CO₂ systems designed for industrial usage shall not be considered as equal.
- .5 The units shall be provided with an illustrated installation, operating and maintenance manual with drawings and detailed written descriptions of all aspects of controller function.
- .6 Inspection of final installation, start -up, calibration and instruction of operating personnel shall be performed by an authorized representative of the manufacturer.
- .7 The flow control unit shall be equal to National Line model NFS-CF-CO2-0030.
- .8 The Contractor shall provide and install one 450 lb. CO₂ bulk storage tanks of stainless steel construction manifolded together and rated at a maximum operating pressure of 2068 kPa (300 PSI) with ASME section 8, revision 1 "U" stamp. Tank shall deliver 45 lbs/ hr maximum and 2.5 lbs/ hr minimum. Tank shall be completed with the following integral devices:
 - .1 Storage tank pressure gauge
 - .2 Contents gauge
 - .3 Sure fill regulator
 - .4 Primary and secondary relief valves
 - .5 Fill valve with remote fill station containing lock assembly, CO₂ contents gauge, CO₂ pressure gauge, gauge isolation switch, liquid fill fittings, contents chart and check valve all within a stainless steel enclosure with lockable hinged front access panel.
 - .6 Gas supply valve (on/off)
 - .7 Tank pressure maintaining regulators
 - .8 Vaporizer coil
 - .9 CO₂ piping from fill station to tank and from tank to C.V. of the two flow control units including connections.
 - .10 Pre-set (adjustable) regulator (4-80 PSI delivery range) with relief line capacity at 586 kPa (85 PSI) line pressure; regulator shall be complete with in line pressure gauge
 - .11 Manifold for supply of CO₂ to all pools.
- .9 Storage tank shall be a complete package and the package shall have a CRN number from the Ministry of Consumer and Commercial Relations (MCCR).
- .10 The Contractor shall provide an initial fill of CO₂ at time of turnover.

PART 3 - EXECUTION**3.1 Installation**

- .1 Equipment Installation

Swimming Pool and Whirlpool Equipment

- .1 The Contractor shall install all equipment indicated on specification drawings according to manufacturer's instructions.
 - .2 All metal within 1500 mm (5 ft.) of any pool tank shall be grounded.
 - .3 Install 6 mm (1/4 in.) PVC water stops for watertight penetration of all concrete walls. Water stops shall be round with outside diameter sized to 150% of the pipe outside diameter. All water stops shall be thermo-welded to the pipe from both sides and shall be located at the centreline of the wall through which the piping is passing prior to the concrete installation to assure a watertight seal.
 - .4 Incorporated in work of other trades and supervise installation of such items.
 - .5 The Contractor shall co-operate with Owner's Agents and other Contractors as they install equipment not included in this Specification.
 - .6 The Contractor shall provide all piping between the whirlpool and the equipment package and vacuum release systems on the inlet of the jet and filter pumps.
- .2 Field Quality Control
- .1 Trench bottoms shall be smooth and free of rocks and debris. Pipe must be supported over its entire length with firm, stable material. Blocking shall not be used to change pipe grade or provide intermittent support over low sections in the trench. Surround piping with backfill meeting the requirements of Section 02200. Compact in layers not to exceed 150 mm (6 in.) with vibratory method. Follow installation methods of ASTM D2774 "Underground Installation of Thermoplastic Pressure Piping".
 - .2 All pool recirculation system piping to be encased in concrete or back-filled shall be pressure tested with water at 170 kPa (25 PSI) from the valves leading to the pools, for a minimum of twelve (12) hours.
 - .3 Pour concrete or backfill only around piping under 170 kPa (25 PSI) pressure. Monitor pressure during back-filling, compaction, and concrete pouring.
- .3 Initial Fill
- .1 When there is sufficient water in the pool to permit the filter system to operate, the filter system may be activated while continuing to fill, provided that the temperature of the water entering the pool is regulated to match the pool shell temperature.
 - .2 The Contractor shall monitor the filters continuously during the filling process and carry out back-washing as required. Add chemicals during the filling process to achieve the chemical levels described in Section 3.1.4. After the pool has been filled with water matching the shell temperature, raise the temperature of water at a maximum rate of 0.3 deg. C per hour.
- .4 Chemical Treatment of Water
- .1 While the pools are being filled, the water shall be treated to bring the following parameters to the recommended levels:
 - .1 Free available chlorine: 0.5 to 1.5 ppm
 - .2 Combined chlorine: > 0.2 ppm maximum
 - .3 pH: 7.4 to 7.8
 - .4 Total alkalinity: 100 ppm

Swimming Pool and Whirlpool Equipment

- .5 Calcium hardness: 250ppm
- .2 Regularly monitor the above levels during the filling process and add chemicals as required throughout the filling process to maintain these values. The Contractor shall ensure that the water is properly treated during filling of the pool to prevent any damage to the grout.
- .3 Prior to the initial filling of the swimming pools, the swimming pool equipment supplier shall conduct the following tests on the source of water and advise the contractor of the correct types and amounts of chemicals to be added during the filling process:
 - .1 Chlorine - Free and combined (ppm)
 - .2 Total alkalinity (ppm)
 - .3 Iron (ppm)
 - .4 Copper (ppm)
 - .5 Calcium hardness
 - .6 Total dissolved solids
- .5 Start-Up
 - .1 The qualified representative of the swimming pool equipment supplier shall attend the filling of the pools and start-up of the pool systems by the contractor.
 - .2 Provide all chemicals required for the initial and subsequent treatment of the water until takeover by the Owner at the date of Substantial Performance.
 - .3 After the start -up, adjust and balance the systems to achieve the specified flows.

END OF SECTION

Testing and Balancing Piping Systems

PART 1 - GENERAL**1.1 Work Included**

- .1 Conform to
 - .1 Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
 - .2 Section 23 08 00 – Commissioning Requirements - Mechanical
- .2 This section is split into two sections of work, the Contractors testing and balancing and the Independent Company's testing and balancing.
- .3 Sample of a Test Verification Sheet is provide at the end of the section and this sheet or a similar one with all pertinent information is to be filled out for all tests called for in the Specification or required by code. The sheets shall be signed by the Contractor and the Independent Company to verify that the data recorded is correct.
- .4 Leakage tests shall be carried out on sections of the work and these sections shall be identified by reference number of the test sheet and by description of the duct system. The reference identification number shall be indicated on the As-Build Drawings.
- .5 The following systems shall be tested and balanced:
 - .1 Refrigeration piping
 - .2 Boilers and heating systems
 - .3 Water treatment systems
 - .4 Life safety and fire protection systems
 - .5 Plumbing systems
- .6 The Contractor shall provide a schedule for all testing and balancing.

1.2 Related Sections

- .1 Section 01 91 13 – General Commissioning Requirements
- .2 Section 01 91 31 – Commissioning Plan
- .3 Section 01 91 41 – Commissioning Training
- .4 Section 23 08 00 – Commissioning Requirements - Mechanical

1.3 Quality Assurance

- .1 The balancing of the water and air systems shall be performed by the same balancing company.
- .2 Balancing companies shall be members of A.A.B.C. or N.E.B.B.

Testing and Balancing Piping Systems

PART 2 - PRODUCTS**2.1 Not Used****PART 3 - EXECUTION****3.1 The Contractors Testing and Balancing**

- .1 Test all plumbing systems in accordance with all applicable plumbing codes.
- .2 Test all fire protection systems in accordance with all applicable N.F.P.A. codes.
- .3 Compressed air and nitrogen systems shall be tested to a minimum of 150 psig and shall be proven tight over a period of 24 hours.
- .4 Test for vacuum shall be 1-1/2 times the operating vacuum.
- .5 All other systems not covered by codes noted above shall be tested and proven tight over a period of 24 hours by a hydrostatic test. Remove vents and gauges and temporarily plug connections.
- .6 Test pressure for steam and water systems shall be:
1-1/2 times the system working pressure but not less than 1035 kPa (150 psig)
OR
The maximum working pressure of expansion joints and vibration isolators.
Repair any leaks or defects and repeat the tests to the satisfaction of the Consultant.
- .7 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.
- .8 Balance on water lines shall be obtained by inserting thermometers between the pipe and insulation of the various return lines and adjusting flow until all thermometers read the same appropriate system temperature.
- .9 Balance on water lines shall be obtained by inserting thermometers in thermometer wells provided for this purpose at each balancing valve and adjusting flow until all thermometers read the same appropriate system temperature.
- .10 All tests for systems shall be performed in the presence of, and test reports signed by, the Independent Company. Notify the Independent Company in writing a minimum of one week in advance of testing.
- .11 Co-ordinate with the Independent Company to ensure all necessary valves for balancing the system are installed.

Notify the Consultant in writing that this co-ordination has taken place before installation begins. If this Contractor fails to co-ordinate with the Independent Company and if failure to co-ordinate results in being unable to balance the systems, the cost of any changes required shall be paid for by the Contractor at no cost to the Owner.
- .12 Ensure that all cooling coil drain pans drain freely and that no standing water remains.
- .13 Ensure access is provided to all valves and equipment that requires servicing.

Testing and Balancing Piping Systems

- .14 The Contractor is responsible for all equipment operating to design conditions and shall trim impellers, etc., to provide the required conditions, but is not responsible for balancing the system.
- .15 The Contractor shall make available staff, as required by the Independent Company, to correct any deficiencies in the mechanical systems which prevent the Independent Company from balancing the system.
- .16 The Contractor shall provide copies of all Shop Drawings requested by the Independent Company.
- .17 The Contractor referred to is the prime Mechanical Contractor.

3.2 The Independent Company's Testing And Balancing

- .1 The Consultant in consultation with the Mechanical Contractor, shall appoint an Independent Company to measure and report to the Consultant. The Independent Company shall submit a proposal to the Consultant for assessment before any selection is made. The proposal shall include:
 - .1 Experience in projects of this size
 - .2 Labour costs per hour plus a maximum upset limit
 - .3 Personnel to be used
 - .4 Equipment to be used for the testing and balancing of the systems
 - .5 Test procedures and methods
 - .6 Any other items requested
- .2 The Independent Company shall 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.
- .3 Each pump shall be checked for design, working and shut-off head conditions and any pump that varies by more than 10% from the design conditions shall have the impeller trimmed until design conditions have been met.
- .4 Flow through all heat exchangers, chillers, boilers and other such equipment shall be balanced to ensure that the pressure drop through the equipment is within 10% of the manufacturer's design conditions.

If the design conditions cannot be met by adjusting the balancing valves throughout the system, then pump impellers shall be either changed or trimmed as required.
- .5 Initial balancing of coils shall be to ensure that the pressure drops are within 10% of the manufacturers design conditions. When both the air and water systems are fully operational entering air and water and leaving air and water readings shall be taken as close as possible to the peak design conditions to ensure the coil performance meets the design conditions. Coil water working conditions shall only be taken in conjunction with the air flow working conditions for the coil.
- .6 Adjust bleed-off from cooling tower, evaporative condensers, spray coils and similar equipment to prevent lime deposits. Record bleed-off rate.

Testing and Balancing Piping Systems

- .7 The Independent Company shall 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 00.00 – BUILDING AUTOMATION SYSTEM. If the Independent Company fails to co-ordinate with Section 23 09 00.00 – BUILDING AUTOMATION SYSTEM and if failure to co-ordinate results in any cost, the cost of any change required shall be paid by the Independent Company at no cost to the Owner.
- .8 The Independent Company shall witness all system tests and sign all test reports. Include one copy of all test reports in each copy of the balancing reports.
- .9 Co-ordinate with the Contractor to ensure that all necessary valves for control and balancing are installed in all locations required. Notify the Consultant in writing that this co-ordination has taken place. Include in this letter any recommendations made regarding valves, locations, installations, etc. If this Independent Company fails to co-ordinate with the Contractor and if failure to co-ordinate results in being unable to balance the systems, the cost of any changes required shall be paid for by the Independent Company at no cost to the Owner.
- .10 The Independent Company is responsible for balancing the systems to obtain the design conditions, and shall repeat the balancing until the required conditions have been met.
- .11 At the time of final inspection, recheck in the presence of the Consultant random selections of data recorded in the certified report. Points or areas for recheck shall be selected by the Consultant and be approximately 10% of the report data.
- .12 A measured deviation of more than 10% between the verification reading and the reported data shall be considered as failing the verification procedure.
- .13 A failure of more than 10% of the selected verification readings shall result in rejection of the report as unacceptable.
- .14 In the event the report is rejected, rebalance all systems, submit new certified reports and make a re-inspection, all at no additional cost to the Owner.
- .15 Following final acceptance of the certified reports by the Consultant, 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.
- .16 Provide 3 copies of the final testing and balancing reports. Reports shall be complete with index pages and index tabs, and certified by the Independent Company. All diagrams as single line representation of a Mechanical system specifically prepared for this project shall be prepared using a CAD system and shall be acceptable to Consultant.

END OF SECTION

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)

Testing and Balancing Air Systems

PART 1 - GENERAL**1.1 Work Included**

- .1 Conform to
 - .1 Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
 - .2 Section 23 08 00 – Commissioning Requirements - Mechanical
- .2 This Section is split into two Sections of work, the Contractors testing and balancing and the Independent Company's testing and balancing.
- .3 Sample of a Test Verification Sheet is provide at the end of the Section and this sheet or a similar one with all pertinent information is to be filled out for all tests called for in the Specification or required by code. The sheets shall be signed by the Contractor and the Independent Company to verify that the data recorded is correct.
- .4 Leakage tests shall be carried out on Sections of the work and these Sections shall be identified by reference number of the test sheet and by description of the duct system. The reference identification number shall be indicated on the As-Built Drawings.
- .5 The following systems shall be tested and balanced:
 - .1 Air conditioning, ventilation and heating systems
 - .2 Miscellaneous ventilation or exhaust systems
 - .3 Life safety systems
 - .4 Air distribution (supply, return and exhaust)
 - .5 VRF systems
- .6 Read, fully understand and comply with all requirements of the Section 21 08 00.00 – COMMISSIONING.
- .7 The Contractor shall provide a schedule for all testing and balancing.

1.2 Related Sections

- .1 Section 01 91 13 – General Commissioning Requirements
- .2 Section 01 91 31 – Commissioning Plan
- .3 Section 01 91 41 – Commissioning Training
- .4 Section 23 08 00 – Commissioning Requirements - Mechanical

1.3 Quality Assurance

- .1 The balancing of the water and air systems shall be performed by the same balancing company.
- .2 Balancing companies shall be members of A.A.B.C. or N.E.B.B.

Testing and Balancing Air Systems

.3 Acceptable balancing companies are limited to the following:

- .1 Design Test
- .2 Pro-Air Testing
- .3 VPG Associates
- .4 Airwaso
- .5 Leslie Danhart Inc.
- .6 Air Audit
- .7 Dynamic Flow Balancing Ltd.
- .8 Vital Canada Group Inc.

PART 2 - PRODUCTS**2.1 Not Used****PART 3 - EXECUTION****3.1 The Contractors Testing and Balancing**

- .1 Test for leakage in accordance with all SMACNA Manuals and Standards, all ductwork except downstream of variable air volume boxes or other pressure reducing devices. Seal ducts at all equipment connections and pressurize with a small blower. Leakage for medium pressure ductwork shall not exceed 10% of total duct volume in cubic feet of duct for that part of the system at a pressure of 1.5 kPa (6 in. W.G.). For example a 600 mm x 600 mm (24 in. x 24 in.) duct 30.48 m (100 ft.) long would have a maximum allowable leakage of 19 L/s (40 cfm). Low pressure ductwork shall be tested as specified for medium pressure ductwork but at a pressure of 0.87 kPa (3.5 in. W.G.). In addition seal any leaks causing noise. Test system as a whole or in parts provided all ductwork is accessible for inspection at the time of test. Provide blower, and all test equipment.
- .2 Refer to Section 23 31 13.00 – DUCTWORK AND SPECIALITIES for pressure ratings of ductwork and systems.
- .3 Supply and exhaust ductwork serving Biohazard Level 3 spaces shall be tested by pressure decay (ANSI/ASME N510) and leakage shall not exceed 0.2% duct volume/minute at 500 Pa (2 in. W.G.). Applies to ductwork serving the following rooms:
- .4 Supply and exhaust ductwork serving Biohazard Level 4 spaces shall be tested by pressure decay (ANSI/ASME N510) and leakage shall not exceed 0.1% duct volume/minute at 500 Pa (2 in. W.G.). Applies to ductwork serving the following rooms:
- .5 HEPA filter housings shall be tested by pressure decay (ANSI/ASME N510) and leakage shall not exceed 0.2% duct volume/minute at 2500 Pa (10 in. W.G.).
- .6 The entire system shall be tested for noise, tightness of joints and proper functioning of the system. Noise tests shall be made under minimum system pressure drop conditions (highest air velocities and clean filter conditions). This Section shall make all necessary alterations and repeat the tests until satisfactory operation is achieved.

Testing and Balancing Air Systems

- .7 All tests for systems shall be performed in the presence of, and test reports signed by, the Independent Company. Notify the Independent Company in writing a minimum of one week in advance of testing.
- .8 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.
- .9 Co-ordinate with the Independent Company to ensure all necessary manual dampers and splitter dampers for balancing the systems are installed. Notify the Consultant in writing that this co-ordination has taken place before installation begins. If this Contractor fails to co-ordinate with the Independent Company and if failure to co-ordinate results in being unable to balance the systems, the cost of any changes required shall be paid for by the Contractor at no cost to the Owner.
- .10 The testing equipment shall be itemized in the test reports and shall be approved by the Independent Company and the Consultant before any tests are undertaken. Calibration of the test equipment must be confirmed and approved by the Independent Company before any tests are undertaken.
- .11 Ensure access is provided to all fire dampers and equipment that requires servicing.
- .12 The Contractor is responsible for all equipment operating to design conditions and shall change fan sheaves, etc., to provide the required conditions, but is not responsible for balancing the system.
- .13 The Contractor shall make available staff, as required by the Independent Company, to correct any deficiencies in the mechanical systems which prevent the Independent Company from balancing the system.
- .14 The Contractor shall provide copies of all Shop Drawings requested by the Independent Company.
- .15 The Contractor will provide new filters, etc. required for the measurements. Costs of filters shall be paid for out of the allowance.

3.2 The Independent Company's Testing and Balancing

- .1 The Consultant in consultation with the Mechanical Contractor, shall appoint an Independent Company to measure and report to the Consultant. The Independent Company shall submit a proposal to the Consultant for assessment before any selection is made. The proposal shall include:
 - .1 Experience in projects of this size
 - .2 Labour costs per hour plus a maximum upset limit
 - .3 Personnel to be used
 - .4 Equipment to be used for the testing and balancing of the systems
 - .5 Test procedures and methods
 - .6 Any other items requested

Testing and Balancing Air Systems

- .2 Co-ordinate with the Contractor to ensure that all necessary manual and splitter dampers for balancing are installed in all locations required. Notify the Consultant in writing that this co-ordination has taken place. Include in this letter any recommendations made regarding dampers, locations, installation, etc. If this Independent Company fails to co-ordinate with the Contractor and if failure to co-ordinate results in being unable to balance the systems, the cost of any changes required shall be paid for by the Independent Company at no cost to the Owners.
- .3 The Independent Company shall balance the entire air systems including air volumes and control settings under maximum system pressure drop conditions (filter at replacement condition).
- .4 The Independent Company will measure, make final adjustments and report upon the air volume at each variable volume box, diffusers, register and grille. The static pressure upstream and downstream of the fan, the fan speed and the motor current.

Also to be reported upon are 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.

Coil working conditions shall only be taken in conjunction with the fluid flow working conditions for the coil.
- .5 The Contractor will provide new filters, etc. required for the measurements. Cost of filters shall be paid for out of the allowance.
- .6 Air volumes measured by the Independent Company shall be 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.

Duct traverse readings shall be taken through the access ports provided. Where no access ports have been provided new holes shall be made as required. These holes shall be resealed after final readings with sheet metal cover plates and sealant. Duct tape is not acceptable.

Where insulation is damaged it shall be repaired including the vapour barrier in an approved manner. Duct tape is not acceptable.
- .7 The Independent Company shall 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 00.00 – BUILDING AUTOMATION SYSTEM. If the Independent Company fails to co-ordinate with Section 23 09 00.00 – BUILDING AUTOMATION SYSTEM and if failure to co-ordinate results in any cost, the cost of any change required shall be paid by the Independent Company at no cost to the Owner.
- .8 In all cases where measurements by the Independent Company show failure to comply with the Drawings and Specifications, the Contractor shall change fan sheaves, etc., as required, and new balancing measurements shall be made by the Independent Company.
- .9 Ensure all thermostats and controls are set to give specified conditions and include settings in report.
- .10 For additional information on variable volume boxes refer to Section 23 36 16.00 - VARIABLE VOLUME BOXES.

Testing and Balancing Air Systems

- .11 The Independent Company shall witness all system tests and sign all test reports. Include one copy of all test reports in each copy of the balancing reports.
- .12 Fans on all systems shall be set up to give the minimum discharge pressure required to overcome the resistance of the box, discharge ductwork and diffusers.
- .13 The Independent Company is responsible for balancing the systems to obtain the design conditions and shall repeat the balancing until the required conditions have been met.
- .14 At the time of final inspection, recheck in the presence of the Consultant random selections of air quantities and fan data recorded in the certified report. Points or areas for recheck shall be selected by the Consultant and be approximately 10% of the report data.

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.

A measured flow deviation of more than 10% between the verification reading and the reported data shall be considered as failing the verification procedure.

A failure of more than 10% of the selected verification readings shall result in rejection of the report as unacceptable.

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 Owner.

- .15 Following final acceptance of the certified reports by the Consultant, permanently mark the settings of all valves, dampers, splitters 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.
 - .16 Provide three copies of the final testing and balancing reports. Reports shall be complete with index pages and index tabs, and certified by the Independent Company. Any diagram as single line representation of a Mechanical System specifically prepared for this project shall be prepared using a CAD system and shall be acceptable to the Consultant
- Submit a sample to the Consultant for review.

END OF SECTION

Testing and Balancing Air Systems

TEST VERIFICATION SHEET – DUCTWORK

Test Number:

Date:

System:

Description and sketch of tested component

Test pressure

Volume 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)

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 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .3 Conform to Section 23 09 23.00 – SEQUENCE OF OPERATION FOR BAS.

1.2 Related Sections

- .1 Section 01 60 00.00 – BASIC PRODUCT REQUIREMENTS
- .2 Section 21 05 14.00 – WIRING AND STARTERS.
- .3 Section 21 05 63.00 – ACCESS DOORS AND ACCESSIBILITY.
- .4 Section 21 08 00.00 – COMMISSIONING.
- .5 Section 26 05 01.00 – 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 Each system, building floor plan and control device shall be displayed through point-and-click graphics.
 - .4 Web based server with network interface card shall gather data from this system and generate web pages that can be accessed through web browser on any PC connected to the network.
 - .5 Operators shall access the system through web browser and browser interface to perform normal operator functions.
 - .6 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 (Droid devices), Windows Mobile Devices.
 - .7 BAS to operate on building LAN communication infrastructure.
- .2 Functional Principals

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- .1 BAS to control mechanical and electrical equipment as specified in CONTROL SEQUENCES, SCHEMATICS AND EQUIPMENT SCHEDULES.
- .2 System architecture to be modular permitting expansion of application software, system peripherals and field hardware.
- .3 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.
- .4 DDC controller may control more than one system provided that points associated with those systems are connected to that same controller.
- .5 DDC controllers to be configured so that main inputs and outputs from any control loop are located in that same controller. Global points used for control loop reset such as outdoor air temperature are exempt from this requirement.
- .6 DDC controllers to be capable of operating with local closed loop programming, independent from the server if communication is interrupted.
- .7 Where PID control loops are called for in the sequences, they are to be implemented within the controller.
- .8 BAS server shall perform global control programs and data consolidation and storage, communicating and obtaining data from all controllers and transmitting instructions to all controllers.
- .9 The supplied system must incorporate the ability to access all data including graphics, reports and alarm detection using standard Web Browsers without requiring proprietary operator interface and configuration programs. An Open Data Base Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on a supplier-installed server for all database access. Systems requiring proprietary database and user interface programs shall not be acceptable.

1.4 Approved Suppliers and Manufacturers

- .1 Approved Suppliers and Manufacturer Product Lines to Table 1. Manufacturer Product Line applies to Operator Software, Controller Resident Software, Building Controllers, Advanced Application Controllers and Specific Application Controllers.

Table 1: Approved Suppliers and Manufacturer Product Lines.			
Supplier	Manufacturer Product Line	Address/Location	Contact
Honeywell Limited	Honeywell Limited: Excel 5000 Open	85 Enterprise Blvd., Markham, ON, L6G 0B5	Lorraine Harris Phone: (289) 333-1033 Fax: (289) 333-1333
Johnson Controls Incorporated	Johnson Controls Incorporated: Extended System Architecture	56 Leek Crescent Richmond Hill ON L4B 1H1	Imad Safdar Phone: (905) 747-3795

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Table 1: Approved Suppliers and Manufacturer Product Lines.

Supplier	Manufacturer Product Line	Address/Location	Contact
Siemens Building Technologies Limited	Siemens Building Technologies Limited: Apogee	1577 North Service Rd. East, Oakville, ON, L6H 0H6	Peter Christiansen Phone: (905) 799-9937 Fax: (905) 799-9277

1.5 Quality Assurance

- .1 Supplier will have completed [three] [ten] [twenty] million dollars of controls installation work for new construction and retrofit projects with the control system manufacturer over each of the past three years. Submit with the Bid Documents a project list validating the completed work; indicate: project name, city, completed date, controls price, floor area, control system manufacturer.
- .2 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.

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.

1.8 Open Protocol Standard

- .1 Intention of this specification is to provide an integrated, open protocol BAS, either BACnet as defined by ANSI/ASHRAE standard 135-2012 or LONWorks as defined by ANSI/CEA standard 709.1.
- .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.

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- .4 LON devices shall utilize Standard Network Variable Types (SNVTs) as defined by LonMark International and shall have all the functionality for network variable binding.
- .5 LON devices shall implement LonMark device profiles as appropriate and be LonMark certified. All devices shall be provided with a LonWorks Network Services (LNS) plug-in configuration utility. If LNS plug-in is not available for a device, all device resource files, XIF files, and points list shall be provided.

1.9 System Communication Architecture

- .1 BAS shall use communication architecture consisting of at least two tiers. Each tier will utilize local area networks with totally open protocols based on industry leading standards.
- .2 The first tier of the BAS network (level 1) 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 level 1. Communication speed on first tier network shall be at rate of 10Mbps or higher.
- .3 Coordinate with the owner 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 owner firewall.
- .4 The lower tiers of the BAS network shall be based on LON or BACnet networks which provide the interconnection of DDC Controllers. Communication speed on lower tier network shall be at rate of 76Kbps or higher
- .5 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.
- .6 Plugging a portable operator interface into any DDC controller shall allow access to any other DDC controller on the BAS.

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.

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 ten 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 ten seconds.

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- .3 Data Scan: Update point object data at controllers and Operator Interfaces with current point object data at a minimum rate of once every ten seconds.
- .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 on local area networks and within forty-five seconds on wide-area networks 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.	

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- .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 To Division 1 – Submittals in printed format and as amended below.
- .3 Provide drawing files on CD.
- .4 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.
- .5 Provide 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 owner firewall.
- .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.
- .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.

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- .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, actuator mounting configuration.
 - .11 Room Schedule: Indicate: controller object name, controller address, controller model number, application designation, room designation, VAV air volume set points, 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 23.00 – 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 23.00 – 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 23.00 – 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.
- .2 Samples:
- .1 Provide with submittal under Part 1: Product Data and Shop Drawings for approval by the Owner and/or Consultant:
 - .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.

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- .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, 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 Record Documents:
 - .1 Operation and Maintenance Manuals:
 - .1 Provide two copies in printed format for review by the Consultant at least ten weeks before the projected substantial completion date.
 - .2 Provide three copies of corrected manuals in printed format and three copies on CD 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:
 - .1 Contact Information: Provide names, addresses, 24-hour telephone numbers of service representatives and installing subcontractors.

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- .2 Operation: Provide owner 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, 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 three copies in printed format and three copies on CD for approval by the Consultant within three weeks following the successful completion of Acceptance Test under Part 3: Execution.
 - .2 Provide drawing files on CD.
 - .3 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.
 - .4 Time-of-Day (TOD) Schedules: Indicate: objects assigned to the TOD Schedule, Occupied Mode times.
- .3 As-built Floor Plans:

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- .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 Consultant 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 three copies of drawing files on CD.
- .4 Software Backup:
 - .1 Provide with As-built Product Data and Shop Drawings.
 - .2 Provide three copies of complete BAS databases on CD.
- .6 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 Owner's requirements and as requested by the Consultant.

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 Provide a single warranty start date even when the Owner 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.
- .4 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 Owner. Provide warranty service during normal business hours and within 24 hours of the Owner's request for service.
- .5 Provide warranty service by factory trained service representatives of the Supplier.
- .6 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 Owner. Notify the Owner of changes and schedule the installation. Update Operation and Maintenance Manuals with firmware release notes.
- .7 Prior to testing date under Part 3: Execution, Acceptance Test, update firmware in controllers to latest revisions at no additional cost to the Owner; update Operation and Maintenance Manuals with firmware release notes.

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- .8 During the Warranty period check the tuning of each control loop once during heating season and once during cooling season; notify the Owner when this work is to occur. Forward to the Consultant documentation indicating observations and adjustments made.
- .9 Warrant products that are reconditioned under the Work to the same requirements as new products.

1.14 BAS Maintenance and Service

- .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 owner.
- .9 As part of the service, provide 24/7 contact number for service calls. Maximum response time to be 4 hours.
- .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.

1.15 Ownership 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 Owner, including and not limited to graphic files, database files, Custom Application Programs, Project Record Documents, Training Manuals.

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- .2 Licensing to permit an unlimited number of users to access the system without additional fees.
- .3 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 Existing Products: To Part 3: Execution, Existing Products.
- .2 New Products: Non-beta versions currently under manufacture and have been applied in similar installations for a minimum period of one year.
- .3 Revisions: Latest available revision for Operator Software, 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.

2.2 Network

- .1 The BAS consists of at least two tiers of communication networks.
- .2 The level 1 network shall have the following minimum capabilities:
 - .1 High speed data transfer for alarm reporting, point log reporting and uploading/downloading of programs.
 - .2 Single or multiple node failure reporting.
 - .3 Message and alarm buffering to prevent data loss.
 - .4 Error detection, correction and re-transmission to ensure data integrity.
 - .5 Synchronization of the real time clocks in the Building Controllers and Advanced Application Controllers.
- .3 Provide network interface modules and routers as required for all connections of the lower tier networks to the level 1 network. Provide network switches for connection of lower tiers of network to level 1 network on every floor of the building.
- .4 Provide lower level communication networks supporting all DDC controllers. Provide full communication capability between the level 1 network and all lower level networks so that all BAS specified downloading, uploading, data transmission, control commanding, alarm handling and programming is achieved smoothly and transparently.
- .5 A failure of any component or controller on any tier communication network shall not interrupt the execution of communication on these networks.
- .6 Review location and quantity of communication hub ports required for connection of lower tier networks to the level 1 network. Coordinate and arrange use of ports with Division 23.
- .7 BAS network shall have an extra 25% capacity for future expansion on all tiers.

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- .8 Remote Network Access: For Local Area Network installations, provide access to the LAN from a remote location, via the Internet. The Owner shall provide a connection to the Internet to enable this access via high speed cable modem, asynchronous digital subscriber line (ADSL) modem, ISDN line, T1 Line or via the customer's Intranet to a corporate server providing access to an Internet Service Provider (ISP). Customer agrees to pay monthly access charges for connection and ISP.
- .9 Fiber Optic Cable System: Optical Cable. Optical cables shall be duplex 900 mm tight-buffer construction designed for intra-building environments. Sheath shall be UL listed OFNP in accordance with NEC Article 770. Optical fiber shall meet the requirements of FDDI, ANSI X3T9.5 PMD for 62.5/125mm. Connectors. Field terminate optical fibers with ST type connectors. Connectors shall have ceramic ferrules and metal bayonet latching bodies.

2.3 Central Server

- .1 Provide industry standard hardware that meets or exceeds DDC System manufacturer recommended specifications and that can achieve response times required by specification Section 1.11 BAS PERFORMANCE.
- .2 Hard Disk to be capable of storing system software, one year of archive trend data and system database that is not less than twice the size of the database required when system is accepted. Provide additional external storage space if required.
- .3 Server shall be on UPS, 15 minutes, minimum 500W and emergency power.
- .4 Minimum server configuration to be the equivalent of current DELL or IBM small business server class computers.

2.4 Operator Interface

- .1 Minimum Operator Workstation configuration to be the equivalent of current DELL or IBM small business workstation performance class computers.
- .2 Workstation shall be on UPS, 15 minutes, minimum 500W.
- .3 OWS Alarm and Event Printers: One line-printer: Tractor paper feed, minimum 160 characters per second, cables, parallel or serial communication, 2000 sheets fanfold paper and two printer ribbons. Locate printer at Operator Workstation.
- .4 OWS Report Printers: [One laser printer: 600 dpi, toner, 500 sheets letter size white 24 lb paper.] [One colour ink-jet printer: black and colour cartridges, 500 sheets letter size white 24 lb paper.]
- .5 Portable Operator Terminals (POT):
 - .1 Portable Operator Laptops (POL):
 - .1 This device may be connected to any point on system network or may be connected directly to any controller for programming, setup and troubleshooting.
 - .2 Provide software to allow remote access to BAS for monitoring and control functions including full graphical displays.

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- .3 Minimum laptop configuration to be the equivalent of current DELL or IBM small business performance class laptops.
 - .2 Portable Operator Handheld (POH):
 - .1 POH Hardware: One handheld keypad with integral display to view, add, delete, modify and command point objects.
 - .2 Cables: For direct communication with Controllers.
- .6 Local Operator Keypad (LOK):
 - .1 Provide ability to view, add, delete and modify all controller objects. Provide ability to commission controller. Provide ability to view, add, delete and modify custom application algorithms. Provide ability for future additions, deletions and modifications to objects.
 - .2 Cables: For direct communication with Controllers.
- .7 Operator Software:
 - .1 User Interface: Completely web based without the need for interface/translation devices or need to load software individually on each computer. All points of user interface to be on standard personal computers. The primary point of interface on these personal computers to be a standard Web Browser such as Microsoft Internet Explorer.
 - .2 The operator interface is to provide complete tool sets, operational features, multi-screen displays and other necessary features to comply to this specification.
 - .3 System and software to permit multiple user remote access via the internet.
 - .4 Security:
 - .1 Access Level: Defines operator's ability to view, command and modify objects, and execute applications and system functions.
 - .2 Definition: Multiple operators are assigned access levels, and independent user login names and passwords are configurable.
 - .3 Processing: Automatically log off operator after an adjustable period of mouse or keyboard inactivity. Log operator activity.
 - .4 Storage: Store operator data, login names and passwords in encrypted format.
 - .5 On-line Help: Context-sensitive for operation and configuration tasks.
 - .6 LON Credits: Minimum 128 or 1.25 times the number of controllers included under the Work, whichever is greater.
 - .7 Database Configuration:
 - .1 Each workstation and server to store a copy of current system database.
 - .2 This database to be updated whenever change is made to system configuration.
 - .3 Storage of this database to be automatic and not require operator intervention.
 - .8 Objects and Properties:
 - .1 Create and delete objects. View and modify object properties.

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- .2 Backup and Restore:
 - .1 Automatically backup objects and operator overrides to local hard drive of the Operator Workstation and Server when a change is made in the controller.
 - .2 Automatically restore objects to a controller with an empty objects database.
- .9 System Diagnostics: Display diagnostic messages at Operator Workstations. Store diagnostic messages to local hard drive of Operator Workstation and Server.
- .10 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. Message displays at Operator Workstations to indicate source, location and nature without using acronyms.
 - .3 Storage: Store alarm and event messages to local hard drive of the Operator Workstation and Server.
- .11 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 to local hard drive of the Operator Workstation and Server. Maintain twelve consecutive months of trend data on the Server hard drive. Trend data shall be available for use in spreadsheets and database programs.
- .12 Reports:
 - .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 printed and stored to local hard drive of the Operator Workstation and Server automatically and by operator command. Report data shall be available for use in spreadsheets and database programs.
- .13 Time-of-Day (TOD) Schedules:
 - .1 Definition: Create, delete and modify TOD Schedules. Assign objects to TOD Schedules based on function and location.
- .14 Custom Application Programs (Algorithms):
 - .1 Definition: Create, delete and modify programs and program statements.
 - .2 Syntax: Support the syntax under Part 2: Products, Controller Resident Software, Custom Application Programs.
- .15 Graphics:

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- .1 Definition: Create, delete and modify graphic representations of the controlled systems. Import and convert images from other programs, including but not limited to: Micrografx Designer, Microsoft Visio, AutoCAD.
- .2 Graphics shall be HTML or JavaScript based and shall require no plug-ins or shall use plug-ins that are widely available to end users such as Active-X or Macromedia Flash.
- .3 The graphics shall be able to display and provide animation based on real-time data that is acquired, derived, or entered.
- .4 Graphics shall be 3 dimensional representations of controlled systems, equipment and devices.
- .5 Provide a color graphic system flow diagram display for each system with all points as indicated on the control diagrams.
- .6 Graphics to be provided as follows:
 - .1 Facility Site Graphic
 - .2 BAS Network Schematics
 - .3 Terminal Unit Floor Plan
 - .4 Primary Equipment Room Floor Plan
 - .5 Individual Graphics for each System and Terminal Unit
- .7 Navigation between systems shall be point and click.
- .8 Dynamic Values: Add point object data to graphic representations.
- .9 Library: Provide library of image files; include standard images for chillers, boilers, air handlers and terminal units and standard symbols for fans, pumps, coils, control devices, pipes, dampers and ducts.
- .16 Clock Synchronization: Real-time clocks in control panels and workstations to use open system synchronization services. Clocks to be synchronized daily. System to change between daylight saving and standard time automatically.

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 (LON or BACnet) for seamless integration with BAS. Include network connection from BAS to 3rd party manufacturer controllers.
- .2 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:

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- .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: Store trend data to controller RAM memory. Trend data is retrieved by the Operator Interface.
 - .3 Samples:
 - .1 Analog Point Objects: Store instantaneous point object data at every point object change of value (COV) for the analog type or at time intervals of fifteen minutes.
 - .1 Temperature COV: 2.0 Deg. C (3.6 Deg. F).
 - .2 Relative Humidity COV: 5 % RH.
 - .3 Other Analog COV: 5 % of scale length.
 - .2 Binary Point Objects: Store instantaneous point object data at every point object 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.
 - .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.

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- .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.
- .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 Analog Inputs:

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- .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.
- .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 Level 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.

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

2.8 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 Supplies:
 - .1 Type: Enclosed; Class 2 current-limiting, or over-current protection in primary and secondary circuits for Class 2 service to the National Electrical Code.
 - .2 Applied Loads: To 80% of rated capacity.
- .3 DC Power Supplies: Regulated output.

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- .1 Built in over voltage and over current protection.
- .2 Able to withstand 150% current overload for at least 3 seconds without trip or failure.
- .4 Power Line Filtering: Provide internal or external transient voltage and surge suppression for workstations and controllers.

2.9 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.

2.10 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:
 - .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 0.35 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 Actuators For Dampers, Electronic:

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- .1 Control Signal: Compatible with BC, AAC and ASC.
- .2 Floating control signal is acceptable only for VAV damper application.
- .3 Operating Time: Maximum 120 seconds throughout the full rotation.
- .4 Angle of Rotation: Adjustable between 0° to 90°.
- .5 Stall protection: Mechanical or electronic.
- .6 Actuators shall have electronic overload protection or digital rotation sensing circuitry to prevent actuator damage throughout the entire rotation.
- .7 Failsafe: Non-spring return for VAV terminals; spring return for other applications. Spring return to normal position within 15 seconds.
- .8 Manual Override: Crank type. External gear release for non-spring return actuators.
- .9 Position Indicator: Reversible for clockwise or counter-clockwise rotation; set the 0 degrees mark to the failsafe position.
- .10 Torque: To damper manufacturer's requirements to provide complete compression of seals between frame and blades and for smooth control.
- .11 Provide UL555S listed damper actuators for all dampers used in smoke control.
- .3 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.
- .5 Leakage: ANSI Class IV.
- .6 Materials:
 - .1 Stems: Stainless steel.
 - .2 Plugs and Seats: Brass or steel.
 - .3 Packing: PTFE for steam.
- .7 Rangeability: 40:1 minimum.
- .4 Actuators for Control Valves, Electronic:
 - .1 Control Signal: Compatible with BC, AAC and ASC.
 - .2 Floating control signal is not acceptable.
 - .3 Operating Time: Maximum 120 seconds throughout the full rotation.
 - .4 Mounting: Corrosion resistant hardware.
 - .5 Stall Protection: Electronic overload or digital rotation sensing.
 - .6 Failsafe: Non-spring return for radiation and terminal reheat coils; spring return for others. Spring returns to normal position within 15 seconds.
 - .7 Manual Override: Crank type. External gear release for non-spring return actuators.
 - .8 Position Indicator: Provide. Indicate valve open and closed positions.
 - .9 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.

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.5 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.

.6 Damper End Switches:

- .1 Type: Lever operated activated by blade position.
- .2 Electrical Contacts: Rated for 10 A resistive, 6 FLA at 120 VAC.
- .3 Regulatory: UL listed.

.7 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.

.8 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.

.9 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 10 A 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.

.10 High Limit Electromechanical Thermostat:

- .1 Type: Bimetallic sensing; manual reset upon activation.

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- .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).
- .11 Electromechanical Thermostat:
- .1 Wall Mount:
 - .1 Provide samples of covers to Part 1: Submittals, Samples.
 - .2 Low Voltage:
 - .1 Type: 24 VAC, bimetal-operated, mercury-switch; adjustable or fixed anticipation heater; vented ABS plastic concealed cover.
 - .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.
 - .3 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.
- .12 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.
- .13 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.

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- .2 Space Temperature Sensors:
 - .1 For installation throughout the facility 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.
- .8 Thermowells:
 - .1 Brass or Type 316 stainless steel suitable for the application.
 - .2 Heat transfer compound compatible with sensing element.
- .14 Guards for Sensors and Thermostats:
 - .1 Materials: Heavy gauge steel.
- .15 Relative Humidity Sensors:
 - .1 Sensors shall be calibrated to NIST standards.

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- .2 Sensing Element:
 - .1 Type: Thin film capacitance.
 - .3 Transmitter:
 - .1 Range: 0 to 100% RH.
 - .2 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.
- .16 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.
 - .4 Capable of withstanding 100% overpressure without damage
 - .2 Air Static Pressure Sensors:
 - .1 Sensing Element:
 - .1 Type: Capacitance sensing with pitot tube sensing tips screwed securely to duct.
- .17 Submersible Pressure Sensor:
- .1 The sensor housing shall be made from high strength stainless steel or titanium for pressure ranges up to 100 PSI (689.5 kPa) and compatible with 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.

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.18 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.

.19 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.

.20 CO2 Sensors:

- .1 Sensor shall employ non-dispersive infrared technology (NDIR).
- .2 Accuracy shall be +/- 75 ppm over 0-1500 ppm range.
- .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°C to 50°C.
- .7 The sensor shall be wall/duct mount.

.21 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

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- .8 Operating Humidity Range: 0-95% RH, non-condensing
 - .9 Operating Temperature Range: -20 to 50°C (-4 to 122°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 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
 - .12 Conforms to: ANSI/UL 61010-1
 - .13 Make and Model: Honeywell E3 Point sensors 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: ±10ppm @ 50 ppm / ±40ppm @ 500 ppm
 - .6 Detection Range: Refrigerants 0-1000 ppm

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.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°C to 40°C (32°F to 100°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.

.22 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 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.

.23 Air Flow Stations (Fan Bell Mouth):

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- .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 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 bank & 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.

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- .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.
- .24 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 bank & 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 Acceptable equal shall be Ebtron Gold Series:

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- .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.
- .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.

2.11 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: Per controls manufacturer recommendations.
 - .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.

PART 3 - EXECUTION**3.1 General Workmanship**

- .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.

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- .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 contractor shall install all in-line devices such as temperature wells, pressure taps, airflow stations, etc.

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.

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- .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 450mm (18 in.) and an enclosure for the electrical connections.

3.4 Power Wiring

- .1 Power for section 23 09 00.00 – 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 mechanical drawings. Wiring and conduit from these boxes to control devices being electrically powered to be provided by section 23 09 00.00 – Building Automation System (BAS).
- .2 Where power for equipment is fed from MCC, 120 VAC power for Section 23 09 00.00 – 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 00.00 – 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.

3.6 Operator Interface

- .1 Operator Software:
 - .1 Security: Set up operators with independent user login name and password and assign access levels to Owner's requirements.
 - .2 Reports: Configure the following reports:
 - .1 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.
 - .2 List of disabled point objects sorted by point object name in ascending order.
 - .3 List of TOD Schedules: Indicate: objects assigned to the TOD Schedule, Occupied Mode times.

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- .2 Graphics: Generate graphic representations for systems under Section 23 09 23.00 – 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.
 - .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 general contractor.

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 23.00 – SEQUENCE OF OPERATION FOR BAS.
- .2 Motor Operated Dampers:
 - .1 Furnish motor operated dampers for installation under Section 23 31.13.00 – DUCTWORK AND SPECIALTIES. Provide supervision on site during installation.
 - .2 Install in areas maintained above freezing.
- .3 Actuators for Dampers, Electronic:
 - .1 Mounting: Direct coupled to drive shaft or jackshaft using a V bolt design.
- .4 Control Valves:
 - .1 Furnish control valves for installation under Section 22 11 13.00 – PIPE, VALVES AND FITTINGS (EXCEPT PLUMBING). Provide supervision on site during installation.
- .5 Actuators for Control Valves, Electronic:
 - .1 Factory install or field install actuator to valve body.
- .6 Low Limit Electromechanical Thermostat:
 - .1 Install hardwire interlocked to supply fan starter for respective system.

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- .2 Provide according to Section 23 09 23.00 – SEQUENCE OF OPERATION FOR BAS.
- .3 Shut down the fan when duct temperature is equal to or less than 1.67 deg. C (35 deg. F).
- .4 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.
- .7 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.
- .8 Electromechanical Thermostats and Temperature Sensors:
 - .1 Furnish sensing wells for installation under Section 22 11 13.00 – 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.
 - .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.

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- .4 Seal interior of conduit at penetration through exterior wall.
- .9 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.
- .10 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.
- .11 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.
- .12 Relative Humidity Sensors:
 - .1 Install to requirements for Electric Thermostats and Temperature Sensors.
- .13 AC Current Sensors and Transducers:
 - .1 Install in motor starter cabinet.
- .14 Water Flow Meters:
 - .1 The installing contractor is responsible for providing suitable mating flanges and any required reducer/expander.
- .15 Air Flow Sensors, Fan Bell Mouth:
 - .1 Coordinate installation of air flow sensors to inlet of fans with fan manufacturer.
- .16 Air Flow Sensors, Duct Mount:
 - .1 Furnish duct mount air flow sensors for installation under Section 23 31 13.00 – 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.

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- .2 Prepare test forms which shall identify each test. The forms shall be sub-divided into points, controllers, programs, loops, networks and graphics.
- .3 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.
- .4 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.
- .5 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.
- .6 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.
- .7 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.
- .8 Dynamic graphics tests shall identify and confirm successful completion of the following:
 - .1 All graphics.
 - .2 All point objects per graphic.
 - .3 All set-points per graphic.

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3.11 Demonstration

- .1 When all tests have been completed and the documentation completed, request a meeting with the Consultant and Owner. Provide at this meeting a demonstration that all systems on the BAS are operating. At the successful conclusion of this demonstration the Consultant will allow the Acceptance Test to begin.
- .2 At the discretion of the Consultant and Owner, demonstrate up to 10% of the tests described in Part 3: Execution, Testing and Commissioning and witnessed by the Consultant and Owner. 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 Consultant will give approval for commencement of the Acceptance Test.
- .2 Notify the Owner 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 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 Owner. Submit training course outline for review by the Consultant before completion of the BAS and before instruction period commences. Instruction shall include:
 - .1 Operation and maintenance of Operator Interfaces.
 - .2 Operation and maintenance of controllers.
 - .3 Custom Application Programming software.
 - .4 Point objects addressing and commanding.
 - .5 Custom reporting.

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- .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.
- .3 Provide an additional three days of training that may be scheduled up to six months after BAS Acceptance. The Owner will advise the BAS Contractor of the training content required.
- .4 One day shall be 7.5 working hours excluding one hour lunch break.

END OF SECTION

Sequence of Operation for BAS

PART 1 - GENERAL**1.1 Work Included**

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS and SECTION 23 09 00.00 – BUILDING AUTOMATION SYSTEM.
- .2 The locations of all sensors shall be discussed with and approved by the Owner and/or Consultant, 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.

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 Refer to SECTION 23 09 00.00 – BUILDING AUTOMATION SYSTEM SECTION for software programs.

PART 3 - EXECUTION**3.1 Heating Water Plant With Two Boilers and Glycol Heat Exchanger**

- .1 System Start:
 - .1 Lead boiler shall be enabled and secondary pump shall start when Outside Air Temperature (OAT) is less than 15.5°C (60 deg F) for more than 30 minutes or as scheduled by building operator.
 - .2 The Glycol Pumps (GLYP1 and GLYP2) and Glycol Control Valve (GCV) shall be enabled when one of the Hot Water Secondary Pumps (HWSP) is running.
- .2 Normal Operation:
 - .1 The lead Hot Water Secondary Pump (HWSP) shall run continuously when the outside air temperature is below system enable set-point.
 - .2 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)	12.8°C (55 deg F)	-15°C (5 deg F)
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Sequence of Operation for BAS

Hot Water Supply Temperature (HWST) Set-Point	43.3°C (110 deg F)	82.2°C (180 deg F)
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- .3 The lag boiler and it's pump shall be enabled if system load requires the second boiler.
- .4 Lead and lag boilers shall change on a weekly basis.
- .5 The Secondary pump and Glycol pump speed shall be modulated via variable frequency drives to maintain the Heating Water Differential Pressure (HWDP) at setpoint. If the Heating Water Differential Pressure (HWDP) exceeds the setpoint at minimum pump VFD speed, the normally closed Heating Water By-Pass Control Valve (HWBPCV) shall modulate to maintain setpoint.
- .6 The lead glycol pump shall run continuously when the system is enabled. Lead and lag glycol pumps shall change on a weekly basis.
- .7 Glycol Control Valve (GCV) shall modulate to maintain Glycol Supply Temperature (GLYST) at set-point.
- .3 System Stop:
 - .1 The system shall be disabled when Outside Air Temperature (OAT) rises above 18.3°C (65 deg F).
- .4 Alarms:
 - .1 Boiler General Alarms (BGAL) from boiler panels.
 - .2 System pumps (PST) from current sensors.
 - .3 Hot Water Supply Temperature (HWST) out of range.
 - .4 Hot Water Return Temperature (HWRT) out of range.
 - .5 Glycol Supply Temperature (GLYST) out of range.
 - .6 Glycol Return Temperature (GLYRT) out of range.

3.2 Pool dehumidification Unit

- .1 Controls for the pool unit shall be supplied under Section 23 74 23.00 – POOL DEHUMIDIFICATION UNIT. Refer to Section 23 74 23.00 for read and read/write points and alarms.
- .2 Applicable Systems:
 - .1 AHU-01-01 – Pool Dehumidifier
- .3 System Start:
 - .1 System start shall be initiated by operator command at the BAS or through time schedule.
- .4 Normal Operation:
 - .1 The Zone Air Temperature (ZAT) setpoint shall be 29.4°C (85 deg F) (adjustable) and the Zone Air Humidity (ZAH) setpoint shall be 60% RH (adjustable).

Sequence of Operation for BAS

- .2 The 25m Pool Water Temperature (PWT) setpoint shall be 30.0°C (86 deg F).
- .3 The Leisure Pool Water Temperature (PWT) setpoint shall be 33.9°C (93 deg F).
- .4 The Hot tub Pool Water Temperature (PWT) setpoint shall be 40.0°C (104 deg F)
- .5 System Stop:
 - .1 System stop shall be initiated by operator command at the BAS or through time schedule.
 - .2 Should the building go into fire alarm mode, the system shall be shut down.
- .6 Schedule:
 - .1 System operates continuously.

3.3 Air Handling Unit Constant Volume 100% Outside Air with Heat Wheel (AHU-01-02 – change rooms)

- .1 Applicable Systems:
- .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 DX cooling, Glycol Heating Valve (GHV) are enabled when system fans are running.
- .3 Normal Operation:
 - .1 BAS shall modulate heat wheel speed through Heat Wheel Variable Speed Drive (HTWVSD) to maintain heat wheel Leaving Air Temperature (LAT) at 12.7°C (55 deg F) (adjustable).
 - .2 DX cooling and Glycol Heating Valve (GHV) shall modulate in sequence to maintain Supply Air Temperature (SAT) at 12.7°C (55 deg F) (adjustable).
 - .3 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.
 - .4 Heat wheel frost control mode: if frosting conditions are calculated to occur using Return Air Humidity (RAH), Return Air Temperature (RAT), Outdoor Air Temperature (OAT) and Heat Wheel Leaving Air Temperature (HTWLAT), Glycol pre-Heat Valve (GHV) shall modulate to maintain heat wheel Entering Air Temperature (EAT) above calculated set-point.
 - .5 Heat wheel standby mode: heat wheel shall be rotated at minimum speed one and a half rotation once per day when not in use.

Sequence of Operation for BAS

- .6 Provide wiring for electrical interlocks between condensing unit and air handling unit.
- .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. DX cooling shall close, Glycol Heating Valve (GHV) shall open.
 - .2 When Outdoor Air Temperature (OAT) is below 3°C (37.4 deg F), Glycol Heating Valve (GHV) shall modulate to maintain heat wheel Leaving Air Temperature (LAT) at 4°C (39.2 deg F).
- .5 Schedule:
 - .1 System operates continuously.
- .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 Safety alarms: low plenum air temperature (FZ), high plenum supply and exhaust air temperatures (F).
 - .5 Supply and Exhaust Pre Filters (PFPD) dirty at 250 Pa (0.035 psi) pressure drop.
 - .6 Final Filters (FFPD) dirty at 375 Pa (0.05 psi) pressure drop.

3.4 VRF System

- .1 General
 - .1 The VRV system provides heating and cooling to the space it serves. The VRV system is utilized to compensate for short term changes in the space conditions. The VRV unit is controlled by a local controller provided by the VRV manufacturer. BAS will integrate to the VRV system via a BACnet gateway.
 - .2 The VRV system is composed of:
 - .1 Outdoor units
 - .2 Indoor units
 - .3 Local thermostats
 - .4 BACnet gateway
- .2 Safeties and Limits

Sequence of Operation for BAS

- .1 Contacts are provided on all windows to indicate when they are open (contacts provided by this BAS contractor). When any window in the space is open the VRV will be shut down. An emergency limit will be put in place that will allow the VRV system to heat the space regardless of window position if the space temperature drops to 8 Deg C. An alarm is sent to the operator when operating in emergency mode.
- .2 Isolating valves are provided for the condensing units. Valves will be open when any fan coil is operating and close once they are all off. Flow must be proven for the condensing unit to operate. Coordinate with VRV manufacturer.
- .3 Mode of Operation
 - .1 The occupied and unoccupied modes are determined by a time of day schedule.
 - .2 Morning warm up/cool down subroutines are enabled to calculate the optimal start time for the systems. Subroutine will calculate the start time based on current space and outdoor conditions. Maximum start time is 1 hour prior to occupancy.
- .4 Occupied Mode
 - .1 The VRV equipment operates via the controls provided by the VRV manufacturer. Stand-alone controls will control the indoor unit, branch box and outdoor units to maintain the space temperature at setpoint. Where applicable the operator can view and adjust control parameters through the stand-alone thermostats.
 - .2 The BACnet interface provides the following information for viewing or commanding via the BAS:
 - .1 Commanding and monitoring the status of the indoor unit (on/off)
 - .2 Monitoring alarms
 - .3 Setting and monitoring the indoor units mode of operation:
 - .1 Cool
 - .2 Heat
 - .3 Fan
 - .4 Auto
 - .5 Dry
 - .4 Setting and monitoring the indoor units fan speed (where applicable)
 - .5 Monitoring the space temperature and adjusting the space temperature setpoint.
 - .6 Enabling/disabling the remote controller completely or partially.
 - .7 Setting the unit to energy saving mode and monitoring the status of the mode.

Sequence of Operation for BAS

- .8 Monitoring compressor, fan, filter and heater status.
- .3 The BAS will annunciate alarms received through the BACnet interface.
- .5 Unoccupied Mode
 - .1 The VRV unit is unoccupied and will control itself to maintain the space temperature at the unoccupied setpoints. Unoccupied space temperature setpoints are adjustable through the local VRV temperature sensors.
- .6 Integration with Other Systems
 - .1 Space temperature reading and space temperature setpoints are obtained via the BACnet interface to the VRV system.
 - .2 Heating and cooling operation status is obtained via the BACnet interface to the VRV system.
- .7 Critical Alarms
 - .1 The space temperature drops below 15 Deg C.
 - .2 The space temperature rises above 30 Deg C.
 - .3 As provided by the VRV BACnet gateway.
- .8 General Alarms
 - .1 During the occupied mode the space temperature is +/- 2 Deg C from setpoint.
 - .2 As provided by the VRV BACnet gateway.

3.5 Fuel System Monitoring Points

- .1 Monitoring Points:
 - .1 Individual pump motor run (2)
 - .2 Individual pump motor overload (2)
 - .3 Low level main tank (1)
 - .4 High level main tank (1)
 - .5 Critical Low level main tank (1)
 - .6 High System pressure (1)
 - .7 Low System Pressure (1)
 - .8 4 additional sets of dry contacts.

3.6 Mechanical and Electrical room Ventilation Fans

- .1 System Start:
 - .1 System start shall be initiated by space temperature demand (SPCT) or through time schedule. Upon signal to start the system, the exhaust and intake dampers shall open (EAD & OAD), when the damper end switches make (EADED & OADES) the fan shall start (EFSS).

Sequence of Operation for BAS

.2 Normal Operation:

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

.3 System Stop:

- .1 System stop is initiated when space temperature (SPCT) is satisfied or through time schedule. Upon signal to stop the system, the exhaust fan shall stop (EFSS) and the exhaust and intake dampers shall close (EAD & OAD).
- .2 Should the building go into fire alarm mode, the system shall be shut down.

.4 Schedule:

- .1 To be determined by the owner.

.5 Alarms:

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

3.7 Exhaust Fan**.1 Applicable Systems:****.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), or shall run continuously during occupied hours.

.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 owner.

.6 Alarms:

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

3.8 Force Flow Heater**.1 Applicable Systems:****.2 System Start:**

- .1 System shall be enabled only in winter mode.

Sequence of Operation for BAS

- .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 Unit Heater

- .1 Applicable Systems:
- .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 supply fan and heating coil valve shall be enabled.
- .3 Normal Operation:
 - .1 Supply Fan (SFSS) and Heating coil Valve (HCV) shall cycle in sequence to maintain Space Temperature (SPCT) at set-point (adjustable).
- .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 fan shall stop. Heating coil valve shall be closed.
- .5 Schedule:
 - .1 To be determined by the owner.
- .6 Alarms:
 - .1 Supply Fan Status (SFST) from current sensor.
 - .2 Space Temperature (SPCT) out of range.

3.10 Air Curtain

- .1 Applicable Systems:
- .2 System Start:
 - .1 System start shall be initiated by entrance door opening. Upon signal to start the system, fan shall start. Heating coil valve shall only be enabled in winter mode.

Sequence of Operation for BAS

.3 Normal Operation:

- .1 Fan (FSS) shall run and Heating Coil Valve (HCV) shall open while the entrance door is opened.

.4 System Stop:

- .1 System stop is initiated when the entrance door is closed. Upon signal to stop the system the supply fan and heating coil valve shall close.
- .2 Heating coil valve shall be disabled in summer mode.

.5 Alarms:

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

3.11 Perimeter Radiation

.1 System Start:

- .1 System start shall be initiated by space temperature demand (SPCT). Heating coil valve shall be enabled.

.2 Normal Operation:

- .1 In occupied mode Radiation Valves (RADV) shall modulate to maintain Space Temperature (SPCT) at set-point (adjustable).
- .2 In unoccupied mode, Radiation Valves (RADV) shall modulate to maintain the night set-back space temperature set-point.

.3 System Stop:

- .1 System stop is initiated when space temperature (SPCT) is satisfied. Heating coil valves shall be closed.

.4 Schedule:

- .1 To be determined by the owner.

.5 Alarms:

- .1 Space Temperature (SPCT) out of range.

3.12 Domestic Water Booster Pump Package

- .1 The BAS shall communicate with the booster pump package through either BACnet or LONWorks communication protocol interface.
- .2 The BAS shall monitor the domestic booster pressure at the pump set, the water inlet, and at the top of the DCW riser and alarm if any are out of range.
- .3 The BAS shall monitor the package general alarm.

3.13 Domestic Hot Water Tanks and Recirculation Pump

.1 Normal Operation:

Sequence of Operation for BAS

- .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 through the operation of domestic water circulator pump P-DHWR-B-02.
 - .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 (P-DHWR-B-01) 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 Consultant.
 - .6 During unoccupied hours the BAS shall start the domestic hot water recirculation pump (P-DHWR-B-01, P-DHWR-01-01) 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.
- .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

3.14 Storm and Sanitary Sump Pits

- .1 The sump pumps come with self-contained controls.
- .2 The BAS shall monitor the alarm (high level) of the sump pump controller and the general alarm.

3.15 Pool Recirculation Pumps

- .1 The BAS shall start/stop and monitor the status of the pool recirculation pumps.
- .2 The BAS shall rotate the lead (standby) pumps on a weekly basis.
- .3 The BAS shall modulate the VSD to maintain the design pump flow rate in response to the inline flowmeter.
- .4 During filter backwash, if the sanitary pit high level alarm is in alarm and the flow switch on the filter backwash senses flow, the BAS shall shut down the associated pumps to prevent overflowing the sump pit during filter backwashing.

3.16 Pool Water Temperature Control

- .1 Maintain 25m Lap Pool return water temperature at 30.0°C (86 deg F) (adjustable) by modulating the control valve on the boiler water connections.
- .2 Maintain Leisure Pool return water temperature at 33.9°C (93 deg F) (adjustable) by modulating the control valve on the boiler water connections.

Sequence of Operation for BAS

- .3 Maintain Hot tub return water temperature at 40.0°C (104 deg F) (adjustable) by modulating the control valve on the boiler water connections.
- .4 Temperature sensor in pool water pipe leaving heat exchanger shall limit valve opening so heat exchanger leaving temperature is not greater than 5.5deg.C. (10deg.F.) above pool return water temperature.

3.17 Miscellaneous Monitoring Points

- .1 Miscellaneous Points:
 - .1 Outdoor Air Temperature.
 - .2 Domestic Water Pump.
 - .3 Domestic Water Pressure.
 - .4 Energy Meter.
 - .5 Sump Water Level.
 - .6 Sump Pump.

END OF SECTION

Oil Lines

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 All piping installation and associated devices/appurtenances shall comply with the latest, in force version of the CSA B139 ON “Ontario Installation Code for Oil-Burning Equipment” and the authority having jurisdiction.
- .3 Submittal
 - .1 Submit shop drawings and or catalogue cuts of all transition sump pits, solenoid valves, anti-siphon valves, oil distribution schematic and all other devices/components required to be installed within the fuel lines in accordance with SECTION 21 05 03.00 – SHOP DRAWINGS.

PART 2 - PRODUCTS

2.1 Materials

- .1 Interior fuel oil lines shall be Schedule 40 black steel with malleable iron fittings, or welded.
- .2 Oil vent shall have fill alarm.
- .3 Provide screw cap with pad lock and chain for each fill line.
- .4 Provide all required ULC listed vacuum breakers, anti-siphon valves, transition sump pits, solenoid valves, and all other devices/components as required by the Oil Burning Code, as shown in the documents and as required for this fuel oil installations.
- .5 Fuel oil return lines shall be one trade size larger than the fuel oil supply line.
- .6 Vent pipes shall be installed to drain towards the tank without sags or traps.

2.2 Buried Oil Lines

- .1 Underground fuel oil pipe 50 mm (2 in.) and smaller shall be multi-layer, flexible thermoplastic construction ULC listed and compatible with petroleum fuels, the underground environment and suitable for direct bury. Pipe shall be OPW or APT.
 - .1 Pipe and couplings shall be UL/ORD-C971 listed.
 - .2 Pipe couplings shall be permanently attached to the primary pipe by internally expanding the coupling insert.
 - .3 Conduit below roadways shall be of a crush resistant, fully bonded, double-wall corrugated construction with a semi-smooth inner liner or PVC rigid sewer pipe to facilitate removal of fuel pipe without deconstructing the roadway.
- .2 Buried oil lines larger than 50 mm (2 in.) shall be NOV Fiber Glass Systems red thread TII double wall fibreglass piping or approved equal and shall be equipped with an approved leak detection system from the primary tube. All underground piping shall be certified under ULC/ORD-C971 for use in buried applications.

Oil Lines

- .1 Pipe and couplings shall be UL/ORD-C971 listed.
- .2 All buried piping shall be installed so that they are protected against expansion, contraction, vibration, settling and stresses from buildings, structures, or vehicular traffic, or stresses caused by temperature variations.
- .3 Pipe, fittings and containment pipe and fittings shall be UL/ULC listed and labelled.
- .4 Adhesives shall be specifically designed for the product and shall be compatible with the fluids being carried.
- .5 All tools used for cutting and tapering joints shall be specifically deigned for the product being used.
- .3 All buried fuel shall enter the building through a ULC listed, monitored transition sump pit. The transition sump pit shall be equipped with a liquid sensor to monitor and alarm when liquid is present in the sump.
- .4 Piping and conduit entries into sumps shall be made with watertight Entry Fittings that require a single hole to be drilled in the sump wall and that can be repaired or replaced from inside the sump without excavation. Provide backfill protection fittings as required.

PART 3 - EXECUTION**3.1 Installation****3.2 Above Grade Fuel Piping**

- .1 All distribution oil piping within the building, but outside the oil pump/tank room, shall be welded. Screwed fittings shall be used at equipment connections only.
- .2 Oil piping shall include fill, vent, suction, return gauge piping, and connections to engine. Vent piping shall terminate in an approved rain cap a minimum of 2134 mm (84 in.) above grade. Piping shall include all necessary strainers, pressure relief valves, pressure gauges, vacuum breakers, anti-siphon valves, solenoid valves and all other devices required by code and by this installation.
- .3 Provide a piping schematic of the entire distribution system c/w all equipment and devices described above. Submit schematic in the form of a shop for Consultant review.
- .4 Fuel oil lines shall be installed in a location that prevents the fuel oil/fuel oil piping from exceeding 38 deg. C. (100 deg. F.).
- .5 When the elevation of the pump is below the level of the fuel in the tank, the fuel line from the tank to the pump shall be equipped with an anti-siphon valve located at the top of the tank, preset to open at 7 kPa (1 psi) higher than the negative head pressure represented by the vertical distance from the top of the tank to the lowest level of the piping. The anti-siphon valve shall be equipped to dissipate excess pressure in the fuel line due to thermal expansion.
- .6 All fuel oil piping shall be installed to drain back to the tank, and without any sags or traps.
- .7 The main tank normal vent shall
 - .1 terminate with an approved pressure/vacuum upward vent, having a maximum opening pressure of 3.5 KPa (0.5 psi), and

Oil Lines

- .2 terminate above the fill point and be at least 2 m (6.6 ft) above the finished grade.
- .8 The overflow pipe of an auxiliary tank shall be equipped with a vacuum breaker located as close to the tank as possible to prevent collapse of the tank. The vacuum breaker shall be set to open on a negative pressure of 3.5 KPa (0.5 psi).
- .9 Install the oil/water separator in the fuel pump discharge line.
- .10 All above grade tank piping located below the product level shall be equipped with either a manual or automatic shut-off valve at the storage tank.
- .11 Install a manual shut-off valve in the fuel line as near as possible to the exit from the supply tank and at other locations as required to avoid spillage during service. Valve shall be readily accessible, have external body components capable of withstanding 538 deg. C. (1000 deg. F.) and certified as suitable for its intended use.
- .12 All valves on the system shall be equivalent to MA Stewart CSS-F-3-HD-FS, Apollo 83B-240-UL-24, full port, 3 piece construction, fire safe valve, certified to API-607 latest edition, min 250 PSIG saturated steam rating (this option is more cost effective)
- .13 Alternative to article above All valves on the system shall be equivalent to MA Stewart HM-3-AFT three piece body full port valve or Apollo 93-100-UL-24 uni-body, fire safe valve, certified to API-607 latest edition.
- .14 When a shut-off valve is installed in the return line from the fuel pump, a suitable pressure relief valve shall be installed in the return line, located between the pump and the shut-off valve, and arranged to return the surplus oil to the supply tank or bypass the surplus fuel oil around the pump.
- .15 Install a suitable, automatically operated shut-off valve to shut-off the oil flow in case of fire in the immediate area of the burner.
- .16 Fuel oil piping shall not be installed in chimneys, vents, elevator shafts, air distribution ducts, chutes, dumbwaiters or duct shafts.

3.3 Below Grade (Buried) Fuel Piping

- .1 The transition sump pit shall be installed outside, within the grade, directly adjacent to a perimeter wall. Double wall buried (plastic) pipe shall be used to connect the buried tank to the transition sump pit. Interior (metallic) fuel piping shall be used to connect to the building side of the transition sump pit, routed through the wall using an approved mechanical sleeve, and installed directly into the building. (Refer to Standard Detail)
- .2 The transition sump pit shall shut and shall provide an audio/visual alarm, located in a maintenance personnel location.
- .3 All buried piping shall be installed so that it slopes toward the transition sump pit. This buried piping shall be installed in a properly graded trench to prevent sagging.
- .4 Prior to be connected to a tank, all underground piping shall be pneumatically or hydrostatically tested to at least 350 kPa (50 psi) gauge or 1½ times it's maximum operating pressure whichever is greater. During the leakage test, applying a leak detection solution before back filling in accordance with the manufacturers recommendations and a record of the tests shall be retained on site.

Oil Lines

- .5 Buried piping systems must be able to maintain pressure and volume for a period of at least 2 hours after steady temperature conditions have been maintained and the source of pressure has been removed. During this pressure testing period, the tank shall not be exposed to pressures in excess of 6.9 kPa (1 psi).
- .6 Buried piping and containment systems shall be installed by contractors trained in the certified manufacturer's installation procedures.
- .7 All buried piping shall be installed so that they are protected against expansion, contraction, vibration, settling and stresses from buildings, structures, or vehicular traffic, or stresses caused by temperature variations.
- .8 All buried piping shall have a minimum coverage of 400 mm (16 in.) and not less than 600 mm (24 in.) below a commercial driveway or parking lot, except where it rises to meet the transition sump.
- .9 Buried piping shall not be installed below foundation walls or under buildings.
- .10 Provide a water tight seal for all buried piping which penetrates an outside wall, c/w a protective sleeve.

END OF SECTION

Oil Pumping Set

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 21 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 All fuel oil pumps, associated devices, and appurtenances shall comply with CSA B139 Installation Code for Oil Burning Equipment with amendments as required and/or approved for use by the Authority having Jurisdiction.
- .3 Submittal
 - .1 Submit shop drawings and or catalogue cuts of all items supplied in accordance with SECTION 21 05 03.00 - SHOP DRAWINGS.

PART 2 - PRODUCTS

2.1 Materials

- .1 Duplex oil pump package shall be Viking or Albany.
- .2 Pumps shall be positive displacement, self-priming heavy duty rotary helical gear type, and each pump shall be flange-mounted and direct drive through a flexible coupling by a TEFC motor complete with coupling safety guard. Pumps shall be cast iron, steel-fitted construction with Buna-Nitrile fitted mechanical seal and self-lubricating carbon shaft bearings.
 - .1 Pump capacities shall be as per schedules.
- .3 Strainer shall be duplex basket type with stainless steel rotor shafts and stainless steel strainer baskets with 60 mesh screen certified to ULC/ORD-C331, and shall meet the requirements of CSA B140.0. Strainer shall be supported independent of piping by a steel mounting foot.
- .4 Each pump shall be complete with suction and discharge pressure and vacuum gauges, discharge line ball valve, suction line ball valve, check valve, relief valve with stainless steel trim, and pressure sensing devices.
- .5 Relief valves shall be sized to relieve the full outlet flow of the pump without causing the pumps motor to overload. There shall be a relief valve for each pump externally mounted and piped to the return pipe or dedicated relief pipe in the field.
- .6 Pump Set shall be assembled on a 6 mm (1/4 in.) fabricated steel base, epoxy lined, with a full perimeter 50 mm (2 in.) drip lip extended under all pumps, strainers, and factory installed piping and components. Provide liquid detection sensor in pump base and wire to pump control panel.
- .7 Provide a factory wired duplex alternating control panel consisting of cUL/CSA Listed, CAN/ULC S661 and UL508A certified, microprocessor-based Programmable Logic Control (PLC) strategy with the following features:
 - .1 NEMA 1 enclosure with individual disconnect switches with thru-the door-operation
 - .1 Thermo-magnetic motor protector for each pump

Oil Pumping Set

- .2 Pilot lights for:
 - .1 'Power On'
 - .2 motor 'Run'
 - .3 motor 'Fault',
- .3 Terminal strip
- .4 Pump failure pilot light and manual reset
- .5 Audible alarm buzzer and silence push button
- .6 High and Low Pressure Cut Outs/ Red Pilot Light/ Reset
- .7 Automatic transfer to non-operating pump in the event of motor overload or short circuit
- .8 Provisions for Auxiliary Tank Status (High Level, Critical High Level, Low Level, and Leak Detection)
- .9 Provisions for Main Tank Status (High Level, Low Level, and Leak Detection)
- .10 Pump Set Basin Leak Detection Signal and Red Pilot Light
- .11 Dry Contacts Provided for All Alarms
- .12 Loss of Power alarm Relay (fail safe)
- .13 24V Transformer
- .14 Provision for Generator run interlock permissive signal
- .8 The pressure sensing device shall be supplied with the pump set and shall be wired to the control panel to signal a pressure variation (lower or higher) from the normal system pressure causing a system fault which will shut down the pumps and alert the operator. Control system must override low pressure sensor during pump starting (time delay).
- .9 Unit shall be prime coated with baked enamel finish, colour to the Consultant's requirements.
- .10 Provide auxiliary tank base leak detection contact. Contact shall be used only as alarm at the panel and BAS.
- .11 Provide 24 VDC and 120 V as required for auxiliary devices (e.g. supervised valve monitoring, level control, etc.).
- .12 Provide indication lights at the pump panel which shall include, but not limited to the following:
 - .1 Power On (white)
 - .2 Common Alarm (red)
 - .3 Individual Run (green)
 - .4 Auxiliary tank high level (red)
 - .1 Auxiliary tank critical high level (red)
 - .2 Auxiliary tank low level (red)

Oil Pumping Set

- .3 Low pressure (red)
- .4 Leak detection alarms (red)
- .5 Buzzer for common alarm c/w silence at panel
- .5 Alarm Contacts (dry DPDT) shall include but not limited to the following:
 - .1 Individual pump motor run
 - .2 Individual pump motor overload
 - .3 Low level auxiliary tank
 - .4 High level auxiliary tank
 - .5 Critical high level auxiliary tank
 - .6 Low level main tank
 - .7 High level main tank
 - .8 Critical Low level main tank
 - .9 High System pressure
 - .10 Low System Pressure
 - .11 Additional sets of dry contacts for BAS
- .6 Provide colour touch screen interface, factory programmed. Use interface to monitor supervised valve position in accordance with Schematics, with provision to expand this for 10 more inputs. Delete if Touchscreen interface not used.
- .7 Visual indication on touch screen interface shall include but not limited to the following:
 - .1 Graphical display
 - .2 Graphical user interface
 - .3 Pump motor run
 - .4 Pump run elapsed time
 - .5 Pump number of starts counter
 - .6 Lead pump failure indication & virtual manual reset, lag pump start
 - .7 Continuous auxiliary tank level monitoring and display in % of full tank
 - .8 Continuous system pressure monitoring and display in PSI
 - .9 Overload alarm indication
 - .10 Low level auxiliary tank alarm indication
 - .11 High level auxiliary tank alarm indication
 - .12 Critical high level auxiliary tank alarm indication
 - .13 Shutdown or alarm are field selectable
 - .14 Low system pressure alarm indication with virtual manual reset

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- .15 High system pressure alarm indication with virtual manual reset
- .16 Pump set basin leak alarm indication
- .17 All supervised valves Open / Close status
- .18 Alarm and monitoring points for above grade tanks: Delete if tanks are below grade. . If tanks are above grade all monitoring can be done by other systems and integrated directly into pump panel however below grade tanks require the Veeder-Root interface (or other specification approved monitoring system)
- .19 Continuous main tank level monitoring and display in % of full tank
- .20 Low level main tank alarm indication
- .21 High level main tank alarm indication
- .22 Critical low level main tank alarm indication
- .23 Tank vacuum leak alarm indication (applicable only for below grade storage tanks)
- .8 Data logging on removable USB drive: Delete if touch screen interface not used.
 - .1 With time and date stamp
 - .2 Auxiliary tank alarms
 - .3 Main tank alarms
 - .4 System pressure alarms
 - .5 Power on
 - .6 Periodic main tank level recording
 - .7 Pump motor overload
 - .8 Pump run elapsed time
 - .9 Alarm reset and silence
 - .10 Last changes
 - .11 Periodic auxiliary tank level recording
 - .12 Supervised valve alarm
- .9 Remote fill station display
 - .1 Provide on fill station in Nema 4, enclosure remote inventory tank display with audible and visual alarms
 - .2 Digital display (b&w) to indicate tank inventory, and its change during filling (counter style).
- .10 The pump shall be Albany Model 03GC61312 Cast Iron Helical Gear Pump Fitted with Carbon Bearings, Buna Mechanical Seal, and Hardened Steel Gears and Shafts. Pump is close coupled to a ½ HP, 575V, 3Ph, 60 hz, 1750 RPM, High Efficiency TEFC Motor.

Oil Pumping Set

- .11 The strainer model shall be Albany Model DBS Series Duplex Basket Strainer, c/w 60 mesh S.S. Screens, certified to ULC/ORD-C331.
- .12 The Fuel oil pump controller model shall be Albany Model DUCON Series.
- .13 Fuel Storage Main tank controls:
- .14 Provide a Model LEVCON-CLT ULC & CSA Listed, CSA Listed Continuous Level Transmitter c/w polycarbonate 4-20mA field mounted 4 Digit LCD loop powered indicator.
- .15 ULC Fill point equipment
 - .1 Albany APA-FILL Remote Fill Station Alarm Panel certified to (CAN/ULC S661), cUL/CSA Listed, c/w Stainless Steel Inner Panel with Heater, Alarm Horn; Test-Silence Selector Switch; 90% High Level/ Tank Fill Alarm with audible and visual alarm; Includes NEMA/CSA 4X. Fiberglass Deadfront Grey Enclosure with Padlockable Snap Latch.
 - .2 Albany LEVCON-1-ADJ-CLIS, cUL, CSA, and ULC Listed Overfill Level Switch (Adjustable).

PART 3 - EXECUTION**3.1 Installation**

- .1 Refer to Section 23 13 00.00 - Oil Tanks for control devices for pumps.
- .2 Relief Valve and Pressuring Sensing Device shall be calibrated on site by the pump manufacturer after installation of distribution system and shall be based on actual system operating pressure. Refer to manufacturer's recommendations for relief valve and pressuring sensing device setting and calibration.
- .3 Install pump set level on concrete housekeeping pad.
- .4 Hard wire controls from auxiliary tank high alarm safety devices to isolate power and provide full stop of pumps.
- .5 Provide all wiring under this Section in accordance with requirements of Electrical Division
- .6 Pump package shall be commissioned with all other disciplines (BAS, Electrical).
- .7 Refer to Section 23 09 00.00 - Building Automation System for wiring of supervised valve alarms from output contacts in the pump panels to the BAS for all output alarms (e.g. supervised valves, high level, critical high level and auxiliary tank or main tank inventory)

END OF SECTION

Oil Tanks

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 21 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Above Ground Tanks

- .1 Above ground oil storage tanks shall be O'Connor, Ferro Metals suitable for above ground installation, Underwriter's approved and labelled.
- .2 Refer the mechanical drawing for capacity details. Tanks shall be constructed from thick welded mild steelplate. Tanks shall be designed for a static pressure of 35 kPa (5 psi) above static head of full fill line or 104 kPa (15 psi) whichever is greater. Tank design shall be stamped and signed by a professional engineer.
- .3 Provide two lifting lugs on each tank, (a 600 mm (24 in.) diameter, manhole and bolted cover), dip stick and connections for 50 mm (2 in.) fill, vent, pump return and pump suction with internal suction pipe to within 225 mm (9 in.) of tank bottom and level gauge. Emergency vent connection shall suit the size of tank as per code.

PART 3 - EXECUTION

3.1 Installation

- .1 Fill alarm to be located adjacent to fill point. Provide threaded connection on fill point suitable for oil companies coupling.
- .2 After all tests and plant acceptance, tanks shall be completely filled with oil, grade as applicable. Provide certificate that the tank has been filled.
- .3 Where double wall tanks are specified, the works secondary tank refer to the annular space between the inside and outside walls of the tank.
- .4 The installer shall be factory certified by the tank manufacturer. Submit copies of the certificate with Shop Drawings for the tank.
- .5 Backfill and bedding for storage tank shall be clean pea gravel, naturally rounded aggregate, not less than 3 mm (1/8 in.) diameter, and not more than 12 mm (1/2 in.) diameter inert and free flowing.
- .6 When recommended by the tank manufacturer in writing, gravel crushings or washed stone having angular particle size no smaller than 3 mm (1/8 in.) size nor larger than 12 mm (1/2 in.) size may be used for backfill provided that all materials meet A.S.T.M. C-33 paragraph 9.1 for quality and soundness. Backfill must not have any particles passing #8 sieve.
- .7 In freezing conditions backfill must be dry and free of the ice.
- .8 Provide a galvanized steel liner for the curbed retention chamber below the tank. All joints shall be welded and the entire unit primed with zinc rich gray paint.

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Oil Tanks

END OF SECTION

Fuel Oil Level Systems

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 21 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Materials

- .1 Equip main oil storage tank for both boilers and for diesel with a remote reading level gauge of the pneumatic type complete with hand operated plunger for increasing air pressure gauge style shall be similar to Liquidometer with Industrial Junior indicating case. Remote gauge shall be mounted in boiler room adjacent to oil pumps for the boiler system.

PART 3 - EXECUTION

3.1 Not Used

END OF SECTION

PART 1 - GENERAL**1.1 Work Included**

- .1 Conform to Section 21 05 00.00 – 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 submittal drawings in accordance with Section 21 05 03.00 – 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 Pipes 100 mm (4 in.) and smaller, alternative for entire system for heating water, chilled water and condenser water in hard-tempered copper ASTM B88, Type L, plain ends. All joints made with 95-5 tin-antimony or tin-silver solder.
- .6 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.
- .7 Fittings 300 mm (12 in.) and larger, black steel ASTM A234, 9.5 mm (0.375 in.) wall, butt-welding ends, ANSI B16.9.
- .8 Fittings 65 mm (2-1/2 in.) to 250 mm (10 in.) black steel ASTM A234, Schedule 40, butt-welding ends, ANSI B16.9.
- .9 Fittings 50 mm (2 in.) and smaller, cast iron ASTM A126, 860 kPa (125 psi) WSP threaded, ASNI B16.4.

Piping, Valves & Fittings (Except Plumbing)

-
- .10 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.
 - .11 Fittings alternative for entire system for heating water, chilled water and condenser water: wrought copper or cast bronze, solder, joint, ANSI B16.22.
 - .12 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.
 - .13 Flange accessories for heating water and condenser water:
 - .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, square head machine with hexagonal nut, steel ASTM A307, ANSI B18.2.
 - .14 Flange accessories for chilled water, gasket, cloth inserted rubber ring, bolts, square head machine with hexagonal nut, steel ASTM A307, ANSI B18.2.
 - .15 Strainers 65 mm (2-1/2 in.) and larger, cast iron 860 kPa (125 psi) WSP, flanged.
 - .16 Strainers 50 mm (2 in.) and smaller, cast iron 1720 kPa (250 psi) WSP, threaded.
 - .17 Strainers 50 mm (2 in.) and smaller, for copper pipes bronze 860 kPa (125 psi) WSP, threaded. Mueller #351M.
 - .18 Gate valves 65 mm (2-1/2 in.) and larger, cast iron 860 kPa (125 psi) WSP, bronze mounted, O.S. and Y A.N.S.I B16.1 Flanges, shall be Crane #465 1/2, Jenkins #454J, Toyo 421 or Kitz 72.
 - .19 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 or Kitz 42.
 - .20 Globe valves 65 mm (2-1/2 in.) and larger, cast iron 860 kPa (125 psi) WSP, bronze mounted, renewable composition disc, A.N.S.I B16.1 Flanges shall be Crane #351, Jenkins #2342, Toyo 400A or Kitz 76.
 - .21 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 or Kitz 9.
 - .22 Eccentric plug valves may be used as an alternative to Globe valves and shall be cast iron body, split alloy steel shaft, top and bottom bearings, resilient elastomer plug. Body with flanged ends. 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.

Valves 100 mm (4 in.) and smaller with lever operator with lock. Valves 150 mm (6 in.) and larger with worm gear manual operator with indication of valve opening.
 - .23 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 or Kitz 22.
 - .24 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.

Piping, Valves & Fittings (Except Plumbing)

- .25 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.
- .26 Radiation and fan coil shut off valves shall be Dahl Model 11042FXUN radiator valve suitable for 1720 kPa (250 psi) at 121 deg. C. (250 deg. F.). Lockshield balance valves shall be Dahl Model 13.013M.
- .27 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.
- .28 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, or Apollo 70-100/200-04.
- .29 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. All valves 65 mm (2-1/2 in.) and larger shall be flanged or grooved and shall be Tour Anderson Model STA-F, valves 50 mm (2 in.) and smaller shall be screwed and shall be Tour-Anderson Model STA-D.
 - .1 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 G.P.M. or L/s.

2.3 Grooved Pipe and Fittings

- .1 For systems less than 93.2 deg. C. (200 deg. F.) at 1139 kPa (165 psi) or less than 65.6 deg. C. (150 deg. F.) at 1380 kPa (200 psi).
- .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 offsetting angle-pattern bolt pads to prove rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9

Piping, Valves & Fittings (Except Plumbing)

- .1 50 mm (2 in.) through 150 mm (6 in.): Installation-Ready, for direct stab installation without field disassembly, with grade EHP gasket rated to 121 deg C. (250 deg. F). Victaulic Style 107.
- .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. 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 77.
- .2 Size 350 mm (14 in.) through 600 mm (24 in.): 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
- .6 Fittings 50 mm (2 in.) to 250 mm (10 in.) cast ductile iron ASTM A536 grade 65-45-12 or malleable iron ASTM A47.
- .7 Fittings 300 mm (12 in.) and larger full flow cast fitting. Fabricated steel fittings to ASTM Grade B may only be used with the approval of Consultant.
 - .1 350 mm (14 in.) and larger shall be complete with Victaulic 'AGS' grooved ends.
- .8 Branch connections: ductile iron ASTM A535 or malleable iron ASTM A47; Victaulic Style 920, 921 or 72.
- .9 Flanges; ductile iron ASTM A536 or malleable iron ASTM A47 for sizes 50 mm (2 in.) to 600 mm (24 in.); Victaulic Style 741.
- .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.).
- .11 Valves 40 mm (1-1/2 in.) to 150 mm (6 in.): ductile iron ASTM A-536, aluminum bronze disc, and EPDM liner for service up to +110 deg. C. (+230 deg. F.). Valves 40 mm to 100 mm (1-1/2 in. to 4 in.) size shall have lever lock handle, and 150 mm (6 in.) shall be gear operated. Valves shall be for bubble-tight service to 1400 kPa (200 psi). Victaulic Series 700.
- .12 Valves 50 mm (2 in.) to 300 mm (12 in.): ductile iron Body to ASTM A536, EPDM coated ductile iron disc 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-Vic300.

Piping, Valves & Fittings (Except Plumbing)

- .13 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.
- .14 Strainers 50 mm (2 in.) to 300 mm (12 in.): ductile iron ASTM A536 with type 304 stainless steel screen. Victaulic Style 730/732.
- .15 As an alternative on vertical in-line pumps, suction elbow may be suction diffusers. Victaulic 731-I.
- .16 All grooved products, including couplings, fittings, valves and specialty items shall be Victaulic.
- .17 For other system components refer to Low Temperature and/or Pressure Water Article.

2.4 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 TSSA or 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.

Piping, Valves & Fittings (Except Plumbing)

- .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.
- .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.

2.5 Requirements

- .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 gasketed 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, or Maid-O-Mist.
- .8 Air Separators shall be manufactured in an ISO recognized facility. Each unit shall be factory tested per Hydraulic Institute standards at the factory of origin. Tangential type air separator shall have flanged or grooved inlet and outlet connections. The vessel shell diameter shall be three times the nominal inlet/outlet pipe diameter. The inlet and outlet connections must be of the same size. The unit will be designed, constructed and stamped for the system design pressure Class in accordance with ASME Boiler and Pressure Vessel Code. Supply the separator with automatic air vent when used in an air elimination system, and connect the vent connection into the bottom of the compression tank for air control systems

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 automatic air eliminators 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.
- .4 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.
- .5 Provide vacuum breakers on all equipment having modulating steam control valves and locate between valve and equipment, unless directed otherwise by equipment manufacturer.
- .6 Pipe vacuum breakers to condensate lines on high pressure systems. Where not piped to condensate lines, install with a pigtail to prevent leakage of steam flashed from the condensate.
- .7 Make reduction in steam main size with eccentric reducing coupling.
- .8 Arrange all runs of piping to prevent interference and to achieve a satisfactory and workmanlike 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.
- .9 Pitch all lines 25 mm in 12 m (1 in. in 40 ft.–0 in.) unless shown otherwise.
- .10 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
- .11 Carefully ream threaded joints and join with compound on the male thread only. Retighten 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.
- .12 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.
- .13 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.

Piping, Valves & Fittings (Except Plumbing)

- .14 Arrange piping to permit ease of equipment removal. Provide flanges or unions on all pipe connections to each piece of equipment.
- .15 Connect all multi-row water coils in counter flow.
- .16 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.
- .17 Connect bases of all pumps with packed glands to drain with 12 mm (1/2 in.) O.D. copper tubing.
- .18 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.
- .19 Provide strainers upstream of each pump suction, steam control valve and steam trap not preceded by a control valve, and where shown.
- .20 Provide butterfly valves where shown; these are permitted in lieu of gate valves in sizes 65 mm (2-1/2 in.) and larger.
- .21 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 Consultant.
- .22 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.
- .23 Provide for the expansion and Contraction of all pipes. Install with sufficient flexibility to prevent end-thrust and movements caused by thermal expansion or Contraction causing detrimental distortion or damage of connection equipment. Provide offsets between mains and equipment of sufficient length to safely absorb the expansion of the main.
- .24 Install all control devices, valves and any other appurtenances as directed by the controls and/or BAS trades.
- .25 Make connections between copper and steel with brass or bronze fittings.
- .26 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.
- .27 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.
- .28 Install all grooved products as per manufacturers latest recommended instructions. The Contractor is responsible to establish training for proper pipe end preparation and assembly by the manufacturer.
- .29 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.
- .30 Install flow balancing valves in the following locations:
 - .1 at each heating, chilled or condenser water riser, or main floor branch

Piping, Valves & Fittings (Except Plumbing)

- .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

END OF SECTION

Centrifugal Pumps

PART 1 - GENERAL**1.1 Work Included**

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

PART 2 - PRODUCTS**2.1 Materials****2.2 General**

- .1 Pumps shall be Armstrong, ITT Industries, Taco or Grundfos-Paco, single or double suction pumps as shown.
- .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 21 05 13.00 – 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.

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.

Centrifugal Pumps

- .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 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 21 05 48.00 – 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 Owner or their representatives.

END OF SECTION

PART 1 - GENERAL**1.1 Work Included**

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

PART 2 - PRODUCTS**2.1 Materials**

- .1 Condensing units shall be a Copeland, Tecumseh, Brunner or other approved manufacturer of water-cooled unit complete with spring-mounted semi-hermetic or hermetic motor compressor, condenser receiver, suction, discharge and liquid valves and high/low pressure switch. Water regulating valves shall be equal to Penn for maximum water pressure drop of 105 kPa (15 psi). Units shall be complete with motor overload protection.
- .2 Evaporator units shall be Keeprite, Worthington Air Coils, Dunham-Bush or other approved manufacturer. Single phase motors shall have integral overload protection.
- .3 Defrost timers shall be Paragon, Eagle or other approved manufacturer.
- .4 Thermostatic expansion valves, solenoid valves, strainer-driers and combination moisture-liquid indicators shall be Sporlan, Alco or other approved manufacturer. There shall be one of each of these installed for each condensing unit. Solenoid valves shall be selected for pressure drop of 20 kPa (3 psi) maximum. Strainer-driers size shall be as shown in manufacturer's literature for field built-up systems.
- .5 Refrigerant valves shall be Henry or Superior valve. Charging valve shall have removable seal cap, chained to valve.
- .6 Refrigerant lines shall be Type L copper tubing. Fittings shall be wrought copper. Brazing shall be done with Sil-Fos or Easy-Flo.
- .7 Electric room thermostats shall be White-Rogers, Penn, Honeywell or other approved manufacturer.
- .8 All suction lines shall be insulated with 12 mm (1/2 in.) thick flexible elastomeric insulation, Armaflex II or Imcoshield.

PART 3 - EXECUTION**3.1 Installation**

- .1 Install fittings in the liquid line from the condensing unit to the evaporator in the following order:
 - .1 Charging valve
 - .2 Strainer-Drier
 - .3 Sight Glass
 - .4 Shut-off Valve

Refrigerant Pipes, Valves, Fittings & Equipment

- .5 Solenoid Valve
- .6 Thermostatic Valve
- .2 After assembly, evacuate each refrigerant system, test and charge using the following procedure. Any further steps required to ensure warranty of the refrigeration equipment shall also be done.
- .3 Evacuate each refrigerant system with a vacuum pump to 1.7 kPa (0.5 in.) of mercury absolute. The system shall maintain this vacuum with the vacuum pump stopped for one hour. The system shall then be charged with refrigerant to 105 kPa (15 psi) followed with an oil pumped nitrogen charge to 150% of the operating pressure of the refrigerant being used. Test the complete system with a Halide or similar acceptable leak detector. If there are any leaks, repair with Sil-Fos or Easy-Flo and repeat the test. Following this, evacuate the system to 1.7 kPa (0.5 in. wg.) of mercury absolute and charge with refrigerant.
- .4 Test all systems at the specified temperature, set and balance, thermostatic valve adjustments and the like to cause systems to operate at specified conditions.
- .5 Testing, charging and adjusting shall be witnessed by the Consultant.
- .6 Trace drain line of freezer with electric heating cable with capacity of 3.05 W/m (10 W/ft.) of drain line.
- .7 Refrigeration systems shall conform to the capacities shown in the Schedule.

END OF SECTION

Steam and Heating Water Treatment

PART 1 - GENERAL**1.1 Work Included**

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Submittals

- .1 Shop Drawings: Submit Shop Drawings of all components of the system in accordance with SECTION 21 05 00.00 – 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:
 - .1 Ashland Drew
 - .2 GE Water and Process Technologies
 - .3 Anco Chemicals Water Treatment Inc.
 - .4 Norkem Inc.
 - .5 Klenzoid

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 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 Ashland Drew PN 9233-04-0, or Neptune DBF-5HP. Pot feeder assembly shall be complete with valved inlet and outlet, screen, drain and pot feeder.
- .2 Provide two (2) corrosion test coupons, one copper equal to Drew PN 7721-01-3 and one steel equal to Ashland Drew 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.
- .3 Corrosion and scale inhibitor for closed loop heating systems shall be equal to GE W&P Technologies CORRSIELD MD4102 or Ashland Drew CSW 311.
- .4 Provide an adequate quantity of chemical treatment for 6 months of operation after Substantial Completion of the Contract.
- .5 Provide bypass filter as specified in Section 23 25 14.00 – PIPE SYSTEM FILTERS.

Steam and Heating Water 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 Owner 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 Owner's representative in the correct use of the treatment, show the Owner 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 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Materials

- .1 Provide pipe system filters equal to Ashland Drew Low Flow Micron Filters Series 9238-02-4 or Filterite LMO Series.
- .2 Provide pipe system filters equal to Ashland Drew Micron Medium Flow Filters Series 9240/ 9241 or GE W&P Technologies 3CMC/6CMC.
- .3 Shell and heads shall be suitable for 1035 kPa (150 psi) working pressure and filter media shall be suitable for 149 deg. C. (300 deg. F.) service temperature.
- .4 Filter media shall be bleached cotton for selective removal of particles from 1 to 100 microns. Media shall be non-rupturing and mounted so that no by-pass of media shall occur. Filters shall be equal to Ashland Drew PN 9236 or Viper VPYC.
- .5 Filters shall be sized for 3% of total system flow and shall be within the mid-capacity of the filter operating flow rate.
- .6 Pipe system filters shall be installed in the following systems:
 - .1 Perimeter heating systems
 - .2 Constant temperature heating system
 - .3 Chilled water system

PART 3 - EXECUTION

3.1 Installation

- .1 Install pipe system filters across the pumps with valved inlet and outlet. Outlet valve shall be a flow balancing 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

Cleaning and Filling

PART 1 - GENERAL**1.1 Work Included**

- .1 Conform to Section 21 05 00.00 – 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 21 05 00.00 – 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 Ashland Drew CSW 600. Refer to manufacturers instructions for chemical concentrations.
- .2 Glycol system solution shall be 40% by volume of factory, pre-mixed solution of inhibited ethylene glycol. Ethylene glycol shall be Dow Chemical Co. "Dowtherm SR-1", Interstat Chemical Co. "Intercool NFE", or Recochem Inc. "Recotherm IG"..
- .3 Glycol make-up packages shall be provided for glycol water make-up. Each glycol make up package shall be equal to Ashland Drew 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 110v (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 All coils shall be disconnected and flow shall be by-passed.
- .4 A temporary pump shall be installed in the system and shall be capable of pumping adequate discharge at adequate head.
- .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.

Cleaning and Filling

- .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 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 Consultant. 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 Consultant for verification prior to final filling.
- .9 Add 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
 - .3 Iron: Less than 2.0 ppm
 - .4 Copper: Less than 0.3 ppm
 - .5 Molybdate: 100 – 150 ppm
- .10 Steam boiler manufacturer shall supervise alkaline boil out of the boilers on site in the presence of Consultant and before thermal efficiency test. Isolate boilers, meter cleaning chemicals into treated water, and fire the boiler according to standard procedures provided by the boiler manufacturer. Blow down through intermittent valves at least one half of the gauge glass every eight hours through the bottom blowdown line. Add make-up as required after each blow down. Boil out for 24 hours, drain and wash thoroughly. Do not allow boiler to cool below 93.33 deg. C. (200 deg. F.) Flush with hot water for two hours, drain and inspect. If oil or grease is present, repeat boil out procedure.
- .11 For glycol systems install glycol make-up system as per manufacturer's instructions and in accordance with Section 23 77 13.00 – 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 Ashland Drew PN 7729-01-7.
- .12 For ground source closed loop heat pump systems after cleaning and draining, fill the system with alcohol anti-freeze solution.

Cleaning and Filling

- .13 For tenant work the base building Contractor shall drain and fill the base building system. Arrange and pay for this work.
- .14 The Mechanical Contractor shall supply the Consultant 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 Consultant.

END OF SECTION

Ductwork and Specialties

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 21 05 00.00 – 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 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.

1.3 Qualifications

- .1 Acceptable sheet metal trade specialists are limited to following:
 - .1 Adelt
 - .2 DMC Mechanical Ltd.
 - .3 Giffin
 - .4 J.C. Rogers
 - .5 Leslie-Danhart
 - .6 Sayers
 - .7 Sureway
 - .8 Sutherland-Schutz
 - .9 Tam-Kal

PART 2 - PRODUCTS

2.1 Materials

- .1 Fabricate all ductwork unless specifically noted otherwise, of galvanized sheet steel with Z180 coating to A.S.T.M. A653/A653M-98.
- .2 Sealing compound: Minnesota Mining and Manufacturing or other approved manufacturer. Duct tape shall be Duro-Dyne or other approved manufacturer.
- .3 Flexible ducting:

Ductwork and Specialties

- .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.
 - .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 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 Consultant. 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.
 - .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 Positive Seal Shut-Off Dampers:

Ductwork and Specialities

- .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 ga) 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 discoloration, burrs and sharp edges. All welding procedures, welders, and welder operators shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX. All production welds shall be visually inspected in accordance with standard procedure incorporating the workmanship acceptance criteria in Section 5 and 6 of A.N.S.I./ANWS D9.1-1990. Specification of Welding of Sheet Metal.
- .4 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.
- .5 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.
- .6 Gravity backdraft dampers shall be multi-blade louvre type, constructed of light grade aluminum. Blades shall be joined with a tie bar and have rust-proof shafts rotating in bronze bushings.
- .7 Motorized dampers for Control Operation: In accordance with applicable requirements control systems (pneumatic) or central energy management systems section.
- .7 Acoustic Insulation: 25 mm (1 in.) thick rigid coated glass fibre.

Ductwork and Specialities

- .8 Interior Duct Protective Coating: Chlorinated rubber base paint or Eisenheiss Black.
- .9 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 Turning vanes shall be either double thickness or single thickness with extended leading and trailing edges as specified in ASHRAE and SMACNA Standards. Rails shall be securely set in the elbow so that they cannot loosen. Turning vanes shall be Dyn-Air or equal.

2.2 Fabrication

- .1 Fabricate ductwork in accordance with applicable duct construction requirements of SMACNA.
- .2 Fabricate kitchen hood and dishwasher exhaust air ductwork of Type 302 stainless steel. Use 1.5875 in thickness (0.0625 in – 16 USS ga.) for hood and 1.27 mm thickness (0.050 in. – 18 USS ga.) for exhaust ductwork.
- .3 Fabricate kitchen hood exhaust air ductwork of mild steel sheets, and dishwasher exhaust air ductwork of Type 302 stainless steel. Kitchen hood exhaust shall be 1.5189 mm thickness (0.0598 in – 18 USS ga) and dishwasher exhaust shall be minimum and 1.27 mm thickness (0.050 in – 18 USS gauge).
- .4 Construct all ductwork and plenums in contact with Swimming Pool air of aluminum Alloy 3003. Duct shall be minimum 1.1480 mm thick (0.0452 in – 17 B&S gauge) and slip joints minimum 1.2903 mm thick (0.0508 in. – 16 B&S gauge). Alternatively large plenums greater than ... mm x ... mm (... in. x ... in.) in size can be constructed from galvanized steel of minimum thickness of 1.56 mm (0.0614 in. – 16 GSG gauge) and with inside surface having two coats of protective duct coating.

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 as follows:

Ductwork and Specialities

TABLE 1: HANGERS

DUCT DIMENSION	HANGER CONSTRUCTION
Horizontal rectangular duct	
Up to 1500 mm (60 in.) for Low Pressure Ductwork Only	Two 25 mm (1 in.) x 16 US gauge straps with two screws on side of duct one screw on bottom. Hangers shall be at each joint but in no case more than a maximum 2400 mm (96 in.) on centres.
For all sizes of Medium and High Pressure Ductwork up to 3000 mm (120 in.) and Low Pressure Ductwork from 1525 mm to 3000 mm (61 in. x 120 in.)	50 mm x 50 mm x 6 mm (2 in. x 2 in. x 1/4 in.) trapeze hanger with two 9 mm (3/8 in.) dia. rods. Hangers shall be at each joint but in no case more than a maximum 2400 mm (96 in.) on centres.
3000 mm to 6000 mm (120 in. to 240 in.)	65 mm x 65 mm x 5 mm (2-1/2 in. x 2-1/2 in. x 3/16 in.) trapeze hanger with two 9 mm (3/8 in.) dia. rods. Hangers shall be at each joint but in no case more than a maximum 1200 mm (48 in.) on centres.
Horizontal round duct	
Up to 450 mm (18 in.)	One 25 mm (1 in.) x 16 US gauge hanger ring supported from one 25 mm (1 in.) x 16 US gauge hanger strap. Hanger shall be at each joint but in no case more than a maximum 2400 mm (96 in.) on centres.
475 mm to 900 mm (19 in. to 36 in.)	One 25 mm (1 in.) x 12 US gauge hanger ring supported from 25 mm (1 in.) x 12 US gauge hanger strap. Hanger shall be at each joint but in no case more than a maximum 2400 mm (96 in.) on centres.
925 mm to 1250 mm (37 in. to 50 in.)	One 25 mm (1 in.) x 12 US gauge hanger ring supported from 25 mm (1 in.) x 12 US gauge hanger strap. Hanger shall be at each joint but in no case more than a maximum 2400 mm (96 in.) on centres.
1275 mm to 2100 mm (51 in. to 84 in.)	Two 38 mm (1-1/2 in.) x 12 US gauge hanger connected to the 32 mm x 32 mm x 3 mm (1-1/4 in. x 1-1/4 in. x 1/8 in.) angle girth reinforcing of duct hanger. Hangers shall be at each joint but in no case more than a maximum 2400 mm (96 in.) on centres.

Ductwork and Specialities

- .5 Support all vertical ducts at each floor, on all sides, with angle riveted to the ducts.
- .6 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.
- .7 Construct low pressure rectangular ducts for systems less than 0.5 kPa (2 in.) static pressure and under 10.2 m/s (2000 fpm) velocity as follows:

Ductwork and Specialties

TABLE 2: LOW PRESSURE DUCT CONSTRUCTION

MAX. DUCT DIMENSION	SHEET METAL US GAUGE	TRANSVERSE JOINT CONNECTION AND BRACING
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.

Ductwork and Specialities

- .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.
- .8 Medium pressure rectangular ducts are required for all smoke exhaust systems and in the following areas. Construct medium pressure rectangular ducts as follows:

Ductwork and Specialties

TABLE 3: 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.

Ductwork and Specialties

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- .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.
- .9 Medium and high pressure round ducts are required in the following areas.....
Medium and high pressure round ducts up to 750 mm (30 in.) dia. shall be factory fabricated, helically wound galvanized iron strips with spiral lock seam as follows:

TABLE 4: MEDIUM AND HIGH PRESSURE ROUND DUCT CONSTRUCTION

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

- .10 Join with galvanized iron coupling sleeves or conduit fittings of welded construction.

Construct larger ductwork as follows with longitudinal lock or butt welded seams:

US GAUGE	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.

- .11 High pressure rectangular ductwork is required in the following areas.....
Construct high pressure rectangular ducts as follows:

Ductwork and Specialties

TABLE 5: 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.

.12 Seal all joint of all ducts. Brush joints with the compound before and again after assembly.

.13 Seal the bottom and side joints of outside air ducts or plenums water-tight.

Ductwork and Specialties

- .14 Flexible hose 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 Flexible ductwork shall be used where shown to allow easy location of diffusers.
 - .2 Minimum length of flexible duct used to connect diffusers and interior troffers shall be 2,400 mm (84 inches).
 - .3 Maximum length of flexible duct shall be 3,000 mm (120 inches).
 - .4 Flexible ductwork shall not pass through floors or fire walls,
 - .5 Flexible ductwork shall be 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. Flexible duct shall be secure to the rigid section using ties and sealant.
 - .6 Flexible duct lengths greater than 2,400 mm (84 inches) shall be supported 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 Consultant
- .18 Select the gauge of metal and method of construction for the new size. Notify the Consultant 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 Consultant 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 Consultant and the testing company before installation.
- .22 Provide flexible connections at each air handling unit and fan duct connection.
- .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 Incorporate gravity backdraft dampers where shown.
- .26 Install motorized dampers where directed.

Ductwork and Specialties

- .27 Install fire dampers where shown and at all penetrations through all fire rated assemblies. Where fire dampers are shown in grilles or diffusers at ceiling level they shall be firestop flap. 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.
- .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 Consultant in advance of fabrication.
- .29 Install combination smoke and fire dampers and smoke dampers where shown. Ensure operators are accessible for maintenance.
- .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.
- .34 Assemble kitchen hood and dishwasher exhaust air ductwork with all welded joints. IN each 3700 mm (12 ft.) of duct run provide a 300 mm x 300 mm (12 in. x 12 in.) access panel run mounted in a gasketed stainless steel frame and held in place with 2 window sash locks. Access doors shall be of the same material as the duct. Access doors shall be located in the top and sides of kitchen exhaust ductwork only.
- .35 Ductwork installed underground shall be round spiral sheet metal constructed in accordance with high pressure duct standards. Joints shall be sealed with high pressure duct sealant and taped. Duct shall be completely covered with a minimum of two coats of bitumastic coatings.
- .36 Air wells shall be 1.95 mm thick (0.0767 in – 14 GSG gauge) galvanized steel construction with all joints welded. Clean all welds so that no water traps occur. Touch-up all welds with zinc rich primer. Suitably brace the entire assembly with steel angle to prevent flexing and drumming. Coat the entire surface exposed to the outside air with 2 coats of rustproofing finish. Submit sample of rustproofing for review. Provide a structural supporting frame to support the entire unit plus an additional live loading of 4.2 kg/sq.m. (100 lbs/sq.ft.).
- .37 Spin-in connections shall only be used downstream of variable volume boxes.
- .38 Ductwork shall be run parallel to the closest wall. Coordinate with piping and structural elements.

Ductwork and Specialities

- .39 All open ends of ductwork 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. Where a duct terminates at a supply, return or exhaust air opening provided by other sections and located less than 2000mm (79 in.) Above the finished floor, the screen shall be installed and painted matte black and shall not be capable of passage of anything larger than a 15mm (1/2 in.) Sphere through the openings.

END OF SECTION

Special Ductwork

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 Conform to Section 23 31 13.00 – DUCTWORK AND SPECIALITIES.
- .3 Special ductwork shall conform to SMACNA – HVAC Duct Construction Standards and all other applicable standards.

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.

PART 2 - PRODUCTS

2.1 Materials

- .1 Buried poly-vinyl coated galvanized ductwork
 - .1 All buried underslab ductwork shall be Alpha Free-Flow Industries Ltd. type Poly-Vinyl Steel (PVS) 4x4 - #2 Corrugated (ULC Class 1) or approved equal. Ductwork shall be PVS round, and shall be SPIROA spiral pipe with a 100 um (4 mil) poly-vinyl coating fused both sides to galvanized sheet steel to ASTM A653/A653M-98, designation Z275. For ducts up to and including 1200 mm (48 in.) diameter, fabricate from PVS steel strips wound helicoidally, four ply lockseam tightly closed to provide a smooth interior.
 - .2 The minimum gauge for round ducts shall be as follows:

DIAMETER	SHEET METAL US GAUGE
Up to 550 mm (22 in.) dia.	0.70 mm thick (0.0276 in. – 24 GSG gauge)
575 mm to 800 mm (23 in. to 32 in.)	0.85 mm thick (0.0336 in. – 22 GSG gauge)
825 mm to 1000 mm (33 in. to 40 in.)	1.01 mm thick (0.0396 in. – 20 GSG gauge)
1025 mm to 1500 mm (41 in. to 60 in.)	1.31 mm thick (0.0516 in. – 18 GSG gauge)

- .3 All fittings shall be factory fabricated to ASHRAE/SMACNA and or SPIDA standards, type A.S.M. with poly vinyl chloride coating.

2.2 Execution

2.3 Installation

- .1 Buried poly-vinyl coated galvanized ductwork
 - .1 Support ducts as recommended by the manufacturer.

Special Ductwork

- .2 Duct transitions and offsets shall be as shown on Drawings. Use stainless steel sheet metal screws or stainless steel sheet metal pip-rivets at a maximum of 100 mm (4 in.) on centres around the joint. Apply PVS sealant between joints prior to screwing or riveting to make the connection completely air and water tight.
- .3 Touch up all raw edges and scratches due to cutting with PVS touch-up paint, and sealed with PVC sealer. After fastening ductwork, cover all screw and rivet heads with PVS touch-up paint.
- .4 Provide a pre-poured base slab 125 mm (5 in.) thick for all underslab ductwork, complete with embedded anchors and 2.75 mm (16 gage) straps spaced 1200 mm (48 in.) apart.
- .5 Encase all underslab ductwork in concrete fill – refer to architectural and structural specification for concrete details. Pour concrete in a minimum of three equal, separate events to prevent duct floatation and deformation. The three pours shall be in addition to the base slab.
- .6 Powered vibration devices for concrete placement are prohibited. Witnessing of the concrete encasement shall be the responsibility of this division.
- .7 Complete leakage tests prior to the concrete encasement. Refer to Section 23 05 93.23 – TESTING AND BALANCING AIR SYSTEMS.
- .8 All ductwork shall be installed in accordance with the manufacturer's recommendations and SMACNA standards, and shall be sloped to drain.
- .9 Protect all ductwork during the construction process.

END OF SECTION

Casings and Plenums

PART 1 - GENERAL**1.1 Work Included**

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 Casings and plenums for built-up air handling units shall be either prefabricated high noise attenuation and high sound transmission loss panels as specified under Section 21 05 48.00 – VIBRATION AND NOISE CONTROLS, or field built-up panels as shown.
- .3 Field built-up panels shall be as specified below.

1.2 Related Work Specified Elsewhere

- .1 120V/1/60 power wiring to the junction box – under Electrical Division.

1.3 Submittals

- .1 Shop Drawings – Submit Shop Drawings for casing, plenum, coil supports and filter supports for review.

PART 2 - PRODUCTS**2.1 Materials**

- .1 Field built-up panels shall be 1.56 mm thick (0.614 in – 16 GSG gauge) galvanized steel sheets with coating to A.S.T.M. 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 Provide air tight hinged access doors where shown and install to swing open against the plenum pressure. Doors shall be 38 mm (1-1/2 in.) minimum thickness, with each face formed of 20 US gauge galvanized steel. Latches shall be factory made specifically for this application and shall be operable from either side. Reinforce frame for door opening with 45 mm x 32 mm x 3 mm (1-3/4 in. x 1-1/4 in. x 1/8 in.) steel angle, welded at the corners.
- .3 Gasket against which door closes shall be foamed rubber or plastic. Doors shall be 500 mm wide x 1350 mm high (20 in. x 54 in.) located 450 mm (18 in.) clear of floor unless shown otherwise. Each door shall have a 300 mm x 300 mm (12 in. x 12 in.) inspection window with 6 mm (1/4 in.) thick safety glass.
- .4 Provide drain pans under each cooling coil as specified in Section 23 82 16.00 – COILS.

Casings and Plenums

- .5 Provide hot rolled steel or H.S.S. steel framework to support the coils and drain pans. In cooling coil sections the lowest portion of the support frame and any other section that may be in contact with water shall be Type 316 stainless steel.
- .6 Provide adjustable rigid sheet metal baffles, where shown or required in all supply air mixing plenums to prevent stratification of entering air.
- .7 Provide all catwalks in apparatus casings for servicing of filters.
- .8 Provide separately switched marine lights with protective metal cages and glass seals installed on the wall opposite access doors. Extend wiring to lights and switches from a junction box (one per unit).

PART 3 - EXECUTION**3.1 Installation**

- .1 Provide readily removable sections of plenums for removal of coils, fan wheels, and motors. These sections shall be flanged, gasketed and bolted such that the section may be removed after withdrawing the bolts.
- .2 Caulk all other joints in plenums. Fit pipe penetrating plenum with a 2.71 mm thick (0.1067 in – 12 GSG gauge) flange, welded to the pipe and bolted and caulked to the plenum.
- .3 Framework for support of coils shall be such that any coil may be removed without disturbing remaining coils.
- .4 Anti-stratification baffles in mixing plenums shall be adjusted after start-up of system and before balancing when outside conditions permit a representative test with thermocouple traverse and to give mixing conditions satisfactory to the Consultant. The baffles shall then be securely fixed in position.

END OF SECTION

Mixed Flow Fans

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 21 05 00.00 – 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 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 Manufacturer's Data
 - .1 Conform to AMCA standard 205, 211 and 311. Fans shall be tested in accordance with ANSI/AMCA Standard 210 and AMCA Standard 300 in an AMCA accredited laboratory and shall be certified to bear the AMCA seal for air and sound performance.
 - .2 Classification for Spark Resistant Construction Conform to AMCA 99.
 - .3 Each mixed flow fan shall be given an electronic vibration analysis in accordance with ANSI/AMCA Standard 204, while operating at the specified fan RPM. The vibration signatures shall be taken on each bearing in the horizontal, vertical and axial direction. The maximum allowable fan vibration shall be 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.

PART 2 - PRODUCTS

2.1 Materials

- .1 Except as otherwise indicated, all mixed flow fans shall be Cook, Carnes, FlaktWoods, Greenheck, PennBarry, or Twin City.
- .2 All fans shall comply with UL/cUL 705.
- .3 All fans used to convey grease laden air shall comply with UL/cUL 762, meet NFPA 96A and have a grease collection device.

Mixed Flow Fans

- .4 Fans shall be of welded and bolted construction utilizing corrosion resistant fasteners. Housing shall be steel with integral inlet and outlet collars for slip fit duct connections. Straightening guide vanes shall be included to assure maximum efficiency and low noise levels. Lifting lugs shall be provided for ease of installation. Adjustable mounting feet shall allow field adjustment of motor position.
- .5 All steel fan components shall be coated with an electrostatically applied, baked polyester powder coating or other equivalent protective coating.
- .6 Wheel shall be steel, non-overloading, high efficiency mixed-flow type. Blades shall be continuously welded to the backplate and inlet shroud. Hubs shall be keyed and securely attached to the fan shaft. The assembled wheel shall be electronically balanced both statically and dynamically to balance grade G6.3 per ANSI S2.19.
- .7 Blower shaft shall be accurately turned and polished steel. Shaft shall be sized for a critical speed of at least 125% of the maximum RPM.
- .8 Motor shall be direct drive or belt drive mounted on outside of casing as shown in the Fan Schedule.
 - .1 Direct drive motor shall have external electrical terminal box.
 - .2 Belt drive motor shall have adjustable motor plate utilizing threaded studs for positive belt tensioning.
 - .3 Belts shall be oil and heat resistant, non-static type.
 - .4 Drives shall be precision machined cast iron type, keyed and securely attached to the wheel and motor shafts.
 - .5 Drives shall be sized for 150% of the installed motor horsepower.
 - .6 Motors shall be in accordance with the requirements of Section 21 05 13.00 – ELECTRIC MOTORS. See Fan Schedule for hp (wattage) ratings.
- .9 Bearings shall be 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. All inaccessible bearings shall be provided with prefilled factory extended lubrication lines fitted with grease fittings terminating at the case exterior. Permanently lubricated bearings are not acceptable.
- .10 Vibration isolation shall be provided as specified in Section 21 05 48.00 – VIBRATION AND NOISE CONTROL.
- .11 All fans, without ducts or dampers on the inlet or outlet, including fans in plenums, shall have protective screens on the openings.
- .12 Fans shall be suitable for operation with variable frequency drives where indicated in the Fan Schedule or as required to meet the requirements of Section 23 09 23.00 – SEQUENCES OF OPERATION.
- .13 Mixed flow fans shall be in accordance with the Fan Schedule.

PART 3 - EXECUTION**3.1 Installation**

- .1 Install fans in locations shown on plans.

Mixed Flow Fans

- .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 450 mm x 450 mm (18 in. x 18 in.) minimum size or larger if required to remove the motor.
- .5 Duct transitions shall be rigidly connected directly to the fan inlet and outlet flanges or connections. Flexible connections required for isolation from the duct system shall be located on the inlet and outlet of the transition piece representing the greatest cross sectional area and lowest velocity. Vibration isolation shall include for the weight of the transitions.

END OF SECTION

Centrifugal Fans

PART 1 - GENERAL**1.1 Work Included**

- .1 Conform to Section 21 05 00.00 – 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 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, 211 and 311. Fans shall be tested in accordance with ANSI/AMCA Standard 210 and AMCA Standard 300 in an AMCA accredited laboratory and shall be certified to bear the AMCA seal for air and sound performance.
 - .2 Classification for Spark Resistant Construction Conform to AMCA 99.
 - .3 Each fan shall be given an electronic vibration analysis in accordance with ANSI/AMCA Standard 204, while operating at the specified fan RPM. The vibration signatures shall be taken on each bearing in the horizontal, vertical and axial direction. The maximum allowable fan vibration shall be 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.

PART 2 - PRODUCTS**2.1 Materials**

- .1 Except as otherwise indicated, all centrifugal and utility fans shall be Carnes, Cook, FlaktWoods, Greenheck, PennBarry or Twin City.
- .2 All fans shall comply with UL/cUL 705.
- .3 All fans used to convey grease laden air shall comply with UL/cUL 762, meet NFPA 96A and have a grease collection device.
- .4 The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The scroll wrapper and side panels shall be steel. The entire fan housing shall have continuously welded seams for leak-proof operation. Bearing support shall be constructed of welded steel members.

Centrifugal Fans

- .5 All steel fan components shall be coated with an electrostatically applied, baked polyester powder coating or other equivalent protective coating.
- .6 Unless shown otherwise, fan wheels handling more than 472 L/s (1000 cfm) shall be of the non-overloading backward inclined centrifugal type. Wheel hub shall be keyed and securely attached to the fan shaft. The wheel and fan inlet shall be carefully matched and shall have precise running tolerances for maximum performance and operating efficiency. The assembled wheel shall be electronically balanced both statically and dynamically to balance grade G6.3 per ANSI S2.19.
- .7 Each fan shall be provided with fan sheave, motor sheave, matched V-belts and belt guard.
 - .1 Belt guard shall be OSHA compliant and completely cover the motor pulley and belt(s).
 - .2 Where motor is 7.5 kW (10 hp) or less, motor sheave shall be variable pitch.
 - .3 Where motor exceeds 7.5 kW (10 hp) motor sheave shall be variable pitch, to be replaced with a correctly sized fixed pitch sheave after balancing.
 - .4 Motors shall be in accordance with the requirements of Section 21 05 13.00 – ELECTRIC MOTORS. See Schedule for hp (wattage) ratings.
 - .5 Belt drive motor shall have adjustable motor plate utilizing threaded studs for positive belt tensioning. Belts shall be oil and heat resistant, non-static type. Drives shall be precision machined cast iron type, keyed and securely attached to the wheel and motor shafts. Drives shall be sized for 150% of the installed motor horsepower.
 - .6 All fans, with the exception of utility fans, shall have arrangement 3 drive or arrangement 2 drive for smaller fans.
- .8 Permanently lubricated bearings are not acceptable. Bearings on shafts 24 mm (15/16 in.) diameter and larger shall be pillow block, self-aligning ball or roller bearings with seals and grease nipple. In addition, bearings on shafts 36.5 mm (1-7/16 in.) diameter and larger shall have grease nipple and grease relief valve. Bearings on shafts smaller than 24 mm (15/16 in.) diameter shall be 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 Consultant. 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. Bearings shall be selected for a minimum L50 life in excess of 200,000 hours at maximum load.
- .9 Blower shaft shall be accurately turned and polished steel. Shaft shall be sized for a critical speed of at least 125% of the maximum RPM. The ends of fan shafts shall be centered depressions to allow for mechanical tachometer readings.
- .10 All fans, without ducts or dampers on the inlet or outlet, including fans in plenums, shall have protective screens on the openings.
- .11 Provide access doors on the fan scroll. Doors shall be hinged, in reinforced angle frames and provided with clamping devices. Minimum size shall be 450 mm x 350 mm (18 in. x 14 in.) or full width of fan scroll, if scroll is less than 450 mm (18 in.) wide.

Centrifugal Fans

- .12 Provide drain connections as shown. Drains shall be minimum 25 mm (1 in.) pipe size, half coupling, welded into the bottom of the scroll with a square headed, threaded, brass plug. Drain shall be extended clear of fan scroll.
- .13 Vibration isolation shall be provided as specified in Section 21 05 48.00 – VIBRATION AND NOISE CONTROL.
- .14 Utility fans shall conform to the Specification for centrifugal fans above with the exception of the drive arrangement and belt guard. Drive shall be standard utility arrangement and belt guard may be omitted if a hood is provided over the drive.
- .15 Fans shall be suitable for operation with variable frequency drives where indicated in the Fan Schedule or as required to meet the requirements of Section 23 09 23.00 – SEQUENCES OF OPERATION.
- .16 Centrifugal and utility fans shall be in accordance with the Fan Schedule.

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.

END OF SECTION

Air Curtains

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Materials

- .1 Air curtains shall be Powered Aire, Miniveil, Enersheild, Biddle, Sigma or Berner. Each unit consists of a factory assembled casing, centrifugal fans, stainless steel inlet screen, discharge nozzle, motor(s), and access panels for motor and fan assembly. The air curtain shall deliver the specified air volume at a uniform outlet velocity across the entire length of the discharge nozzle area.
- .2 Casing shall be not less than 1.214 mm thick (0.0478 in. – 18 MSG) stainless steel. Provide access to the control specified below with top and bottom access panels.
- .3 Unit shall come complete with galvanized discharge nozzle extension where unit is recessed mounted within the ceiling space.
- .4 Unit support shall be integral to the unit frame or casing. All weight bearing structural support shall be formed 1.897 mm thick (0.0747 in. – 14 MSG) stainless steel and galvanized steel. Units shall be furnished in single increments of sufficient structural strength to be supported from the top or back per manufacturer's instructions
- .5 Inlet screen shall be 0.912 mm thick (0.0359 in. – 20 MSG) perforated type stainless steel.
- .6 Discharge nozzle shall be high efficiency discharge plenum. Air curtain shall create a positive air seal with directional air foil vane. The vane shall facilitate a deflection of the air stream by +/- 20 degrees.
- .7 Fans shall be galvanized forward curved centrifugal type, double inlet design, with zinc plated hubs.
- .8 Motors shall be ODP, multi-speed, resiliently mounted, continuous duty, air over with integral thermal-overload protection. Bearings shall be heavy duty type permanently lubricated, shielded ball bearings of equal size.
- .9 Hot water coil shall have seamless copper tube headers with brazed joints and mechanically bonded fin and tube joint mounted to the intake of air curtain. Coil performance shall be in accordance with ARI standard 410.
- .10 Controls
 - .1 Provide unit mounted control panel to house the unit controls complete with non-fused disconnect.
 - .2 Provide remote mounted automatic door switch in the door area to activate the unit each time the door opens and deactivate the unit each time the door closes.

Air Curtains

- .3 Provide an adjustable time delay (adjustable from 2.0 to 120 seconds) to maintain air curtain operation until a specified time after the door closes. Provide a unit mounted Hand/Off/Auto switch to override this automatic door switch.
- .4 Provide a unit mounted High/Low/Off speed selector switch
- .11 Provide mounting brackets as required to clear any obstructions over the door
- .12 Unit shall not vibrate or rattle at any speed.
- .13 Thermostat and controls are specified under the Building Automation System Section.
- .14 Air curtains shall have capacities as shown in the Cabinet Heater Schedule and with air entering at 15.6 deg. C. (60 deg. F.).

PART 3 - EXECUTION

3.1 Installation

- .1 Install in accordance with manufacturer's current installation guidelines.
- .2 Start-up each air curtain in accordance with the manufacturer's Operations and Maintenance Manual and Installation Instructions. Adjust air-directional vanes as necessary.
- .3 After electrical circuitry has been energized, start unit to confirm motor rotation and unit operation.

END OF SECTION

Diffusers, Grilles and Registers

PART 1 - GENERAL**1.1 Work Included**

- .1 Conform to Section 21 05 00.00 – 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, Titus or Carnes 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 A.S.H.R.A.E. 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 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 - 5) discharge slots 12.5 mm, 19 mm, 25 mm (1/2 in., 3/4 in., 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, Carnes CHDB.
- .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 type "R1" on the drawings.

2.3 Sill, Sidewall and Floor Grilles

- .1 Grilles shown as type "G" shall be heavy duty linear grille type with 3 mm x 19 mm (1/8 in. x 3/4 in.) extruded heavy duty aluminum bars on 6 mm (1/4 in.) centers for zero deflection. Diffusers shall be in floor frame. Core shall be removable to allow servicing. Set frame high enough to suit architectural floor covering. E.H. Price LBMH-15A. Krueger 1850 Series, Carnes CTLB.
- .2 Sill and side wall registers as type "M" shall be linear extruded aluminum blades mechanically locked into a heavy extruded aluminum border. Grilles shall have fixed (0, 15, 30 degree) blades spaced (1/4", 1/2", 7/16") on center. The border shall be complete with precise factory mitered corners. E.H. Price border Style 750. Blades shall run parallel to the long dimension of the grille. Supply grilles shall be complete with an integral volume control damper of opposed blade type and shall be constructed of aluminum for pool environments. The damper shall be operable from the register face. E.H. Price LBPH, Nailor 4900 Series, Krueger 1850 Series, Carnes CT580. The grille border shall be mounted in place with a concealed bracket. E.H. Price Concealed MTG BRKT.

2.4 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 520D, Nailor 6100 Series, Krueger 880 Series, Carnes RWDBH.

Diffusers, Grilles and Registers

2.5 Return, Exhaust And Transfer Grilles

- .1 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, Carnes model RSBAH.

2.6 Special Environment Diffusers

- .1 Supply diffusers shown as type "N" shall be air nozzle diffusers. Jet nozzle assembly shall be constructed of a series of concentric round nozzles and have the ability to swivel in the range of range of $\pm 30^\circ$. Diffuser shall be steel construction with white powder coat finish. E.H. Price AND.

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 though 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 ... mm (... in.) centers.
- .8 Contractor shall be responsible for mounting concealed flange linear diffusers in heated environment and following manufacturers' instructions.
- .9 Contractor shall caulk around edges of linear diffusers in installations with imperfect walls.

END OF SECTION

Kitchen Exhaust Hoods

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 Conform to Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.2 Related Work Specified Elsewhere

- .1 Supply and installation of fire protection for hoods and ducts – under Section 11 40 00 – FOOD SERVICE EQUIPMENT (KITCHEN DIVISION).
- .2 The installation only of pressure sensors set into ductwork – under Section 23 31 13.00 – DUCTWORK AND SPECIALITIES.
- .3 120V uninterrupted power supply to the system control centre, and any other applicable wiring – under Electrical Division.
- .4 Supply and installation of under-voltage shunt trip electrical equipment shutdown devices – under Electrical Division.

1.3 Submittals

- .1 Shop Drawings:
- .2 Submit Shop Drawings of all hoods with catalogued components to be supplied. Include manufacturer's data sheets for hood efficiency certification, performance criteria, ratings, and physical dimensions and finishes.

PART 2 - PRODUCTS

2.1 Materials

- .1 Kitchen Hood type "KH-02-02" shall be "Wolf", model "PW302210" 30" Low profile wall hood complete with the following
 - .1 Heavy-duty stainless steel construction
 - .2 Handfinished with hemmed edges and welded seams
 - .3 Bright halogen lighting
 - .4 Infinite speed blower control
 - .5 Heat sentry for safety
 - .6 Recessed controls for sleeker look
 - .7 Internal blower

Kitchen Exhaust Hoods

2.2 Installation

- .1 Kitchen exhaust system shall be designed to fit within the space allocated with sufficient space for servicing all equipment.
- .2 Co-ordinate all work with the respective trades.
- .3 Conceal all piping wherever possible, and coordinate installation to ensure best appearance with adequate support. Avoid grease collection locations.
- .4 Hoods shall be tested on site to ensure correct operation and for volume of exhaust air. Provide written test results.
- .5 Install hoods where shown and as per unit supplier recommendations.

END OF SECTION

Chimney & Breeching for Forced Draft Equipment

PART 1 - GENERAL**1.1 Work Included**

- .1 Conform to Section 21 05 00.00 – 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 breeching system being supplied, including details and catalogue cuts of any standard components being incorporated into the system.
- .2 Draft Calculations: Provide detailed venting design draft calculations. Calculations shall clearly note the dimensions and height of the venting system and shall bear the signed seal of a Professional Engineer licensed to practice in the appropriate discipline and province of installation.

PART 2 - PRODUCTS**2.1 Materials**

- .1 Positive Pressure vent
 - .1 The vent shall be of double wall, factory built type, designed for use in conjunction with Category I, II, III or IV condensing or non-condensing gas fired appliances or as specified by the heating equipment manufacturer. The vent can also be used on type L-vent certified appliances.
 - .2 Maximum continuous flue gas temperature shall not exceed 480°F (249°C).
 - .3 Vent shall be listed for a minimum positive pressure rating of 6" W.C. and shall have passed at 35" W.C.
 - .4 The vent system shall be continuous from the appliance's flue outlet to the vent termination outside the building. All system components shall be UL / ULC listed and supplied from the same manufacturer.
 - .5 The vent shall be constructed with an inner and outer tube, where the annular space between the tubes is 1-inch.
 - .1 The inner tube (flue gas conduit) shall be constructed from AL29-4C® stainless steel, with a minimum wall thickness of .015" for 3" through 9" diameter vents, .020" for 10" through 16" and .024" for 18" through 24" diameter vents.
 - .2 The outer tube (jacket) shall be constructed from 441 stainless steel with a minimum wall thickness of .015" for 3" through 9" diameter vents, .020" for 10" through 16" and .024" for 18" through 24" diameter vents.

Chimney & Breeching for Forced Draft Equipment

- .6 All system components such as vent supports, roof or wall penetrations, terminations, appliance connectors and drain fittings require to install the vent system shall be UL / ULC listed and provided by the vent manufacturer.
- .7 Vent layout shall be designed and installed in compliance with manufacturer's installation instructions and all applicable local codes.
- .8 Chimney and breeching shall be Secure Seal SSD by Security Chimney, Selkirk type IPS, Schebler Co. model P1, Van Packer Type DW-PLUS, Chiminée Lining model IPPL2.
- .9 The vent above the roof line shall have a 304SS outer shell.
- .10 Inner liner material shall suit boiler manufacturers specifications.
- .11 Chimney shall be complete with 1 year warranty from date of substantial completion.

PART 3 - EXECUTION**3.1 Non-Condensing**

- .1 Height of chimney shall be at least 600 mm (2 ft.) higher than any portion of the building within 3000 mm (10 ft.). and shall be supported as appropriate to suit diameter. Should Guy wires be required, wires shall be all stainless steel and come complete with all accessories. Submit details for review. Guy wires shall run from chimney to guy wire supports located approximately mid-span of beams. Guy wires shall be adjustable. Refer to Architectural and Structural Drawings.

END OF SECTION

Forced Draft non-condensing Boiler (Oil)

PART 1 - GENERAL**1.1 Work Included**

- .1 Conform To Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Related Work Specified Elsewhere

- .1 Supply and installation of concrete boiler base – under Division 3.
- .2 Electrical hard wire supply [and connections to electrical components] – under Electrical Division.
- .3 Emergency shut-down switches located at each door, and furnishing of wiring back to panels – under Electrical Division

PART 2 - PRODUCTS**2.1 Materials**

- .1 Boilers shall be Viessmann, Fulton, Buderus, forced draft non-condensing oil type. Each boiler shall be A.S.M.E. tested and complete with the following.
 - .1 High limit Aquastat set at 98.9 deg. C. (210 deg. F.).
 - .2 High fire Aquastat
 - .3 Low fire Aquastat
 - .4 Pressure temperature gauge
 - .5 Burners for operation on #2 Fuel Oil.
 - .6 A.S.M.E. pressure relief valve
 - .7 Electronic flame safeguard control
 - .8 100% safety shut-off pilot control
 - .9 Blow-off pipe with gate valve from lowest water space led to drain
 - .10 Low water fuel cut-off
 - .11 Pre-wired control panel
 - .12 Built-in draft hood
 - .13 Control lights
- .2 Boiler to come to site in multiple skids to be assembled on site by contractor.
- .3 Sequence Programmer:
 - .1 Sequence programmer shall be equal to Cleveland to provide fully automatic lead-lag control of the boilers and associated pumps.

Forced Draft non-condensing Boiler (Oil)

- .2 Lead pump shall always operate. On a call for heating, the programmer shall, after a suitable time delay and provided flow has been established, energize the lead boiler on low fire. When the lead boiler modulates to high fire, and provided that after a suitable time it fails to maintain system temperature the second boiler and associated pump shall be energized as described for the lead equipment.
- .3 Similarly for all other boilers and pumps, when the demand decreases and all boilers have modulated to low fire, the programmer shall de-energize the boiler first and then after a suitable time delay stop the associated pump in the reverse sequence of start-up.
- .4 Unit shall have a fully adjustable cut-in and cut-out set points for each boiler, together with indicating lights to show status. Unit shall be complete with temperature sensor. Provide a 7 day timer to alternate lead boiler and associated pump. Time delay for starting lag boiler shall be fully adjustable and initially set for 30 minutes.
- .4 Burner manufacturer Weishaupt
 - .1 Burner/Gas train approval Standard approvals are CSA (for Canada) and UL (for U.S.).
 - .2 Electrical requirements Weishaupt -G(L) It is generally acceptable to use voltages within ten percent of the supply voltage.
 - .3 Burner to be fully modulating down to 29%
 - .4 Factory pre-wired components all components.
 - .5 Burner assembled to be a forced draft linkageless type.
- .5 Boiler control panel shall be based on open system communication protocol either BACnet as defined by ANSI/ASHRAE standard 135-2001 or LONWorks as defined by ANSI/CEA standard 709.1 for seamless integration with Section 23 09 00.00 - BUILDING AUTOMATION SYSTEM (BAS).
- .6 As a minimum, the following hardware points shall be available for direct connection to Section 23 09 00.00 - BUILDING AUTOMATION SYSTEM (BAS):
 - .1 Boiler Enable
 - .2 Hot Water Supply Temperature Set-Point
 - .3 Boiler General Alarm
- .7 Valves: One of the manufacturer's noted in Section 22 11 13.00 – PIPES, VALVES AND FITTINGS.

PART 3 - EXECUTION**3.1 Installation**

- .1 Install temperature sensors in common supply header. Provide lights to indicate boiler and pump operation.
- .2 Install sequence programmer panel remote from boilers and in accordance with the manufacturer's instructions.

Forced Draft non-condensing Boiler (Oil)

- .3 Install boiler on 100 mm (4 in.) concrete base, with isolators as specified in Section 21 05 48.00 – VIBRATION AND NOISE CONTROL. Furnish anchor bolts and setting diagrams to Work of Division 3 for correct setting in place.
- .4 Co-ordinate boiler controls and panel as required for interconnecting with door switches provided by other trades.
- .5 BAS connection to boiler control panel provided under Section 23 09 00.00 – BUILDING AUTOMATION SYSTEM (BAS).
- .6 At time of start-up, the manufacturer shall check the installation, check the efficiency, instruct the Owner and provide a written report to the the Consultant detailing all work undertaken.

END OF SECTION

Heat Exchangers - Plate Type

PART 1 - GENERAL**1.1 Work Included**

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

PART 2 - PRODUCTS**2.1 Materials**

- .1 Plate type heat exchangers shall be Xylem, Alfa-Laval, Armstrong, Tranter, A.P.V., Taco, GEA or AIC Inc. with fluids and performance in accordance with the Heat Exchanger Schedule.
- .2 Where applicable, heat exchanger performance shall be AHRI 400 certified.
 - .1 The AHRI certification does not cover fluids other than water or sea-water. For other fluids, such as glycol mixtures or domestic water, the selection shall include a minimum of 10% excess surface.
- .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 and titanium for units serving pool water.
- .6 For potable water applications the heat exchanger shall be double wall with two plates pressed together to create two fluid leak paths to atmosphere. Each plate thickness to be 0.35mm and total thickness of two plates pressed together to be 0.7mm.”
- .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 Consultant.
- .9 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.

Heat Exchangers - Plate Type

- .10 Provide two A.S.M.E. 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.
- .11 For units where both sides are part of a closed loop system, the heat exchangers shall be selected with a 0.0001 fouling factor for the unit (0.00005 applied to each side) based on the capacities given in the Schedules.
- .12 For units where one or both sides are part of an open loop system, the heat exchangers shall be selected with a 0.00025 fouling factor for the unit (0.000125 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 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

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 ARI 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 Backseating 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.
 - .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)

Air Cooled Condensing Units

- .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 cutouts, and compressor winding thermostat cutout.
 - .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 Contractors 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 pumpdown 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 The unit shall be complete with electronic coating for corrosion protection.
- .7 Condensing unit control panel shall be based on open system communication protocol either BACnet as defined by ANSI/ASHRAE standard 135-2001 or LONWorks as defined by ANSI/CEA standard 709.1 for seamless integration with Section 23 09 00.00 - BUILDING AUTOMATION SYSTEM (BAS).
- .8 As a minimum, the following hardware points shall be available for direct connection to Section 23 09 00.00 - BUILDING AUTOMATION SYSTEM (BAS):
 - .1 Condenser Start/Stop

Air Cooled Condensing Units

- .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 backseating 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.

PART 3 - EXECUTION**3.1 Installation**

- .1 Set and install unit so it is level, properly supported and with sufficient clearances.
- .2 Provide all refrigerant piping as detailed on plans and Specification.
- .3 Leak test of all piping, then dehydrate and charge according to following:

Air Cooled Condensing Units

- .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 and charge system in accordance with manufacturer's recommendations.
- .4 Electrical interlocks between condensing units and equipment provided under Section 23 09 23.00..
- .5 BAS connection to condensing unit control panel provided under Section 23 09 00.00 – BUILDING AUTOMATION SYSTEM (BAS).

END OF SECTION

Energy Recovery Enthalpy Wheels

PART 1 - GENERAL**1.1 Work Included**

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

PART 2 - PRODUCTS**2.1 Materials**

- .1 Energy recovery wheels shall be Semco, Engineered Air, Novelaire, or Corroventa.
- .2 Wheel heat transfer media shall be as follows:
 - .1 Provide wheel media of sheet aluminum coated to prohibit corrosion: etched or oxidized surfaces are not acceptable.
 - .2 Wheels shall be tension wound on to a central hub with alternate layers corrugated and with adjacent layers glued to each other for stability.
 - .3 All surfaces shall be coated with a non-migrating adsorbent specifically developed for the selective transfer of water vapor. Provide verification in writing from the desiccant manufacturer confirming that the desiccant being provided limits adsorption to materials not larger 4.0 angstroms. Dry particles up to 800 microns shall pass freely through the media.
 - .4 Equal sensible and latent recovery efficiencies must be clearly documented through a certification program conducted in accordance with ASHRAE 84-78P and ARI 1060 standards. The certification must have been conducted by a qualified independent organization.
 - .5 The media shall be cleanable with compressed air, low temperature steam, hot water or light detergent without degrading the latent recovery.
- .3 Provide wheel media 2 m (80 in.) or greater in diameter in a segmented fashion to allow for field erection or replacement of one section at a time without requiring full wheel width side access. The media shall be rigidly held by a structural spoke system made of extruded aluminum.
- .4 Provide the unit with a factory set, field adjustable purge sector designed to limit cross contamination to less than 0.4 percent of that of the exhaust air stream concentration.
- .5 The unit shall be supplied with non-contact labyrinth face seals around the perimeter of the wheel and across the face at the division between the exhaust and supply air streams. At no time are these seals required to make contact with any rotating surface of the exchanger rotor. These multi-pass seals shall utilize four labyrinth stages for optimum performance.
- .6 The unit housing shall be a structural framework that limits the deflection of the rotor due to air pressure loss to less than 0.8 mm (1/32 in.). The housing sheet metal shall be made of galvanized steel to prevent corrosion. The housing structural framework shall be of tubular construction painted with epoxy paint.

Energy Recovery Enthalpy Wheels

- .7 The wheel shall be supported by two pillow block bearings that can be maintained or replaced without the removal of the rotor from its casing or the media from its spoke system.
- .8 The wheel shall be driven by a self-adjusting belt system. Provide an A/C motor with internal overload protection for variable speed applications.
- .9 Provide energy recovery enthalpy wheels in accordance with the Energy Recovery Enthalpy Wheel Schedule.

2.2 Controls

- .1 All temperature sensors shall be provided by the air handling unit manufacturer.
- .2 For normal supply air temperature operation, an adjustable setpoint on the supply air discharge side of the wheel shall allow a selection of 11.1 deg. C. (52 deg. F.) to 23.3 deg. C. (74 deg. F.). In the heating mode, as the discharge air temperature nears this setpoint, the rotational speed of the wheel shall be reduced down as necessary to maintain setpoint. When the minimum speed is reached, and a cooling demand exists, the wheel shall stop completely. The wheel will then remain off until the outdoor air temperature exceeds the exhaust air temperature, at which time the wheel shall resume operation at full speed.
- .3 When the outdoor air temperature drops below the frost threshold, a frost prevention mode shall be enabled for the enthalpy wheel, overriding the temperature control mode. This control sequence shall be provided by the wheel manufacturer and shall modulate the rotational speed of the enthalpy wheel to prevent frosting based on supply air temperature.
- .4 All temperature sensors shall be provided by the Controls Contractor. Refer to Section 23 09 00.00 – BUILDING AUTOMATION SYSTEM.
- .5 Energy recovery enthalpy wheel sequencing shall be as outlined in Section 23 09 23.00 – SEQUENCE OF OPERATION FOR BAS.

PART 3 - EXECUTION**3.1 Installation**

- .1 All abrasions and other blemishes shall be touched up after installation with zinc rich paint.

END OF SECTION

Packaged Air Conditioning Unit

PART 1 - GENERAL**1.1 Work Included**

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Related Work Specified Elsewhere

- .1 120V/1/60 electrical hard wire supply and primary connections to disconnect device – under Electrical Division.

1.3 Submittals

- .1 Submit shop drawings of units.
- .2 Submit manufacturer's certified sound power ratings with an octave band analysis, and indicate the basis on which they have been established. Make one set of these curves available to the supplier of sound and vibration isolation equipment.

PART 2 - PRODUCTS**2.1 Materials**

- .1 Packaged air handling units shall be Carrier, Daikin or York.
- .2 Each unit shall be complete with one or more of the following components as shown:
 - .1 Fan section with centrifugal fans.
 - .2 V-belt drive and belt guard
 - .3 Cooling and heating coils, arranged as shown
 - .4 Filter section with filters
 - .5 Face and bypass section with dampers as shown
 - .6 Discharge air dampers for multi-zone unit as shown
 - .7 Fan section arranged for draw through or flow through as shown
 - .8 Condensing unit
 - .9 Variable inlet vanes
 - .10 Variable speed drive
- .3 Fabricate casings from galvanized or bonderized and painted steel sheets or sufficient thickness to prevent drumming when unit is in operation. Adequately reinforce casings with galvanized or bonderized and painted steel angles, and make panels removable for access to unit interior. Apply 25 mm (1 in.) thick internal coated glass-fibre insulation to casings, and external moisture proof insulation to drain pans. Dampers shall rotate in brass or nylon bushings.

Packaged Air Conditioning Unit

- .4 Fan section shall have centrifugal fans. Fan wheels and drive shaft assembly shall be statically and dynamically factory balanced and shall operate quietly and without pulsation. All inaccessible bearings shall have lubrication lines extended to accessible locations. Published performance fan ratings shall be obtained in accordance with the procedures as set forth by the A.M.C.A. Test Code for sound power ratings.
- .5 V-belt drive shall be designed for 150% of motor nameplate rating. Motor sheave shall be adjustable pitch type.
- .6 Coils shall be copper type, aluminum fin construction with heavy gauge galvanized steel frame. Coils shall have the minimum number of rows and capacity shown.
- .7 Refrigerant coils shall be suitable for 1270 kPa (250 psi). Coil face shall not exceed 2.54 m/s (500 fpm).
- .8 Hot water coils shall have serpentine circuiting arranged for counter flow between the air and water, suitable for 860 kPa (125 psi) water pressure and complete with plugged drain and vent connections, readily accessible. Coil face velocity shall not exceed 3.56 m/s (700 fpm).
- .9 Filter section shall be complete with Farr Type D/S or other approved manufacturer of 50 mm (2 in.) thick throwaway media in permanent frame with media efficiency of 85% on standardized dust test. Filter frames shall be designed for sliding filters in through hinged access door of side of unit.
- .10 Face and bypass section shall be external or internal type as shown. Dampers shall rotate in brass or nylon bushings.
- .11 Provide marine lights with protective metal cage and glass seals, controlled by factory-wired switch with an indicator light installed on the exterior of the unit. Install lights on the wall opposite the access doors. Electrical power shall be 120V/1/60.
- .12 Where DX cooling coils and condensing units are noted, the condensing unit shall be factory mounted on a frame on top of the unit casing as a complete package.
- .13 The condensing unit shall be complete with electronic coating for corrosion protection.
- .14 Where indicated, separate fan sections from the coil section and ductwork by flexible connections.
- .15 On draw-through cooling systems when the fan is split from the coil section, provide a galvanized sheet metal splash guard over the bottom flexible connection. Slope splash guard to coil section, and attach to coil section only.
- .16 Provide fans in accordance with the Fan Schedule and coils in accordance with the Coil Schedule and filters in accordance with the Filter Schedule.
- .17 Air handling system to include free cooling mode of operation.

PART 3 - EXECUTION**3.1 Installation**

- .1 Ensure all curbs, inserts, and other mounting devices are correctly installed for the unit supplied.

Packaged Air Conditioning Unit

- .2 Mount or hang the unit and install all components required for a complete and operational unit.

END OF SECTION

Pool Dehumidification Unit

PART 1 - GENERAL**1.1 Work Included**

- .1 Conform to Section 15010 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

PART 2 - PRODUCTS**2.1 Materials**

- .1 Provide factory assembled indoor dehumidification air handling unit and remote outdoor air cooled fluid cooler in configuration as indicated on drawings. Unit shall include all specified components installed at the factory.
- .2 The pool dehumidification unit shall be completely factory assembled, wired, piped, and test run prior to shipping. All controls shall be factory adjusted and pre-set to the design conditions. A factory test report shall be available upon request.
- .3 The unit shall be ETL listed.
- .4 The entire system shall have a 24 month limited parts warranty from ship date. The compressor(s) shall have a 5 year warranty from ship date.
- .5 Unit capacity shall be in accordance with the Pool Dehumidification Unit Schedule.
- .6 Standard of Acceptance: Seresco and Dectron.

2.2 Unit Construction

- .1 Cabinet:
 - .1 All cabinet sheet metal shall be galvanized G90 steel, mill applied zinc phosphate primer followed by an exterior grade white silicone modified polyester top coat or galvalume. The cabinet shall be 2-inch double-wall construction with a fully painted inner metal liner and 2-inch fibreglass insulation. The unit cabinet must not drum, rattle or vibrate under operation and be able to provide a 1000hr salt spray resistance when tested in accordance with ASTM B117 – Standard Practice for Operating Salt Spray Apparatus.
 - .2 Panels shall be fastened to the frame with stainless steel hardware. Panels shall be isolated from the steel frame with dielectric gaskets to prevent galvanic corrosion. All seams shall be caulked with silicone inside and out to prevent air and water leakage.
 - .3 Fire resistance rating to conform with NFPA Standard 90A and 90B. Sound attenuation coefficient shall be not less than 1.02 at a frequency of 1000 Hz as per ASTM Standard C423. Insulation shall be securely fastened with approved adhesive and mechanical fasteners.

Pool Dehumidification Unit

- .4 The unit shall have a mechanical vestibule where the electrical panel, compressors, pool water heat exchangers, receivers and most of the refrigeration controls are out of the process air stream.
- .5 The unit frame shall be constructed of heavy gauge galvanized steel with a formed galvanized structural steel base. Lifting lugs shall be provided on the base frame for rigging the unit.
- .6 Access doors shall be supported on multiples hinges and have multiple compression latches to provide quick access. Doors shall be provided for entrance to all sections housing components requiring routine maintenance. Full height access doors have "hold back" latches to prevent door closure during the performance of service procedures.
- .7 All access doors shall be sealed against the unit frame with a continuous raised weatherproof vinyl compression gasket. The compression gasket shall be fastened to the enclosure in a freeze proof seam. Foam gasketing and glued gasketing shall not be acceptable.
- .8 The entire cabinet shall be painted internally and externally.
- .9 The unit shall have a built in air filter rack with separate hinged access door.
- .2 Outdoor Air Connection
 - .1 Unit shall be equipped with duct collars to admit the minimum outdoor air as scheduled. The outdoor air intake assembly shall have a built in air filter rack with separate access door, heat recovery coil rack, manual air balancing device and motorized damper.
- .3 Coils
 - .1 All coils shall be fully dipped and coated with a polyester/enamel coating for maximum corrosion protection. Coating shall comply with ASTM B117/D1654 and ASTM D2126 for corrosion resistance against common acids, salt and gases.
 - .2 Coils that have coated fins only shall not be acceptable. Painted end plates are not acceptable.
 - .3 System performance from coated coils must be fully disclosed.
 - .4 Evaporator (Dehumidifier Coil)
 - .1 Shall be not less than six rows deep for maximum moisture removal capacity with air velocity not to exceed 500 fpm, with a minimum ½" OD seamless copper tubing mechanically expanded to assure high heat transfer with maximum ten flat aluminum fins per inch.
 - .2 Heat transfer fluid shall be refrigerant R-407c or R-410a.
 - .3 Coil shall be specially designed for heavy moisture removal. Coil shall be designed such that at design conditions system performance does not change due to overloading with condensate.

Pool Dehumidification Unit

- .4 Corrugated or facetized fins shall not be acceptable. Possible system performance reduction from coated coils must be fully disclosed.
- .5 Coils shall have a 14 gauge galvanized casing and end plates.
- .6 A motorized damper shall be installed for apparatus dew point control during cold water start up. Capacity reduction methods shall not be used for dew point control. Provide motorized face damper over the DX cooling coil. Coils without bypass air shall not be acceptable.
- .5 Air Reheat Coil
 - .1 Shall be sized for variable heat transfer (ON/OFF is not acceptable) into the air with the ability to transfer 100% of the compressor heat of rejection into the air if necessary with ½" OD seamless copper tubing mechanically expanded to assure high heat transfer with maximum twelve aluminum fins per inch. Copper fins shall not be acceptable.
 - .2 Heat transfer fluid shall be 40% Propylene Glycol from the heat rejection loop.
 - .3 Coil shall have 18 gauge galvanized casing and end plates.
- .6 Heat Recovery Coils
 - .1 The unit shall have heat recovery between the dedicated low level exhaust and code outdoor air streams per specifications. The heat recovery coils shall be sized for heat transfer between the two air streams.
 - .2 The heat recovery fluid circulating between coils shall be glycol. The module shall be a complete package and independent circuit that includes a circulating pump, fill valves and expansion tank.
 - .3 Aluminum fin and copper tube joints mechanically bonded to assure high heat transfer
- .4 Drain Pan
 - .1 Each unit shall be equipped with a sloped self draining pan under the entire evaporator coil and shall prevent condensate carryover. Flat drain pans shall not be acceptable.
 - .2 The drain pan shall be double walled with insulation and constructed of aluminum or PVC.
 - .3 The drain pan shall have an external 1 ½" P- trap connection using compression ring fitting for easy disassembling and cleaning.
- .5 Blowers
 - .1 Supply and return fans shall be direct drive single width/single inlet backward inclined plenum type blower or belt drive double width/double inlet backward inclined centrifugal blower. The wheel and inlet cone shall be G90 galvanized steel with epoxy coating or high performance composite material. The shaft shall be machined, ground and polished solid steel coated with a rust inhibitor.

Pool Dehumidification Unit

- .2 Ball bearings shall be grease lubricated self-aligning for 200,000 hours average life.
- .3 The complete blower/motor assembly shall be statically and dynamically balanced on precision electronic balancers.
- .4 The blower/motor assembly shall be mounted on a 1" deflection spring isolated rack.
- .5 The fan inlets shall be equipped with accidental contact protection screen.
- .6 Blower Motors
 - .1 Motor shall be Premium efficiency painted cast iron construction TEFC, NEMA MG1-PART 31 Inverter Duty 15:1 Constant Torque Severe Duty with a service factor 1.25. Motors shall have double lip seals on both ends with regreasable bearings 254T frame and larger with Polyurea grease.
 - .2 As an alternative to TEFC motors with VFD, blower motors may be EC motors provided that the motor design is such that individual components can be replaced without replacement of the entire fan/motor assembly.
- .7 Variable Frequency Drives
 - .1 The variable frequency drives and harmonic filters shall be as per Section 21 05 15.00 – VARIABLE FREQUENCY DRIVES. Yaskawa shall be added to the list of acceptable manufacturers.
- .8 Unit Mounted Motor Operated 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.
 - .2 Frame: 125 mm x 25 mm x 3 mm (5 in. x 1 in. x 0.125 in.) 6063T5 extruded aluminum hat channel with mounting flanges on adjacent sides and reinforced with corner bracing for flanged to duct mounting.
 - .3 Blades: Airfoil shape, 6063T5 extruded aluminum, maximum 150 mm (6 in.) depth.
 - .4 Seals:
 - .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: Teflon coated.
 - .6 Linkage: Corrosion resistant steel and concealed in the frame.

Pool Dehumidification Unit

- .7 Drive Shaft: Corrosion resistant steel of square or hexagon shape.
- .8 Axle: Corrosion resistant steel.
- .9 Leakage: Maximum 0.26 L/s/sq m (6 CFM/sq ft) at 1.0 kPa (4 in. w.g.) of differential pressure across fully closed damper when tested to AMCA Standard 500.
- .10 Make and Model: Ruskin CD-50 or equivalent.
- .9 Actuators For Motor Operated Dampers
 - .1 Control Signal: Compatible with BC, AAC and ASC.
 - .2 Operating Time: Maximum 120 seconds throughout the full rotation.
 - .3 Mounting: Direct coupled to drive shaft or jackshaft using a V bolt design. Stall protection: Mechanical or electronic.
 - .4 Dampers shall be provided with a power open and spring return outside air and exhaust air dampers.
 - .5 Manual Override: Crank type. External gear release for non-spring return actuators.
 - .6 Position Indicator: Reversible for clockwise or counter-clockwise rotation; set the 0 degrees mark to the failsafe position.
 - .7 Torque: To damper manufacturer's requirements to provide complete compression of seals between frame and blades and for smooth control.
- .10 Filters
 - .1 Filters shall be standard sized, replaceable, and off-the-shelf.
 - .2 Outdoor air intake, return air and exhaust air filters shall be 2in thick MERV 8 rated filters in accordance with Section 23 41 16.00 – DISPOSABLE FILTERS.
- .11 Compressors
 - .1 The unit shall be complete with two heavy duty scroll compressors, serviceable type, suction gas cooled, suitable for refrigerant R-407c or R-410A equipped with stainless steel discuss valves, internal solid state thermal protection sensor, service valves, vibration isolators, easily removable crankcase heater for liquid migration protection, spring mounted, muffler plate on the discharge valve, oil pump for forced lubrication, oil level sight glass, pump down cycle protection and oil failure protection.
 - .2 Compressor manufacturer must have a wholesale outlet for replacement parts in the Toronto area.
 - .3 Compressors shall have a 3-year warranty extension for a total of 5 years coverage.
- .12 Refrigeration Circuit
 - .1 The unit shall consist of two refrigeration circuits for humidity and/or air conditioning control.

Pool Dehumidification Unit

- .2 Refrigeration circuit shall have pressure transducers monitoring the refrigerant high and low pressures. The refrigeration circuit shall be accessible for diagnostics, adjustment and servicing without the need of service manifold gauges.
 - .3 Shall have solenoid control valves, check valves, a liquid line filter drier with up and downstream isolation valves, liquid and moisture indicator, thermostatic expansion valve and pump down solenoid valve.
 - .4 Unit shall have an externally adjustable balanced port design mechanical thermostatic expansion valve. The valve shall have a removable power head.
 - .5 Tamper proof, hermetically sealed non-adjustable high and low pressure controls and refrigeration service valves shall be installed using Schrader type valves. Refrigeration service valves shall be located outside of the airstream.
 - .6 Receiver shall have two refrigerant level (maximum and minimum) indicating sight glasses.
 - .7 Suction line shall be fully insulated with ½ inch closed cell insulation.
 - .8 The unit shall be complete with a full factory charge of refrigerant.
- .13 Pool Water Heaters
- .1 Unit shall include one pool water heating condenser per pool with control valves sized specifically for the water heating requirements.
 - .2 Heaters shall be coaxial, double wall, vented, for maximum heat transfer from refrigerant or glycol to pool water and have cross contamination prevention feature. Pool heaters shall be corrosion resistant, cupro-nickle water circuit, self-purging and self-draining counter flow design.
 - .3 Water circuit piping shall be transparent braided hose, for visual water flow confirmation.
 - .4 Terminating connections are PVC schedule 40 NPT fittings located at the cabinet wall for easy connection.
- .14 Glycol Heat Exchanger
- .1 The heat exchanger used for the heat rejection loop shall be unit mounted and sized by the equipment manufacturer.
 - .2 The heat exchanger shall be sized to reject 100% of the compressor heat rejection to the glycol loop. Concentration shall be 40% Propylene Glycol.
- .15 Glycol Circulator Pump
- .1 The circulating pump for the heat rejection loop shall be unit mounted and sized by the equipment manufacturer. The pressure drop from piping between the dehumidifier and the fluid cooling is 74.6 kPa 25 ft WC).
 - .2 Pump shall be powered internally to the unit.
 - .3 Refer to Section 23 21 23.00 – CENTRIFUGAL PUMPS.
- .16 Glycol Expansion Tank

Pool Dehumidification Unit

- .1 The expansion tank for the heat rejection loop shall be unit mounted and sized by the equipment manufacturer.
- .2 Refer to Section 23 77 13.00 –EXPANSION TANKS.
- .17 All internal piping in accordance with BOCA code P-308.2 for corrosion resistant coating of copper tubing and M-702.0 for joints and connections.
- .18 Remote Fluid Cooler
 - .1 Excess compressor heat is rejected to a remote outdoor air-cooled heat exchanger via a glycol fluid loop. The remote outdoor air-cooled dry cooler shall be capable of rejecting 100% of the compressor heat rejection at summer design conditions.
 - .2 Heat transfer fluid shall be 40% Propylene Glycol.
 - .3 The outdoor heat exchanger shall be equipped with a 24VAC control including contactor for fan motor.
 - .4 Heat exchanger coils shall have copper tubes expanded onto aluminum fins. Coils shall be tested at 425 PSIG and mounted vertically for complete surface utilization. Coils shall be counter flow and have adequate capacity to dissipate the total heat rejection of the system at design conditions. Dry-cooler shall have guards to protect the coils from vandalism and weather related damage.
 - .5 Fans shall be coated steel and have a steel hub locked on a stainless steel motor shaft with a keyway and square head set screws. Fans shall have a radius spun type venturi for efficient performance. Fans shall have vinyl coated external guards capable of being removed for service without removing the fan motor.
 - .6 Fans shall be direct driven by NEMA constructed, three phase motors operating at 1140 RPM at high speed and drop down to low speed based on the head pressure of the refrigeration system. This will allow for quieter operation at 67 bBA
 - .7 Each motor shall have a shaft slinger to prevent water seepage into the motor.
 - .8 Power shall be single point 575V connection.
- .19 Control Panel
 - .1 Shall be built in within a separate compartment in order not to disturb the airflow during servicing.
 - .2 Blower motor and compressors shall be protected with push button operated, adjustable thermal trip and fixed magnetic trip overloads.
 - .3 Voltage monitor shall be provided to shut down electrical system to prevent damage in the event of temporary voltage fluctuation or phase loss. Voltage monitor shall be auto reset.
 - .4 Power block terminal shall be provided for proper wire size.
 - .5 Dry contacts shall be provided for the following:

Pool Dehumidification Unit

- .1 Alarm
- .2 Blower interlock
- .3 Outdoor air damper control
- .4 Outdoor-air cooled equipment (dry-cooler)
- .5 System on
- .6 Auxiliary pool heater
- .7 Heat recovery
- .6 Terminals shall be provided for 24 volt power to the outdoor air cooled condenser fan contactor.
- .7 Colour coding and wire numbering shall be provided for easy troubleshooting. All wires shall be in conduit. Wiring diagrams located near electrical panels on unit.
- .8 Compressors shall have a time delay start to prevent short cycling.
- .9 Pressure transducers for refrigerant high pressure and suction pressure shall be provided.
- .10 Airflow switch and dry contact for alarm shall be provided.
- .11 All wiring shall be installed in accordance with CSA safety electrical code regulation and shall be in accordance with NFPA. All components used shall be CSA listed.
- .12 All wiring shall be installed in accordance with Division 16 specification.
- .13 For the indoor unit, provide a non-fused disconnect switch. Main power to the unit shall be disconnected when the unit's electrical door is opened.
- .14 For the outdoor condenser, provide a weatherproof dead front door safety fused disconnect switch. Main power to the unit shall be disconnected when the unit's electrical door is opened.
- .20 Microprocessor Control
 - .1 Unit shall be monitored and controlled with a solid-state microprocessor system complete with control panel equipped with keypad and display panel with a backlit graphic liquid crystal display.
 - .2 All set points and adjustments are preprogrammed at the factory during quality control and test operation.
 - .3 All sensors shall be factory tested and calibrated. Humidity sensor shall be corrosion resistant, especially suited for harsh exposure such as indoor pools with chlorine containing environments.
 - .4 The operator panel shall be CSA approved.
 - .5 Unit shall have pressure transducers monitoring the refrigerant high and low pressures. The refrigeration circuit shall be accessible for diagnostics, adjustment and servicing without the need of service manifold gauges.

Pool Dehumidification Unit

- .6 The controller shall interface via BACnet with the base building BAS system for monitoring, set point adjustment and alarm purposes. Refer to Section 23 09 23.00 – SEQUENCE OF OPERATION FOR BAS. The controller shall have the following monitoring points available to the BAS:
- .1 Compressor on (each compressor)
 - .2 Compressor auto/off (each compressor)
 - .3 Compressor overload (each compressor)
 - .4 Compressor high pressure (each compressor)
 - .5 Compressor low pressure (each compressor)
 - .6 Compressor overheat (each compressor)
 - .7 Compressor oil failure (each compressor)
 - .8 Compressor pump down (each compressor)
 - .9 Unit remote off
 - .10 Dirty filter alarms
 - .11 Manual reset required
 - .12 Evaporator damper closed
 - .13 Low water flow circuit 1
 - .14 Low water flow circuit 2
 - .15 Blower off
 - .16 Blower overload
 - .17 Anti short cycle timer compressor (each compressor)
 - .18 Replace backup battery.
 - .19 Voltage monitor/Power failure
 - .20 Call for dehumidification
 - .21 Call for cooling
 - .22 Call for pool water heating
 - .23 Call for ventilation
 - .24 Dehumidification on
 - .25 Air conditioning on
 - .26 Water heater 1 on
 - .27 Water heater 2 on
 - .28 Firestat on
 - .29 O/A damper open
 - .30 Minimum Exhaust Fan on

Pool Dehumidification Unit

- .31 Purge Exhaust Fan on
- .32 Freezestat on
- .33 Active/non active period
- .34 Service mode
- .35 Auxiliary air heat on
- .36 Compressor run time (each compressor)
- .37 Supply air temperature
- .38 Supply air relative humidity
- .39 Zone air temperature
- .40 Zone air relative humidity
- .41 Entering pool water temperature
- .42 Leaving pool water temperature
- .43 Zone pressure relative to adjacent spaces
- .7 The controller shall have the following configuration/monitoring points available to the BAS:
 - .1 Unit on/off command
 - .2 Unit mode selection
 - .3 Zone air temperature setpoint
 - .4 Zone air relative humidity setpoint
 - .5 Filter signal and alarm setpoints
 - .6 Pool water temperature setpoint
 - .7 Zone relative pressure setpoint
- .21 Sequence of Operation
 - .1 Principal of Operation
 - .1 The unit shall be designed to maintain optimum comfort levels. The unit shall be able to simultaneously heat pool water and reject heat to the air or provide air conditioning. The unit shall not allow wide swings in pool water or room air conditions. Units with oversized pool water heaters that cool the space shall not be acceptable.
 - .2 The unit shall operate according to the following sequence. The warm humid air from the natatorium passes through the dehumidifying coil and is cooled below its dew point, thereby condensing moisture. The heat captured by this process and the heat generated by the compressor power consumption are absorbed via a heat exchanger into a glycol loop. This heat is then distributed as specified herein.

Pool Dehumidification Unit

- .3 Besides humidity control, the first priority is to maintain the pool water temperature by rejecting compressor heat through a water cooled condenser. An automatic compensation system shall proportionally direct the heat where it is required and permit unit start up regardless of water temperature.
- .4 All remaining heat shall be transferred to the air and contribute to the pool enclosure heating requirement unless air conditioning is in operation. The leaving supply air dry bulb temperature is always the same or higher than the entering return air temperature, except when air conditioning is in operation.
- .2 Supply Blowers
 - .1 Operation is continuous and can be remotely controlled by a BMS signal.
 - .2 Blower stops and all motorized dampers close on:
 - .1 power failure
 - .2 firestat alarm
 - .3 freezestat alarm
 - .4 remote off control (manual or from BMS)
 - .5 fire alarm signal
- .3 Exhaust Blower
 - .1 Minimum exhaust blower operation is continuous or can be controlled through the BMS or Microprocessor in occupied/unoccupied modes. To maintain a negative pressure in the space the minimum exhaust fan VFD shall modulate to maintain the space negative pressure relative to adjacent spaces at setpoint.
 - .2 Blower stops and all motorized dampers close on:
 - .1 power failure
 - .2 firestat alarm
 - .3 freezestat alarm
 - .4 remote off control (manual or from BMS)
 - .5 fire alarm signal
- .4 Dehumidification Mode
 - .1 Return air relative humidity is above humidity setpoint.
 - .2 The lead compressor starts.
 - .3 If the unit cannot maintain relative humidity within setpoint, the lag compressor will start. Compressor sequencing continues for all compressors.

Pool Dehumidification Unit

- .4 The compressor heat is rejected into the glycol fluid loop. This heat can be rejected 100% in the reheat coil or the fluid cooler or modulated to precisely control the space. The reheat coil is the first stage of heat rejection.
- .5 The reheat coil has full (0-100%) modulating capabilities. The reheat output will modulate to maintain the space temperature at set point year round.
- .5 Cooling Mode
 - .1 Return air temperature is above room temperature setpoint.
 - .2 The lead compressor starts if not already operating in dehumidification mode.
 - .3 If unit cannot maintain return air temperature within setpoint, the lag compressor will start.
 - .4 The compressor heat is rejected into the glycol fluid loop. This heat can be rejected 100% in the reheat coil or the fluid cooler or modulated to precisely control the space. The reheat coil is the first stage of heat rejection.
 - .5 The reheat coil has full (0-100%) modulating capabilities. The reheat output will modulate to maintain the space temperature at set point year round.
- .6 Pool Water Heating Mode
 - .1 Return pool water temperature is below pool water setpoint.
 - .2 If the lead compressor is already operating from a Dehumidification or Air Conditioning demand, the solenoid valves divert the compressor hot gas through the coaxial heat exchanger/pool water heater and the rest of the compressor heat is rejected at either the reheat coil or the AC heat exchanger.
 - .3 If there is no pre-existing demand for the compressor to operate, the microprocessor sends a signal to the auxiliary pool water heater (remote by others) to operate. The compressor will not normally operate solely for a pool water heating demand unless configured to do so at the controller.
- .7 Space Heating Mode
 - .1 Return air temperature is below room temperature setpoint.
 - .2 If compressors are already operating, free heat is rejected back into the airstream via the modulating air reheat coil.
 - .3 The Microprocessor shall modulate the 2-way heating control valve (provided by this section) to maintain the space temperature at set point year round. The signal output will regulate based on the return air temperature.
- .8 Exhaust Air Heat Recovery Mode

Pool Dehumidification Unit

- .1 Once the outdoor air temperature falls below the heat recovery setpoint (65 F adjustable) the glycol pump shall operate and circulate glycol between exhaust air and outdoor air heat recovery coils and recovering heat from the high energy/warm exhaust air and using it to preheat the incoming outside air.
- .9 Purge Mode
 - .1 Purge mode occurs on a call for purge mode from operator panel or BMS Signal. This timer-operated mode (2-20 minutes) is intended to ventilate the space with one complete air change and then automatically resume normal operation.

PART 3 - EXECUTION**3.1 Installation**

- .1 Install units in accordance with manufacturer's instructions and as indicated.
- .2 Assemble and install all components furnished as per manufacturer's literature. Provide all wiring as per manufacturer wiring and control diagrams.
- .3 Contractor shall provide necessary piping between the indoor air handler and the remote fluid cooler.
- .4 Contractor shall provide necessary piping for condensate drains complete with deep seal trap.
- .5 Provide the services of a factory trained service technician to start up, balance, calibrate and demonstrate the unit to the Owner Representative.

END OF SECTION

Expansion Tanks

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 21 05 00.00 – 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 Explanflex Type 'AL', ITT 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 38mm (1-1/2 in.) threaded bottom inlet, air pressure gauge, 19mm (3/4 in.) drain valve, and air inlet connection to facilitate adjusting of pre-charge pressure to meet actual system conditions.
 - .4 Tanks shall be complete with ring base, and lifting rings.
 - .5 Tanks shall have capacities as indicated in the Expansion Tank Schedule.
 - .6 Tanks shall have capacities as indicated on the Drawings.
- .2 Water Pressure Reducing Valve: Watts, or Cash Acme, equal to Watts UB5, screwed with bronze body for operating pressures up to 2070 kPa (300 psi) at 71 deg. C. (160 deg. F.). Upstream from pressure reducing valve, provide a backflow preventer equal to Watts No. 9 or 909 acceptable under the requirements of the Ontario Water Resources Act. 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 at 140 kPa (20 psig) and pressure relief valve at 210 kPa (30 psig). Pipe pressure relief valve to nearest floor drain.
- .3 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 100mm housekeeping pads.

Expansion Tanks

- .2 Provide 19 mm (3/4 in.) drain line to nearest floor drain.
- .3 Hang expansion tanks from roof structure on angle iron frame. Support tank below each saddle. Refer to Drawings for additional details.
- .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

Variable Refrigerant Volume AC System

PART 1 - GENERAL**1.1 Work Included**

- .1 Equipment under this section is pre-purchased complete with associated DX piping and complete with associated VRF controls wiring. Refer to GC general sections for the \$ amount to be carried by this Division. This Division shall assume the warranty of the equipment.
- .2 Conform to Section 15010 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Submittals

- .1 Provide full system schematics complete with refrigerant pipe sizing, length of piping between components and control details. Submittal shall be signed and stamped by a Professional Engineer for the province where the installation will take place.

PART 2 - PRODUCTS**2.1 Materials**

- .1 The units shall be listed by Electrical Laboratories (ETL) and bear the cETL label.
- .2 All wiring shall be in accordance with the National Electric Code (NEC)
- .3 The system will be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.
- .4 (AC) shall be Daikin, York.
- .5 The variable capacity air conditioning system shall be equal to Daikin Variable Refrigerant Volume Series heat pump split system as specified. The system shall consist of multiple evaporators, REFNET joints and headers, a two pipe refrigeration distribution system using PID control, and Daikin VRV outdoor unit. The outdoor unit is a direct expansion (DX), air-cooled heat pump, multi-zone air-conditioning system with variable speed driven compressors using R-410A refrigerant.
- .6 The system must be installed by the manufacturer's factory trained contractor / dealer. The bidders shall be required to submit training certification proof with bid documents.
- .7 The warranty period shall commence on the date of initial start-up and shall continue for a period of (1) year not to exceed (15) months from date of shipment.
- .8 The units shall be designed for R-410A refrigerant, and be equipped with an electronic expansion valve.
- .9 Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The unit shall be equipped with a programmed drying mechanism that dehumidifies while inhibiting changes in room temperature when used with matching remote control.

Variable Refrigerant Volume AC System

- .10 Indoor units shall be completely factory assembled and tested. Internal unit components shall be factory wired and piped. And complete with electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, self-diagnostics, auto-re-start function, 3-minutes fused time delay and test run switch.
- .11 All refrigerant pipes shall be charged with dehydrated prior to shipment from the factory.
- .12 Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
- .13 Concealed ceiling ducted unit shall be designed for ceiling concealed installation and shall be supplied with a horizontal discharge air connection and horizontal air opening. A return air thermistor shall be mounted inside the return air opening.
- .14 Standard filter shall be mold resistant, washable.
- .15 Provide two sets of filters for VRV units.
- .16 Cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.
- .17 The fan shall be a direct-drive type fan, with a statically and dynamically balanced impeller, with high and low fan speeds settings.
- .18 Units shall be provide with 65% high efficiency air filters.
- .19 The outdoor condensing unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit and the condensing unit shall consist of scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filter, shut-off valves, oil separators, service ports and refrigerant regulator.
- .20 The outdoor unit shall be completely weatherproof and with electronic coating for corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.
- .21 The system shall automatically restart operation after a power failure and will not cause any settings to be lost, this elimination the need for reprogramming.
- .22 The following safety devices shall be included on the condensing unit; high pressure switch, control circuit fuses, crankcase heaters, fusible plug, high pressure switch, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.
- .23 To ensure the liquid refrigerant does not flash when supplying to the various fan coil units, the circuit shall be provided with a sub-cooling feature.
- .24 The condensing unit fan shall have multiple speed operation. Fan shall be in a vertical discharge configuration.
- .25 The fan motor shall have inherent protection and permanently lubricated bearings and be mounted.
- .26 The fan motor shall be provided with a fan guard to prevent contact with moving parts.

Variable Refrigerant Volume AC System

- .27 The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.
- .28 The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance.
- .29 The heat exchanger on the condensing units shall be manufactured from Hi-X seamless copper tube with N-shape internal grooves mechanically bonded on to aluminum fins to an e-Pass Design.
- .30 The fins are to be cover with an anti-corrosion acrylic resin and hydrophilic film type E1.
- .31 The inverter scroll compressors shall be variable speed (PAM inverter) controlled which is capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit. In addition, samplings of evaporator and condenser temperatures shall be made so that the high / low pressures detected are read every 20 seconds and calculated. With each reading, the compressor capacity (INV frequency or STD ON /OFF) shall be controlled to eliminate deviation from target value.
- .32 The inverter driven compressor in each condensing unit shall be of highly efficient reluctance DC (digitally commutating), hermetically sealed scroll "G-type" with a maximum speed of 7,980 rpm.
- .33 Compressor capacity shall be modulated automatically to maintain a constant suction pressure, while varying the refrigerant volume for the needs of the cooling or heating loads.
- .34 Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type. At complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.
- .35 Each compress shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector. Oil separators shall be standard with the equipment together with an intelligent oil management system. Oil recovery cycle shall be automatic occurring 2 hours after star of operation and then every 8 hours of operation.
- .36 Fan coil units shall be supplied with individual zone controllers.
- .37 Fan coils shall be supplied with individual temperature LED controllers.
- .38 Zone controllers shall be installed by installing contractor.
- .39 Controller shall have be able to function as follows.
 - 1) The controller shall have a maximum wiring length of 1,640 feet (500meters)
 - 2) The controller shall have a self diagnosis function that constantly monitors the system for malfunctions (total of 80 components).
 - 3) The controller shall be able to immediately display fault location and condition.
 - 4) The controller shall be equipped with a thermostat sensor in the remote controller making possible more comfortable room temperature control.

Variable Refrigerant Volume AC System

- 5) The controller shall monitor room temperature and preset temperature by microcomputer and can select cool/heat operation mode automatically (REYQ heat recovery outdoor unit only).
 - 6) The controller shall have a 48 hour clock / calendar backup.
 - 7) Controller shall have built-in schedule timer.
- 2.1.39 Provide BACnet or Lonworks interface to base building BAS system for monitoring and alarm purposes. At minimum provide the following information to the BAS.
- 1) Room temperature and setpoint
 - 2) Compressor status
 - 3) System Start / Stop
 - 4) Remote reset
 - 5) Alarm conditions
- 2.1.40 The power supply to the outdoor unit shall be 208 / 3 /60 with a voltage range from 187 volts to 252 volts.
- 2.1.41 The control voltage between the indoor and outdoor unit shall be 16VDC non-shielded 2 conductor cable.
- 2.1.42 The control wiring shall be a two-wire multiplex transmission system, making it possible to connect multiple indoor units to one outdoor unit with one 2-cable wire, thus simplifying the wiring operation.
- 2.1.43 The condensing unit EER (Ducted) shall be 12.30 and IEER(Ducted) shall be 19.30

PART 3 - EXECUTION**3.1 Installation**

- .1 Refrigeration piping detail must be confirmed with the Consultant and the unit manufacturer before installation.
- .2 Install complete refrigeration and controls in accordance with the manufacturer's recommendations.
- .3 Condensers shall be complete with feet and secured to precast concrete paving slabs. Install units on a flat surface level within 1/8 inch. Provide intermediate supports recommended by the equipment manufacturer.
- .4 Provide certified wiring schematics to the electrical division for associated equipment and controls.
- .5 Provide all necessary control wiring as recommended by the manufacturer.
- .6 High / low pressure gas line, liquid and suction lines must be individually insulated between the outdoor and indoor units.
- .7 Provide an authorized technician to commission the installation and provide training for the operators.

Variable Refrigerant Volume AC System

- .8 Division 15 shall provide disconnect switches for each indoor and outdoor, condensing unit. Disconnect switches shall be installed at the unit, or as indicated on the drawings for condensing units.

END OF SECTION

Wall Fin Convectors

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 Submittals

- .1 Shop Drawings: Submit Shop Drawings of wall fin convectors, including unit capacities, sizes, piping, connections, and construction details. Shop Drawing shall clearly show amount of expansion on each section, and method of control.
- .2 Mock-up: Install in one full bay of wall fin convector units with enclosures, piping, valves and other incidentals completely piped up for Consultant review.

PART 2 - PRODUCTS

2.1 Materials

- .1 Wall fin convectors shall be Sterling, Dunham-Bush, Engineered Air, Sigma, Rittling or Rosemex.
- .2 Wall fin convectors shall be complete with:
 - .1 Convector elements consisting of 40, 108 mm x 108 mm (4¼ in. x 4¼ in.) aluminum fins per foot on 32 mm (1-1/4 in.) copper tubes, one or two tiers high, as required to obtain capacities shown.
 - .2 Convector elements consisting of 40, 108 mm x 108 mm (4¼ in. x 4¼ in.) steel fins per foot on 32 mm (1-1/4 in.) steel tubes, one or two tiers high, as required to obtain capacities shown.
 - .3 Convector elements consisting of 40, 100 mm x 75 mm (4 in. x 3 in.) aluminum fins per foot on 19 mm (3/4 in.) copper tubes with a minimum wall thickness of 0.66 mm (0.026 in.), one or two tiers high, as required to obtain capacities shown.
 - .4 Common element and enclosure hangers with elements supported on rollers to allow for expansion.
 - .5 Cabinet shown of 1.2141 mm thick (0.0478 in. – 18 US gauge) prime coated steel with required trim strips to ensure a neat appearance and access doors or openings to valves.
 - .6 Cabinets shall be as specified under Special Unit Enclosures.
 - .7 Manually operated air vent, accessible through access door.
 - .8 19 mm (3/4 in.) tube and element shall be supported on maximum 1220 mm (48 in.) centres.
 - .9 Coordinate element support with the special unit enclosures.
- .3 Elements shall be of finned lengths shown.
- .4 Wall fin convectors shall have capacity with air entering at 18.3 deg. C. (65 deg. F.).

Wall Fin Convectors

- .5 Expansion couplings shall be slant Fin Hydro – Tite or Amtrol.

PART 3 - EXECUTION

3.1 Installation

- .1 Install fin elements so that every section of the perimeter wall is covered. Take special care in locating control valves and other such equipment to ensure that the maximum fin element length is obtained. Following review and acceptance of wall fin convector mock-up, commence installation of entire system; match quality of accepted mock-up for balance of Work.

END OF SECTION

Cabinet Heaters

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Materials

- .1 Cabinet Heaters shall be Dunham-Bush, Engineered Air, 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 For floor and wall mounted units, temperature controllers shall be Honeywell, Powers, Johnson, Penn or White Rodgers with bulb firmly clamped in bulb holder in return air stream. For ceiling mounted units provide a wall thermostat with range, 5 to 25 deg. C. (41 to 77 deg. F.). Temperature controller shall cycle fan.
- .5 Thermostat and controls are specified under Section 23 09 00.00 – BUILDING AUTOMATION SYSTEM.
- .6 Permanent type filters of cleanable aluminum shall be concealed from sight.
- .7 Cabinet heaters shall have capacities as shown (on Drawings) in the Cabinet Heater Schedule with air entering at 15.6 deg. C. (60 deg. F.).

2.2 HEATING UNIT (In Corridor Beside Kitchen)

- .1 Fan coil units: Jaga – Briza EC 12 Hybrid, Kampmann.
- .2 Trench fan coil units shall be suitable for installation within the dimensions as provided. All parts of the units shall be serviceable through the front of the unit.
- .3 The unit shall be complete with energy saving maintenance free EC motor heating only unit and electronic speed control with 0-10V signal.

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.
- .3 Install remote bulb temperature controller inside of wall and floor units. For ceiling mounted units install temperature controller on wall adjacent to unit. Provide all interconnecting wiring.

Cabinet Heaters

END OF SECTION

Unit Heaters

PART 1 - GENERAL

1.1 Work Included

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Materials

- .1 Unit Heaters shall be Dunham-Bush, Engineered Air, Sigma, Rittling, or Sterling for horizontal or downward air discharge as shown.
- .2 Each unit heater shall be 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 louvre cone diffuser.
 - .4 Enamel finish prime coated.
 - .5 Manual starter on unit
- .3 Wall thermostat, Honeywell, Power, Johnson, Penn or White Rodgers with range 4.4 deg. C. to 26.7 deg. C. (40 deg. F. to 80 deg. F.). Thermostat shall cycle fan.
- .4 Thermostat and controls are specified under the Building Automation System Section.
- .5 Unit heaters shall have capacities as shown (in the Unit Heater Schedule), and with air entering at 15 deg. C. (60 deg. F.).

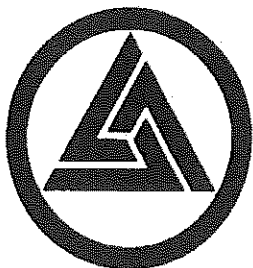
PART 3 - EXECUTION

3.1 Installation

- .1 Install in accordance with manufacturer's current installation guidelines.

END OF SECTION

Hydrant Water Flow Test Summary Report



Life Safety Systems



☒ 9 Ralston Avenue
Dartmouth, NS
Tel: (902) 468 - 7500
Fax: (902) 468 - 3289

☐ 290 Baig Blvd Unit 5
Moncton, NB
Tel: (506) 386 - 7500
Fax: (506) 384 - 0495

☐ 78 Clyde Avenue
Mount Pearl, NL
Tel: (709) 738 - 7940
Fax: (709) 738 - 7941

General Information

Date: 07-Jul-17 Time: 9:30 AM
Customer Name: _____
Job Number: _____
Property Name: #180 Park Road
Address: Elmsdale
City: _____ Province: NS
Name of Tester (please print): Todd Dempsey
Witness Name (please print): J Pelley

Underground System Data

Underground Main type: ☐ Loop ☐ Two Way ☐ Dead End
Size of Main: 16"
Source Reliable: ☒ Yes ☐ No
If no, explain: _____

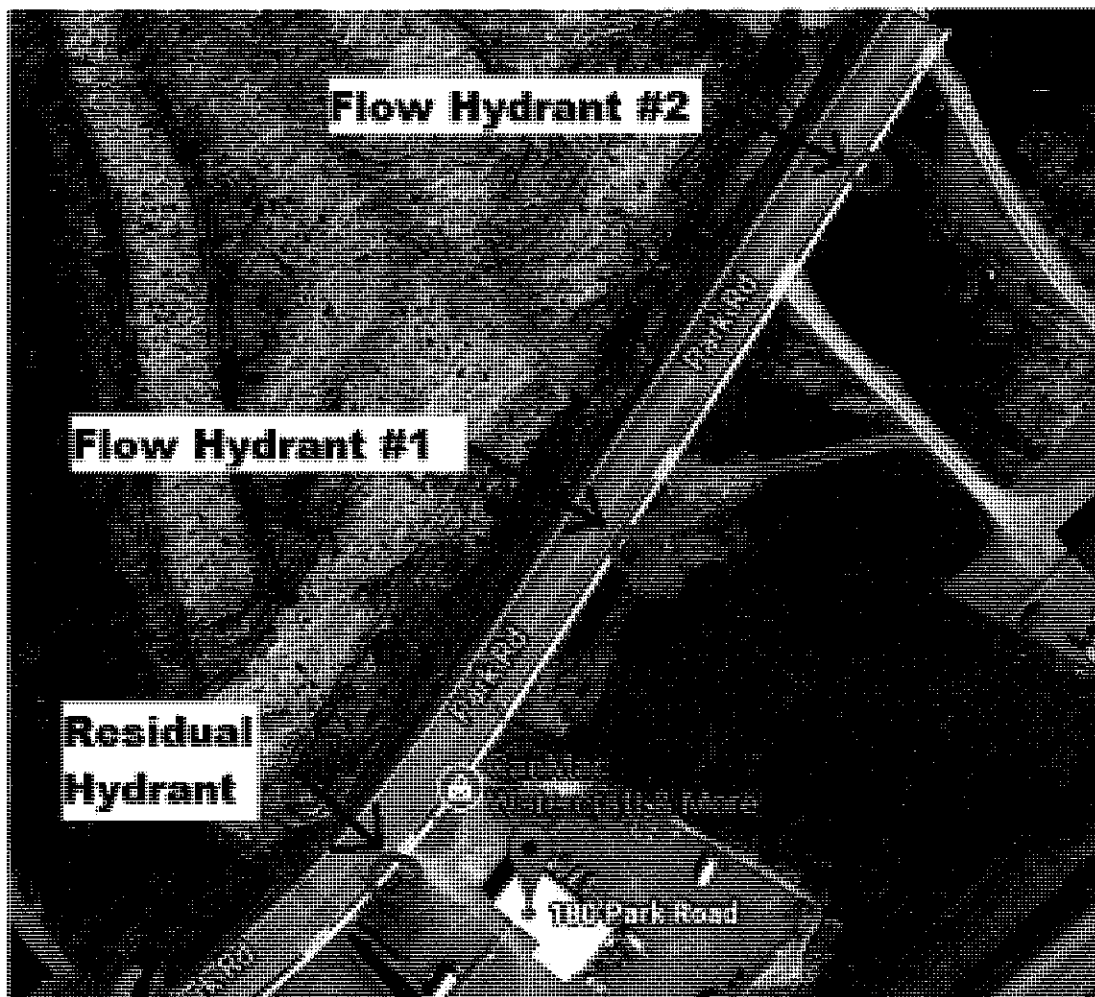
Hydrant Flow Test Data

Location of Residual Hydrant: Lot 180 Park Rd
Location of Flow Hydrant #1: Next hydrant north
Location of Flow Hydrant #2 (If applicable): 2nd hydrant north
Location of Flow Hydrant #3 (If applicable): _____
Static Pressure: 46 (psi)

Flow Point Number 1				Residual Pressure: 24 (psi)		
Flow Hydrant Number	Number of Outlets	Nominal Orifice Size (inch)	Pitot Reading (psi)	Theoretical Flow (gpm)	Orifice Coefficient (c =)	Actual Flow (gpm)
1	1	4"	8	1350	0.8	1080
2 (If Applicable)	1	4"	10	1510	0.8	1208
3 (If Applicable)						
Total Flow:		2288 (gpm)				

Flow Point Number 2 (If Applicable)				Residual Pressure: 20 (psi)		
Flow Hydrant Number	Number of Outlets	Nominal Orifice Size (inch)	Pitot Reading (psi)	Theoretical Flow (gpm)	Orifice Coefficient (c =)	Actual Flow (gpm)
1	1	4"	6	1170	0.8	936
1	2	1-3/4"	5	204	0.97	198
2	1	4"	6	1170	0.8	936
2	2	1-3/4"	7	242	0.97	235
2	3	1-3/4"	5	204	0.97	198
Total Flow:				2503 (gpm)		

Hydrant Flow Test Data Summary				
	Static	Flow Point Number 1	Flow Point Number 2	Flow Point Number 3
Total Actual Flow (gpm)	0	2288	2503	n/a
Pressure (psi)	46	24	20	n/a





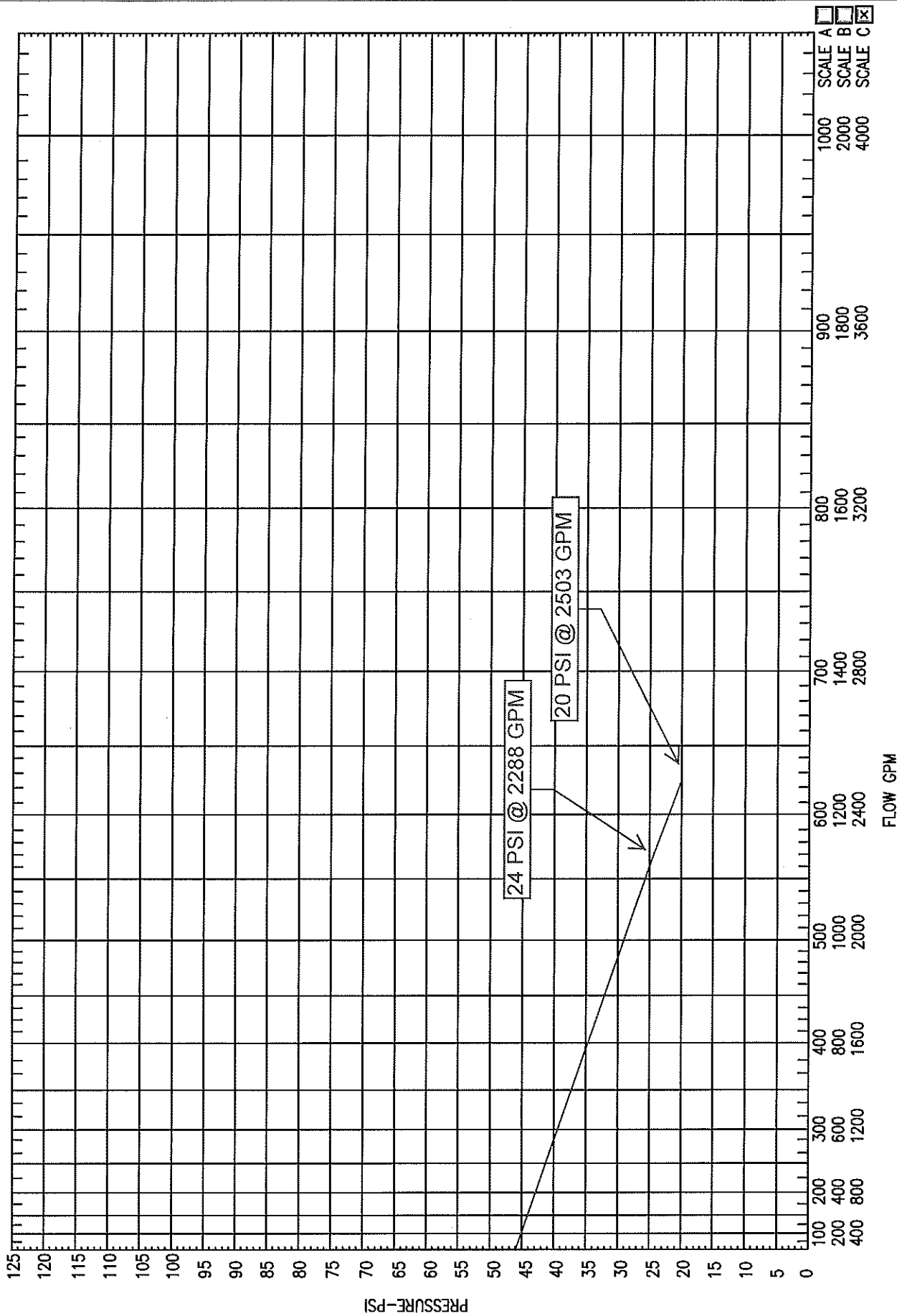
**Life Safety
Systems**

ADDRESS OF JOB SITE
TIME OF TEST
LOCATION OF STATIC HYDRANT
LOCATION OF FLOW HYDRANT (S)

1180 Park Road, Elmsdale, NS
8:50 AM
1180 Park Road
1st & 2nd hydrants north of static hydrant

TEST INFORMATION

STATIC	FLOW #1	FLOW #2	FLOW	PRESSURE
			0 GPM	46 PSI
			2288 GPM	24 PSI
			2503 GPM	20 PSI



EQUIPMENT NO.			AHU-01-02													
Area Served			Multi/Change													
Location			Level 1 Mechanical													
Supply Fan Designation			SF-AHU-02													
Related Return Fan																
Related Exhaust Fan			EF-AHU-02													
Air Blender																
Mixing Plenum Required																
Pre-filters			PF-AHU-02													
Final filters			FF-AHU-02													
Specialty filters																
Face and Bypass Section																
Auditorium Bypass Section																
Preheat Coil																
Heating Coil			HC-AHU-02													
Reheat Coil																
Cooling Coil			CC-AHU-02													
Multizone Dampers																
Humidifier																
GENERAL DIMENSIONS [Co-ordinate with drawings]																
Length	mm	in.	4622.8	182		--		--		--		--		--		--
Width	mm	in.	1727.2	68		--		--		--		--		--		--
Height	mm	in.	2235.2	88		--		--		--		--		--		--
Equipment Weight	kg	lbs.	1668.8	3,679.0		--		--		--		--		--		--
Remarks																

EQUIPMENT NO.			B-B-01		B-B-01											
Make			Viesman		Viesman											
Model			Vitron 200 VD2-780		Vitron 200 VD2-780											
Output			2699 MBH		2699 MBH											
Working Pressure	psig	kPa		--		--		--		--		--		--		--
Entering Water Temperature	°F	°C	160.0	71.1	160.0	71.1		--		--		--		--		--
Leaving Water Temperature	°F	°C	180.0	82.2	180.0	82.2		--		--		--		--		--
FUEL																
Gas Pressure	psig	kPa		--		--		--		--		--		--		--
No. 2 Oil	USgpm	L/min	0.5	2	0.5	2		--		--		--		--		--
Motor	hp	kW	2.10	1.6	2.10	1.6		--		--		--		--		--
Equipment Weight	Lbs	kg	7,326	3,323	7,326	3,323		--		--		--		--		--
Remarks																
EQUIPMENT NO.																
Make																
Model																
Output																
Working Pressure	psig	kPa		--		--		--		--		--		--		--
Entering Water Temperature	°F	°C		--		--		--		--		--		--		--
Leaving Water Temperature	°F	°C		--		--		--		--		--		--		--
FUEL																
Gas Pressure	psig	kPa		--		--		--		--		--		--		--
No. 2 Oil	USgpm	L/min		--		--		--		--		--		--		--
Motor	hp	kW		--		--		--		--		--		--		--
Equipment Weight	Lbs	kg		--		--		--		--		--		--		--
Remarks																

EQUIPMENT NO.			UH-B-01		UH-B-02		UH-B-03		UH-B-04		UH-01-01		UH-01-02		FFH-B-01		FFH-B-02	
Make			SIGMA		SIGMA		SIGMA		SIGMA		SIGMA		SIGMA		SIGMA		SIGMA	
Model			040H		040H		040H		040H		040H		040H					
Size															3		3	
Maximum Air Flow Rate	cfm	L/s	840.0	396	840.0	396	840.0	396	840.0	396	840.0	396	840.0	396	300.0	142	300.0	142
Air Pressure Drop	In H2O	Pa		--		--		--		--		--		--		--		--
HEATING CAPACITY	MBH	kW	33.4	9.8	33.4	9.8	33.4	9.8	33.4	9.8	33.4	9.8	33.4	9.8	32.9	9.6	32.9	9.6
Entering Water Temperature	°F	°C	180.0	82.2	180.0	82.2	180.0	82.2	180.0	82.2	180.0	82.2	180.0	82.2	180.0	82.2	180.0	82.2
Water Flow Rate	USgpm	L/min	3.4	13.0	3.4	13.0	3.4	13.0	3.4	13.0	3.4	13.0	3.4	13.0	3.4	12.9	3.4	12.9
Water Pressure Drop	ft H2O	kPa	2.2	7	2.2	7	2.2	7	2.2	7	2.2	7	2.2	7	1.1	3	1.1	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	0.13	0.09	0.13	0.09	0.13	0.09	0.13	0.09	0.13	0.09	0.13	0.09	0.10	0.07	0.10	0.07
Remarks																		
EQUIPMENT NO.			FFH-B-03		FFH-01-01		FFH-01-02		FFH-01-03		FFH-01-04		ACH-01-01					
Make			SIGMA		JAGA		SIGMA		SIGMA		SIGMA		BIDDLE					
Model					BZBC.03805200								SR L-200-H3-230/22					
Size			2				2		2		2							
Maximum Air Flow Rate	cfm	L/s	220.0	104	215.0	101		--	220.0	104	220.0	104	1110.0	524		--		--
Air Pressure Drop	In H2O	Pa		--		--		--		--		--		--		--		--
HEATING CAPACITY	MBH	kW	21.6	6.3	18.0	5.3	13.6	4.0	21.6	6.3	13.6	4.0	32.0	9.4		--		--
Entering Water Temperature	°F	°C	180.0	82.2	180.0	82.2	180.0	82.2	180.0	82.2	180.0	82.2	180.0	82.2		--		--
Water Flow Rate	USgpm	L/min	2.2	8.3	1.8	6.8	1.4	5.3	2.2	8.3	1.4	5.3	1.0	3.8		--		--
Water Pressure Drop	ft H2O	kPa	3.0	9		--	1.0	3	3.0	9	1.0	3	12.7	38		--		--
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	0.10	0.07		--	0.10	0.07	0.10	0.07	0.10	0.07	1.55	1.16		--		--
Remarks																		

[illegible]

EQUIPMENT NO.			CC-AHU-02													
Location			Level 1 Mechanical													
Airflow Rate	cfm	L/s	3,750	1,858		--		--		--		--		--		--
Number of Coils			1													
Width	In	mm	47	1,194		--		--		--		--		--		--
Height	In	mm	33	838		--		--		--		--		--		--
Area	ft²	m²	10.8	1.0		--		--		--		--		--		--
Face velocity	fpm	m/s	348.0	1.9		--		--		--		--		--		--
Type			OD Sweat													
Minimum Rows			6													
Fins per inch			8													
Series																
AIR SIDE																
Entering Air Temperature (db)	°F	°C	80.3	26.8		--		--		--		--		--		--
Entering Air Temperature (wb)	°F	°C	68.4	20.2		--		--		--		--		--		--
Leaving Air Temperature (db)	°F	°C	54.3	12.6		--		--		--		--		--		--
Leaving Air Temperature (wb)	°F	°C	53.0	11.8		--		--		--		--		--		--
Air Pressure Drop	In H2O	Pa	0.41	111.9		--		--		--		--		--		--
FLUID SIDE																
Fluid			R410A		Water		Water		Water		Water		Water		Water	
Fluid Flow Rate	USgpm	L/min		--		--		--		--		--		--		--
Entering Fluid Temperature	°F	°C		--		--		--		--		--		--		--
Leaving Fluid Temperature	°F	°C		--		--		--		--		--		--		--
Fluid Pressure Drop	ft H2O	kPa		--		--		--		--		--		--		--
MINIMUM CAPACITY																
Total	MBH	kW	179.4	54.4		--		--		--		--		--		--
Sensible	MBH	kW	106.6	32.4		--		--		--		--		--		--
Latent	MBH	kW		--		--		--		--		--		--		--
Turbulators																
REMARKS																

EQUIPMENT NO.			DHWT-B-01		DHWT-B-02											
Make			PVI		PVI											
Model			L600A-TR		L600A-TR											
Size																
Storage Capacity	USgal	L	600	2,271	600	2,271		--		--		--		--		--
Recovery @ 100°F Rise	GPH	L		--		--		--		--		--		--		--
Entering Water Temperature	°F	°C	140.0	60.0	140.0	60.0		--		--		--		--		--
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																
Max kW per Element	KW															
Total kW	KW															
Volt/Phase/Cycle																
Motor	hp	kW		--		--		--		--		--		--		--
Remarks			Storage Tank		Storage Tank											
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																

EQUIPMENT NO.			ERW-AHU-02															
System			AHU-02															
Location			Level 1 Mechanical															
Service																		
Airflow Rate	cfm	L/s	3,750		1,770		--				--				--			
Width	In	mm			--		--				--				--			
Height	In	mm			--		--				--				--			
Area	ft2	m2			--		--				--				--			
Face velocity	fpm	m/s	626		3.2		--				--							
			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)			80.6	27.0	-7.6	-22.0	--	--	--	--	--	--	--	--	--	--	--	--
Entering Air Temperature (wb)			69.8	21.0	-7.6	-22.0	--	--	--	--	--	--	--	--	--	--	--	--
Leaving Air Temperature (db)			80.3	26.8	36.2	2.3	--	--	--	--	--	--	--	--	--	--	--	--
Leaving Air Temperature (wb)			68.3	20.2	35.4	1.9	--	--	--	--	--	--	--	--	--	--	--	--
Effectivness			91.25		85.54													
			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)			80.0	26.7	80.6	27.0	--	--	--	--	--	--	--	--	--	--	--	--
Entering Air Temperature (wb)			66.6	19.2	69.6	20.9	--	--	--	--	--	--	--	--	--	--	--	--
Leaving Air Temperature (db)			80.0	26.7	6.5	-14.2	--	--	--	--	--	--	--	--	--	--	--	--
Leaving Air Temperature (wb)			66.6	19.2	6.4	-14.2	--	--	--	--	--	--	--	--	--	--	--	--
Effectivness			91.25		85.54													
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			--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sensible			--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Latent			--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
			Exhaust				Exhaust				Exhaust				Exhaust			
			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			--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sensible			--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Latent			--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Air Pressure Drop	In H2O	Pa		--		--		--		--		--		--				
Make			Daikin															
Model			SXA-1400MW															
Remarks																		

EQUIPMENT NO.			ET-B-01		ET-B-02		ET-B-03							
Make			H&G/Calefactio		H&G/Calefectio		Bell & Gossett							
Model No.			AL-400		AL-130		PTA-80V							
Location			Basement Mechanical		Basement Mechanical		Basement Mechanical							
System			Water		Glycol		Domestic Water							
Approximate System Volume	gal	litres	994	3762	150	568	1625	6151						
Fluid			Water		Glycol		Domestic Water							
Minimum Temperature	deg f	deg C	40	4.4	40	4.4	40	4.4						
Maximum Temperature	deg f	deg C	180	82.2	175	79.4	140	60.0						
Precharge Pressure	psi	kPa	15	103.43	15	103.43	15	103.43						
System Fill Pressure	psi	kPa	25	172.38	25	172.38	25	172.38						
Maximum System Pressure	psi	kPa	50	345	30	207	45	310						
Fluid Expansion	gallon	litres	27.5	104	23.2	88	41.6	157						
Acceptance Factor			0.336		0.336		0.503							
Minimum Tank Volume	gallons	litres	106	401	35	132	53	201						
Tank Dimensions														
Height	inches	mm	49	1245	37	940	40.5	1029						
Diameter	inches	mm	30	762	20	508	24	610						
Remarks														

EQUIPMENT NO.			SF-AHU-02		EF-AHU-02		SF-B-01		SF-01-01		EF-B-01		EF-01-01		EF-01-02		EF-01-03	
System			AHU-02		AHU-02		Pool Filtration Room		Electrical/Boiler room		Pool Filtration		Outdoor WC		Mechanical Room		Electrical Room	
Location			Level 1 Mechanical		Level 1 Mechanical													
Service																		
Airflow Rate	cfm	L/s	3,780	1,784	1,985	937	2,100	991	1,515	715	2,900	1,369	150	71	800	378	865	408
External Static Pressure	In H2O	Pa	1.0	249	1.3	323	0.5	124	0.5	124	0.7	162	0.4	99	0.4	99	0.5	124
Total Static Pressure	In H2O	Pa	3.7	930	2.2	557		--		--		--		--		--		--
Brake	hp	kW	3.29	2.45	1.04	0.78	0.38	0.28	0.26	0.20	0.56	0.42	0.10	0.07	0.26	0.19	0.28	0.21
Motor	hp	kW	5.00	3.73	1.50	1.12	0.75	0.56	0.33	0.25	1.00	0.75		--		--		--
SOUND DATA																		
2nd Band	Inlet	Outlet	72	82			69	70	68	77	70	71	58		63		66	
3rd Band	Inlet	Outlet	77	92			67	68	75	64	74	74	60		59		62	
4th Band	Inlet	Outlet	70	83			66	65	68	66	75	76	57		55		56	
5th Band	Inlet	Outlet	61	82			67	66	61	66	70	70	52		52		54	
Make							Cook		Cook		Cook		Cook		Cook		Cook	
Model							135QMX		150SQN10D		150QMX		GN-188		GN-842		GN-842	
Type			Centrifugal Plenum		Centrifugal Plenum		Mixed Flow Inline		Centrifugal Square Inline		Mixed Flow Inline		Inline Fan		Inline Blower		Inline Blower	
Size																		
RPM			2003		1942		1336		1072		1310		1102		873		962	
Variable Inlet Vanes	Yes/No																	
Variable Frequency Drive	Yes/No																	
Remarks																		

EQUIPMENT NO.			FF-AHU-02-01	FF-AHU-02-02	FF-AHU-02-03	FF-AHU-02-04				
Fan Served			SF-AHU-02	SF-AHU-02	SF-AHU-02	SF-AHU-02				
Location			Level 1 Mech	Level 1 Mech	Level 1 Mech	Level 1 Mech				
Airflow Rate	cfm	L/s	3,750	1,770	3,750	1,770	3,750	1,770		--
Number of Filters			1	1	1	2				
Total Height	In	mm	24	610	24	610	12	305		--
Total Width	In	mm	24	610	20	508	12	305		--
Media Depth	In	mm	12	305	12	305	12	305		--
Media Type			Varicel SH	Varicel SH	Varicel SH	Varicel SH				
Media Efficiency			MERV 14	MERV 14	MERV 14	MERV 14				
Initial Air Pressure Drop	In H2O	Pa	0.9	221	0.9	224	0.9	224		--
Remarks										
EQUIPMENT NO.										
Fan Served										
Location										
Airflow Rate	cfm	L/s		--		--		--		--
Number of Filters										
Total Height	In	mm		--		--		--		--
Total Width	In	mm		--		--		--		--
Media Depth	In	mm		--		--		--		--
Media Type										
Media Efficiency										
Initial Air Pressure Drop	In H2O	Pa		--		--		--		--
Remarks										

EQUIPMENT NO.			HE-HTG-B-01		HE-HTG-B-02		HE-PL-B-01		HE-PL-B-02		HE-PL-B-03					
Location			Basement		Basement		Basement		Basement		Basement					
Make			Bell & Gossett		Bell & Gossett		Bell & Gossett		Bell & Gossett		Bell & Gossett					
Model			P47 PN:BY5415		P19 - DW		P22 PN:BY5434		P22 PN:BY5434		P7 PN:BY5442					
Type																
Serves			Heating		Domestic water		Lap Pool		Leisure Pool		Hot tub					
PRIMARY SERVICE																
Fluid (Steam/Water/%Glycol)			Water		Water		Water		Water		Water					
Fluid Flow Rate	USgpm	L/min	129	488	118	447	128	485	220	833	26	97		--		--
Fluid Pressure Drop	ft H2O	kPa	8.5	25	9.7	29	2.5	7	2.8	8	2.1	6		--		--
Entering Fluid Temperature	°F	°C	180.0	82.2	180.0	82.2	180.0	82.2	180.0	82.2	180.0	82.2		--		--
Leaving Fluid Temperature	°F	°C	160.0	71.1	160.0	71.1	160.0	71.1	160.0	71.1	160.0	71.1		--		--
Operating Pressure	psig	kPa	0	--	0	--	0	--	0	--	0	--		--		--
Steam Flow Rate	Lb/hr	Kg/hr		--		--		--		--		--		--		--
SECONDARY SERVICE																
Fluid (Steam/Water/%Glycol)			40% Propy. Glycol		Domestic water		Water		Water		Water					
Fluid Flow Rate	USgpm	L/min	138	522	23	87	251	949	432	1,635	50	190		--		--
Fluid Pressure Drop	ft H2O	kPa	9.5	28	0.5	1	10.2	30	11.3	34	8.3	25		--		--
Entering Fluid Temperature	°F	°C	155.0	68.3	40.0	4.4	86.0	30.0	93.0	33.9	101.0	38.3		--		--
Leaving Fluid Temperature	°F	°C	175.0	79.4	140.0	60.0	96.0	35.6	103.0	39.4	111.0	43.9		--		--
Operating Pressure	psig	kPa	0	--	0	--	0	--	0	--	0	--		--		--
Minimum Surface Area	sq.ft.	s.m.	264	24.5	45	4.2	64	6.0	120	11.2	8	0.8		--		--
Remarks			Heat exch.=1260 MBH		Heat exch.=1150 MBH		Heat exch.=1250 MBH		Heat exch.=2150 MBH		Heat exch.= 250 MBH					
					Double walled		Titanium plates		Titanium plates		Titanium plates					
EQUIPMENT NO.																
Location																
Make																
Model																
Type																
PRIMARY SERVICE																
Fluid (Steam/Water/%Glycol)																
Fluid Flow Rate	USgpm	L/min		--		--		--		--		--		--		--
Fluid Pressure Drop	ft H2O	kPa		--		--		--		--		--		--		--
Entering Fluid Temperature	°F	°C		--		--		--		--		--		--		--
Leaving Fluid Temperature	°F	°C		--		--		--		--		--		--		--
Operating Pressure	psig	kPa		--		--		--		--		--		--		--
Steam Flow Rate	Lb/hr	Kg/hr		--		--		--		--		--		--		--
SECONDARY SERVICE																
Fluid (Steam/Water/%Glycol)																
Fluid Flow Rate	USgpm	L/min		--		--		--		--		--		--		--
Fluid Pressure Drop	ft H2O	kPa		--		--		--		--		--		--		--
Entering Fluid Temperature	°F	°C		--		--		--		--		--		--		--
Leaving Fluid Temperature	°F	°C		--		--		--		--		--		--		--
Operating Pressure	psig	kPa		--		--		--		--		--		--		--
Minimum Surface Area	sq.ft.	s.m.		--		--		--		--		--		--		--
Remarks																

EQUIPMENT NO.				HC-AHU-02													
Location				Level 1 Mechanical													
Airflow Rate	cfm	L/s	3,750	1,770		--		--		--		--		--		--	
Number of Coils			1														
Width	In	mm	44	1,118		--		--		--		--		--		--	
Height	In	mm	33	838		--		--		--		--		--		--	
Area	ft²	m²	10	1		--		--		--		--		--		--	
Face velocity	fpm	m/s	372	2		--		--		--		--		--		--	
Type			Threaded														
Minimum Rows			2														
Fins per inch			10														
Series																	
AIR SIDE																	
Entering Air Temperature (db)	°F	°C	-7.6	-22.0		--		--		--		--		--		--	
Leaving Air Temperature (db)	°F	°C	82.7	28.2		--		--		--		--		--		--	
Air Pressure Drop	In H2O	kPa	0.1	0.03		--		--		--		--		--		--	
FLUID SIDE																	
Fluid			Glycol		Water		Water		Water		Water		Water		Water		
Fluid Flow Rate	USgpm	L/min	38.7	146.5		--		--		--		--		--		--	
Entering Fluid Temperature	°F	°C	175.0	79.4		--		--		--		--		--		--	
Leaving Fluid Temperature	°F	°C	154.4	68.0		--		--		--		--		--		--	
Fluid Pressure Drop	ft H2O	kPa	4.9	15		--		--		--		--		--		--	
MINIMUM CAPACITY																	
Total	MBH	kW	370.3	108.5		--		--		--		--		--		--	
Turbulators	Yes/No																
REMARKS																	
															</		

EQUIPMENT NO.		AHU-01-01			
ROOM VOLUME	cu.ft.	cu.m.	315,250	8,928	
Space Temperature	°F	°C	85.0	29.4	
Relative Humidity	Occupied	Unoccupied	60%	50%	
MAKE					
Model Number			Dectron		
			DS-NM-362-345 AE		
SUPPLY FAN					
Model			ANPA22 @ 4Nos.		
Type			PL SWSI		
Motor	hp	kW	10.0	7.5	
Airflow Rate	cfm	L/s	7,888	3,723	
VFD			YES		
Supply Fan FLA			4@10.4		
VFD			YES		
External Static Pressure	In H2O	Pa	1.5	373.1	
VENTILATION (MINIMUM) EXHAUST FAN					
Model (Quantity)	cfm	L/s	7,710	3,639	
Type			ANPL 22		
External Static Pressure	In H2O	Pa	1.5	373.1	
Motor	hp	kW	7.5	5.6	
Ventilation Exhaust Fan FLA			7.8		
VFD			YES		
MINIMUM OUTDOOR AIR					
	cfm	L/s	6,210	2,931	
PURGE EXHAUST FANS					
Model (Quantity)	cfm	L/s	25,340	11,960	
Type			ATLI 28 - 28 T2		
External Static Pressure	In H2O	Pa	1.5	373.1	
Motor	hp	kW	20.0	14.9	
Purge Exhaust Fan FLA			19.3		
VFD			YES		
PURGE MODE OUTDOOR AIR					
	cfm	L/s	31,550	14,892	
REFRIGERANT					
Number of Compressors/Stages			R407C		
LRA (compressor 1 / 2)			2/2		
			280/280		
Motor	hp	kW		--	
Total Capacity	MBH	kW	1003.2	293.9	
Total Moisture Removal Capacity	lbs/hr	kg/hr	476.0	216.4	
Number of Independent Refr. Circuits			2		
Total Evaporator Sensible Capacity	MBH	kW	570.0	167.0	
Total Reheat Capacity	MBH	kW	1,191.0	349.0	
POOL WATER HEATER					
Pool Served			Lap Pool/ Leisure Pool		
Type			CuNi Vented Coax.		
Water Flow Rate (heater 1/2)	USgpm	L/min	80/60		
Water Pressure Drop	ft H2O	kPa	13.9		
HEATING (40% Propylene Ethylene Glycol)					
Entering Air Temperature (db)	°F	°C	75.9	24.4	
Leaving Air Temperature (db)	°F	°C	102.0	38.9	
Entering Water Temperature	°F	°C	175.0	79.4	
Leaving Water Temperature	°F	°C	155.0	68.3	
Water Flow Rate	USgpm	L/min	99.2	375.5	
Water Pressure Drop	ft H2O	kPa	12.40	37.00	
Coil number of rows			2		
Coil fins per inch			12		
FLUID COOLER					
Capacity	MBH	kW	1196.0	350.4	
Entering Ethylene glycol temperature	°F	°C	120.0	48.9	
Leaving Ethylene glycol Temperature	°F	°C	109.8	43.2	
Water Flow Rate	USgpm	L/min	254.7	964.1	
Water Pressure Drop	ft H2O	kPa	24.70	73.70	
UNIT ELECTRICAL DATA					
Maximum Circuit Ampacity			193		
MOP (amps)			225		
Nominal Unit kW			100.9		
Voltage/Phase/Hertz			575/3/60		
Remarks					
			Unit c/w heat rec. coils		

EQUIPMENT NO.			PF-AHU-02-01	PF-AHU-02-02	PF-AHU-02-03	PF-AHU-02-04				
Fan Served			SF-AHU-02	SF-AHU-02	SF-AHU-02	SF-AHU-02				
Location			Level 1 Mech	Level 1 Mech	Level 1 Mech	Level 1 Mech				
Airflow Rate	cfm	L/s	3,750	1,770	3,750	1,770	3,750	1,770		--
Number of Filters			1	1	1	2				
Total Height	In	mm	24	610	24	610	12	305		--
Total Width	In	mm	24	610	20	508	12	305	24	610
Media Depth	In	mm	2	51	2	51	2	51		--
Media Type			Pleated	Pleated	Pleated	Pleated				
Media Efficiency			MERV 8	MERV 8	MERV 8	MERV 8				
Initial Air Pressure Drop	In H2O	Pa	0.6	139	0.6	149	0.6	149		--
Remarks										
EQUIPMENT NO.										
Fan Served										
Location										
Airflow Rate	cfm	L/s		--		--		--		--
Number of Filters										
Total Height	In	mm		--		--		--		--
Total Width	In	mm		--		--		--		--
Media Depth	In	mm		--		--		--		--
Media Type										
Media Efficiency										
Initial Air Pressure Drop	In H2O	Pa		--		--		--		--
Remarks										

EQUIPMENT NO.			P-DHWR-B-01	P-HTG-B-01	P-HTG-B-02	P-HTG-B-03	P-HTG-B-04	P-HTG-B-05	P-HTG-B-06	P-SAN-B-01
System			Domestic Hot Water Recirc	Primary Heating Water	Primary Heating Water	Secondary Heating Water	Secondary Heating Water	Glycol Heating Loop	Glycol Heating Loop	Sanitary Sump
Location			Basement Mechanical Room	Basement Mechanical Room	Basement Mechanical Room	Basement Mechanical Room	Basement Mechanical Room	Basement Mechanical Room	Basement Mechanical Room	Basement Filtration Room
Service										Sanitary
Fluid			Water	Water	Water	Water	Water	Glycol	Glycol	Water
Fluid Flow	USgpm	L/min	9 34	270 1,022	270 1,022	425 1,609	425 1,609	140 530	140 530	338 1,279
Head	ft H2O	kPa	30.00 89.52	36.00 107.42	36.00 107.42	45.00 134.28	45.00 134.28	50.00 149.20	50.00 149.20	34.50 102.95
Brake	hp	kW	--	3.31 2.47	3.31 2.47	6.67 4.97	6.67 4.97	3.00 2.24	3.00 2.24	5.00 3.73
Motor	hp	kW	0.17 0.12	5.00 3.73	5.00 3.73	7.50 5.59	7.50 5.59	5.00 3.73	5.00 3.73	--
RPM			3300	1800	1800	1800	1800	1800	1800	1750
Make			Bell & Gossett	Bell & Gossett	Bell & Gossett	Bell & Gossett	Bell & Gossett	Bell & Gossett	Bell & Gossett	Sulzer
Model			PL-36	e-80 4x4x7B	e-80 4x4x7B	e80 4x4x9.5B	e80 4x4x9.5B	e80 2.5x2.5x9.5C	e80 2.5x2.5x9.5C	EJ 50D-4
Variable Frequency Drives	Yes / No		No	Yes	Yes	Yes	Yes	Yes	Yes	No
Remarks										
EQUIPMENT NO.			P-SAN-B-02	P-STM-B-01	P-STM-B-02	P-PL-B-01	P-PL-B-02	P-PL-B-03	P-PL-B-04	P-PL-B-05
System			Sanitary Sump	Storm Sump	Storm Sump	Lap Pool Recirc	Lap Pool Recirc	Leisure Pool Recirc	Leisure Pool Recirc	Hot Tub Recirc
Location			Basement Filtration Room	Basement	Basement	Basement	Basement	Basement	Basement	Basement
Service			Sanitary	Storm	Storm	Pool	Pool	Pool	Pool	Hot Tub
Fluid			Water	Water	Water	Water	Water	Water	Water	Water
Fluid Flow	USgpm	L/min	338 1279.47	125.00 473.18	125.00 473.18	615 2,328	615 2,328	420 1,590	420 1,590	175 662.45
Head	ft H2O	kPa	34.50 102.95	33.10 98.77	33.10 98.77	80.00 238.72	80.00 238.72	80.00 238.72	80.00 238.72	80.00 238.72
Brake	hp	kW	5.00 3.73	2.00 1.49	2.00 1.49	15.40 11.48	15.40 11.48	12.07 9.00	12.07 9.00	5.21 3.89
Motor	hp	kW	--	--	--	20.00 14.91	20.00 14.91	15.00 11.19	15.00 11.19	7.50 5.59
RPM			1750	1750	1750	1800	1800	1800	1800	1800
Make			Sulzer	Sulzer	Sulzer	Armstrong	Armstrong	Armstrong	Armstrong	Armstrong
Model			EJ 50D-4	EJ 20D-2	EJ 20D-2	Series 4300	Series 4300	Series 4300	Series 4300	Series 4300
Variable Frequency Drives	Yes / No		No	No	No	Yes	Yes	Yes	Yes	Yes
Remarks						Pool Standards Bronze pump	Pool Standards Bronze pump	Pool Standards Bronze pump	Pool Standards Bronze pump	Pool Standards Bronze Pump

EQUIPMENT NO.			P-PL-B-06	P-PL-B-07	P-PL-B-08	P-PL-SL-01	P-PL-WF-01	P-PL-WF-02	P-PL-WF-03	P-PL-WF-04
System			Hot Tub Recirc	Heat Recovery Pump	Heat Recovery Pump	Water Feature Pumps	Water Feature Pumps	Water Feature Pumps	Water Feature Pumps	Water Feature Pumps
Location			Basement	Basement	Basement	Basement		Belle tower Basement	Air Bubbler	Slant Finger jet Basement
Service			Hot Tub			Slide				
Fluid			Water	Water	Water	Water		Water		Water
Fluid Flow	USgpm	L/min	175 662	80 303	60 227	350 1,325		41 155	--	60 227
Head	ft H2O	kPa	80.00 238.72	118.00 352.11	118.00 352.11	85.00 253.64	--	58.00 173.07	--	69.00 205.90
Brake	hp	kW	5.21 3.89	5.37 4.00	4.98 3.71	11.93 8.90	--	1.18 0.88	--	2.16 1.61
Motor	hp	kW	7.50 5.59	15.00 11.19	15.00 11.19	15.00 11.19	2.50 1.86	2.00 1.49	2.50 1.86	3.00 2.24
RPM			1800	1800	1800	1800		1800		3600
Make			Armstrong	Armstrong	Armstrong	Armstrong	Fuji Electric	Armstrong	Fuji Electric	Armstrong
Model			Series 4300	Series 4300	Series 4300	Series 4380	VFC50	Series 4380	VFC50	Series 4380
Variable Frequency Drives	Yes / No		Yes	No	No	Yes	No	No	No	No
Remarks			Pool Standards Bronze pump	Pool Standards Bronze Pump	Pool Standards Bronze Pump	Pool Standards Bronze Pump	Air Blower	Pool Standards Bronze Pump	Air Blower	Pool Standards Bronze Pump
EQUIPMENT NO.			P-PL-WF-05	P-PL-WF-06	P-PL-WF-07	P-PL-WF-08	P-PL-WF-09	P-PL-WF-10	P-PL-WF-11	P-PI-WF-12
System			Water Feature Pumps	Water Feature Pumps	Water Feature Pumps	Water Feature Pumps	Water Feature Pumps	Water Feature Pumps	Water Feature Pumps	Water Feature Pumps
Location			Hydrotherapy Basement	Lazy river Basement	Sheet flo Basement	Hydrotherapy Basement	Hydrotherpay Basement	Slant jet Basement	Channel bubblers	Pop corn Basement
Service										
Fluid			Water	Water	Water	Water	Water	Water		Water
Fluid Flow	USgpm	L/min	760.00 1279.47	800 3,028	50 189	160 606	320 1,211	60 227	--	62 235
Head	ft H2O	kPa	83.00 102.95	55.00 164.12	65.00 193.96	85.00 253.64	85.00 253.64	69.00 205.90	--	68.00 202.91
Brake	hp	kW	20.20 3.73	15.52 11.57	1.83 1.36	5.14 3.83	9.61 7.17	2.16 1.61	--	2.20 1.64
Motor	hp	kW	25.00 --	20.00 14.91	5.00 3.73	7.50 5.59	15.00 11.19	3.00 2.24	2.50 1.86	3.00 2.24
RPM			1800	1800	1800	1800	1800	3600		3600
Make			Armstrong	Armstrong	Armstrong	Armstrong	Armstrong	Armstrong	Fuji Electric	Armstrong
Model			Series 4380	Series 4380	Series 4380	Series 4380	Series 4380	Series 4380	VFC50	Series 4380
Variable Frequency Drives	Yes / No		No	No	No	No	No	No	No	No
Remarks			Pool Standards Bronze pump	Pool Standards Bronze Pump	Pool Standards Bronze Pump	Pool Standards Bronze Pump	Pool Standards Bronze Pump	Pool Standards Bronze Pump	Air Blower	Pool Standards Bronze Pump

EQUIPMENT NO.			P-DOM-B-01/02	P-DHWR-01-01	P-PL-FL-B-01	P-PL-FL-B-02	P-DHWR-B-02			
System			Domestic water booster	Tempered Water Recirc	Fuel Oil	Fuel Oil	Domestic Hot Tank Circ.			
Location			Basement	Level 1	Basement	Basement	Basement			
Service				Standing Shower	Fuel Oil	Fuel Oil	Domestic Hot Water			
Fluid			Domestic water	Domestic Water	No. 2 Fuel Oil	No. 2 Fuel Oil	Domestic Water			
Fluid Flow	USgpm	L/min	110 416	2 8	3 11	3 11	23 87		--	--
Head	ft H2O	kPa	164.00 489.38	15.00 44.76	173.25 516.98	173.25 516.98	35.00 104.44		--	--
Brake	hp	kW		--	--	--	--		--	--
Motor	hp	kW	5.00 3.73	0.08 0.06	0.50 0.37	0.50 0.37	0.50 0.37		--	--
RPM			3600	2650	1750	1750	3600			
Make			Armstrong	Bell & Gossett	Albany-FODUP series	Albany-FODUP series	Bell & Gossett			
Model			N280302-5 hp	PL-30	03GC61312	03GC61312	XL 55-45			
Variable Frequency Drives	Yes / No		Yes	No	No	No	No			
Remarks			Two pumps Drawdown tank-600L							
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									
Remarks										

EQUIPMENT NO.			SL-AHU-01-01		SL-AHU-01-02		SL-AHU-01-03		SL-AHU-02-01		SL-AHU-02-02					
Fan Served			AHU-01		AHU-01		AHU-01		AHU-02		AHU-02					
			Exhaust		Return		Supply		Exhaust		Supply					
Airflow Rate	cfm	L/s	6,200	2,926	26,803	12,651	31,505	14,870	1,947	919	3,745	1,768		--		--
Type																
Diameter	In	mm		--		--		--		--		--		--		--
Width	In	mm	32	813	60	1,524	56	1,422	32	813	38	965		--		--
Height	In	mm	24	610	46	1,168	56	1,422	24	610	16	406		--		--
Length	In	mm	48	1,219	84	2,134	84	2,134	36	914	36	914		--		--
INSERT LOSS																
2nd Band			9		10		11		10		12					
3rd Band			11		11		16		16		16					
4th Band			14		20		20		17		15					
Class																
Air Pressure Drop	In H2O	Pa	0.18	45	0.28	70	0.17	42	0.03	7	0.23	57		--		--
Remarks			Film Lined		Film Lined		Film Lined									
Make			Vibro Acoustics		Vibro Acoustics		Vibro Acoustics		Vibro Acoustics		Vibro Acoustics					
Model			RFL-HV-A21455		REFL-UHV-A21455		REFL-UHV-A21455		RD-MLV-A21455		RD-MLV-A21455					
EQUIPMENT NO.																
Fan Served																
Airflow Rate	cfm	L/s		--		--		--		--		--		--		--
Type																
Diameter	In	mm		--		--		--		--		--		--		--
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.			IU-01-01/02		IU-01-03		IU-01-04		IU-01-06		IU-01-08			
							IU-01-05		IU-01-07					
Make			Daikin		Daikin		Daikin		Daikin		Daikin			
Model			FXMQ30PBVJU		FXMQ15PBVJU		FXMQ07PBVJU		FXMQ24PBVJU		FXSQ05TAVJU			
Type			Ducted Concealed		Ducted Concealed		Ducted Concealed		Ducted Concealed		Ducted Concealed			
Location			--		--									
Supply Air Flow Rate (Max)	cfm	L/s	1,094	516	560	264	317	150	688	325	281	133		
External Static Pressure	In H2O	Pa	0.4	99	0.4	99	0.2	50	0.4	99	0.2	50		
Total Static Pressure	In H2O	Pa		--		--		--		--		--		
Motor	hp	kW		--		--		--		--		--		
COOLING														
Total Capacity	MBH	kW	30.0	9	15.0	4	7.5	2	24.0	7	5800.0	1,699		
Sensible Capacity	MBH	kW	23.8	7	12.0	4	6.4	2	18.8	6	4700.0	1,377		
Entering Air Temperature (db)	°F	°C	80.0	26.7	80.0	26.7	80.0	26.7	80.0	26.7	80.0	26.7		
Entering Air Temperature (wb)	°F	°C	67.0	19.4	67.0	19.4	67.0	19.4	67.0	19.4	67.0	19.4		
Leaving Air Temperature (db)	°F	°C		--		--		--		--		--		
Leaving Air Temperature (wb)	°F	°C		--		--		--		--		--		
HEATING														
Total Capacity	MBH	kW	34.0	10	17.0	5	8.5	2	27.0	8	6500.0	1,905		
Entering Air Temperature (db)	°F	°C	70.0	21.1	70.0	21.1	70.0	21.1	70.0	21.1	70.0	21.1		
ESP range		Pa												
Pre-filter														
Final filter														
REMARKS			230 V/1/0.6 MCA 15A MOP		230 V/1/0.6 MCA 15A MOP		230 V/1/0.6 MCA 15A MOP		230 V/1/0.5 MCA 15A MOP		230 V/1/0.5 MCA 15A MOP			
ASSOCIATED CONDENSER			CU-01-01											
Model			RWEYQ96TTJU											
Total Cooling Capacity	MBH	kW	90.0	26										
Total Heating Capacity	MBH	kW	100.0	29										
Ambient Air Temperature	°F	°C	95.0	35.0										
ELECTRICAL DATA														
Minimum Circuit Ampacity			38											
Volts/Phase/Cycle			230/3/60											
			45A Fuses											
REMARKS														



Smith + Andersen

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ELECTRICAL SPECIFICATION

PROJECT NAME:

EAST HANTS AQUATIC CENTER

COMMERCE COURT, ELMSDALE, NOVA SCOTIA

OUR PROJECT NUMBER:

17079.000

DATE:

MARCH 1, 2018

ISSUED / REVISION:

FOR TENDER

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END OF SECTION 26 00 00.00

Operating and Maintenance Instructions

PART 1 - GENERAL**1.1 work Included**

- .1 Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 03.00 – RECORD DRAWINGS.
- .3 Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- .4 Section 26 08 00.00 – COMMISSIONING.
- .5 Section 26 08 01.00 – TECHNICAL SERVICES DIVISION START-UP SERVICE.

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 CD or DVD or USB stick. As-Built Drawings to be included on the CD or DVD or USB stick.
- .2 The contractor to identify the cost of Record 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 03.00 – Record 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 "(Project Name)".
- .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 an 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.

Operating and Maintenance Instructions

- .3 Originals of test forms.
- .4 Originals of test certificates.

3.3 Operating Instructions

- .1 Instruct the Owner'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 00.00 – COMMISSIONING, for duration of tests.
- .3 Instruct the Owner for a minimum of five (5) working days.
- .4 All instruction sessions to be video-taped and copy must be provided to the Consultant/Owner.
- .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 Consultant/Owner.
- .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, Consultant, etc.), system or equipment involved and signature of the Owner'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.
- .7 Review information with the Owner's 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 generator.
 - .3 Automatic transfer switches.
 - .4 Fire alarm systems.

3.4 Trial Usage

- .1 The Owner 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 Owner 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 workmanship 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, which applies to and forms part of all sections of the work. In case of discrepancy between this section and division 1, division 1 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 Contractor.

1.3 Sections Affected

- .1 These instructions apply to and form a part of all electrical sections.

1.4 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 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 Consultant 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 drawings take precedence.
 - .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.

1.5 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 Drawings and specifications should not conflict with the above regulations but where there are apparent discrepancies the contractor shall notify the Consultant.

1.6 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.

General Instructions for Electrical Sections

- .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.

1.7 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.

1.8 Coordination With Mechanical Divisions.

- .1 Unless indicated otherwise on the Electrical Drawings, Electrical Contractor 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.
 - .5 Provisions of disconnects to all mechanical equipment.
 - .6 All power wiring (120V & above) to all mechanical equipment.
 - .7 Electrical ramp heating cables and controls.
 - .8 All motorized damper power connections (120V & above).
 - .9 Fire alarm devices.
 - .10 Wiring to electric space 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 electrical heaters including baseboard heaters, cabinet heaters, force flow heaters and radiant heaters.
 - .5 All interposing relays, relays, contactors and 120V control devices.
 - .6 All 120V and low voltage control wiring and conduits.

General Instructions for Electrical Sections

- .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 unistrut 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 contractor 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 contractor change any of the motor or equipment sizes from those identified on the mechanical schedules and drawings at any stage of the project to aide their installation, the mechanical contractor will incur all extra electrical costs to revise the electrical feeders, breakers, starters and equipment to supply power to the revised piece of equipment.

1.9 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 Surface mounted electrical equipment boxes are to be installed on galvanized unistrut stand-offs. Electrical equipment boxes shall include, but not be limited to electrical panels, LV lighting control, fire alarm, security, communication, electrical sub-metering, etc. Panels are to be grouped on common base wherever practical.
- .3 Provide steel re-enforced concrete housekeeping pads under all floor mounted electrical equipment and where noted on the drawings. All housekeeping pads to be a minimum of 100mm high above finished floor and shall not extend beyond 50mm beyond the electrical equipment unless shown otherwise on the drawings.

1.10 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.

1.11 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.

General Instructions for Electrical Sections

- .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.

1.12 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 General Contractor.
- .2 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.
- .3 Service penetration assemblies: certified by ULC in accordance with CAN/ULC-S115 (latest edition) and listed in ULC Guide No. 40 U19.
- .4 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.
- .5 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.
- .6 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.
- .7 Fire stops and smoke seals at openings around penetrations for conduits, cable trays, pipes, ductwork and other electrical and mechanical items requiring sound and vibration control: elastomeric seal; do not use a cementitious or rigid seal at such locations.
- .8 Primers: to manufacturer's recommendation for specific material, substrate, and end use.
- .9 Water (if applicable): potable, clean and free from injurious amounts of deleterious substances.
- .10 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.
- .11 Sealants for vertical joints: non-sagging.

General Instructions for Electrical Sections

- .12 Colour: if range available to Consultant's choice of standard colours, generally to match background colour where visible in finished spaces.
- .13 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.
- .14 Where holes are core drilled in existing structures, sleeves shall be provided as specified complete with fire stopping as noted above.
- .15 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.
- .16 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.

1.13 Hoisting

- .1 Electrical Contractor will be responsible for the hoisting of all the equipment in the contract. Contractor to coordinate with General Contractor for use of the general hoisting facilities. If hoist facilities are inadequate then subcontractors must provide their own. Subcontractors must inform general 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 Contractor to include for the qualified millwrights to move and place all equipment over 1000lbs. Contractor to provide proof of millwright certification.

1.14 Cleaning And Waste Removal

- .1 Cleaning and waste removal shall adhere to the requirements of division 1.

1.15 Sprinklers

- .1 All electrical equipment shall be suitable for installation in a sprinklered environment and enclosures are to be CSA Type-2 sprinkler proof.

1.16 Temporary Light And Power

- .1 Temporary power shall adhere to the requirements of division 1 with supplemental requirements below:

General Instructions for Electrical Sections

- .1 Temporary light and power for construction shall be provided, metered, and maintained by the electrical trade, as directed by the General Contractor; 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.

1.17 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 2m 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 Owner and/or Consultant, 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 Owner and/or Consultant.

1.18 Drawings 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. The installation shall be complete with all accessories required for a complete and operative installation.
- .2 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 Consultant to make reasonable changes required to accommodate conditions arising during the progress of the work, at no extra cost to the Owner.
- .3 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.
- .4 The actual location of switches, outlets and luminaries, etc. shall be reviewed by the Consultant before installation.
- .5 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.
- .6 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 Owner.

General Instructions for Electrical Sections

- .7 Leave areas clear where space is indicated as reserved for future equipment, and equipment for other trades.
- .8 Adequate space and provisions shall be left for removal of components and servicing of equipment, with minimum inconvenience to the operation of systems.
- .9 Where equipment is shown to be 'roughed-in only' obtain accurate information from the Consultant before proceeding with the work.
- .10 Contractor is to review Architect's specifications, drawings and details to confirm locations of devices and equipment.
- .11 This Contractor is responsible to mark-out his work, fully co-ordinated with all other trades, in sufficient time for review by Architectural Consultant prior to rough-in. Prepare dimensioned layouts of each room prior to rough-in for review by Architectural Consultant. Do not proceed with any work until the Architectural Consultant has reviewed the layout drawings.
- .12 The Contractor will reimburse the Consultant 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.

1.19 Installation, Interference And Setting Drawings

- .1 Refer to section 01 33 00 for requirements.

1.20 Approved Manufacturers

- .1 Refer to section 01 25 00 – Product Substitution Procedures, for details on approved manufacturers and procedures for alternates or substitutions.
- .2 Refer to section 01 60 00 – Product Requirements, for the definition of "Basis of Design".

1.21 Products And Materials

- .1 Make and quality of materials used in the construction of this project shall be subject to the approval of the Consultant.
- .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.
- .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 contractor 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 30days of the award of contract, the Contractor is to submit a complete list of the manufacturers for all equipment being supplied on the project.

General Instructions for Electrical Sections

.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 Consultant 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 Owner 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 Owner to pay the cost differential in sentence .2 above.

1.22 Co-Operation With consultants

- .1 To assist in the successful execution of the project, the Contractor shall receive a job report that summarizes the expectations of the Consultant and the Contractor. This job report is intended to reiterate and elaborate on key items of the Contract Documents and is not intended to impose new requirements.

1.23 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 Owner.
- .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 Contractor 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 Contractor.

General Instructions for Electrical Sections

1.24 Temporary Use Of Equipment

- .1 Where the electrical systems are operated during construction, the Electrical Contractor shall maintain the system and equipment in proper operating condition.
- .2 Before any area of the building is turned over to the Owner 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 Owner and Consultant and is only to be used on a limited basis. All equipment must be cleaned prior to turnover.

1.25 Statement Of Prices

- .1 To form a basis for progress payments the successful bidder shall submit a sample progress draw for the various portions of the work. The format of the sample progress draw shall be as shown in the example progress draw below. The sample progress draw shall include a breakdown which illustrates all categories shown on the example progress draw 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 progress draw. The electrical Consultant reserves the right to request that additional categories be added to the progress draw if the Consultant feels that doing so will aid in assessing the contractor's progress on site, thereby expediting contractor payment. Progress draws not including the categories shown on the example progress draw where relevant to the project and / or not providing separate labour value and separate material value subcategories will be rejected.
- .2 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.
- .3 Contractor to list and track all fixed per unit cost luminaires as part of Light Fixtures - Materials on the progress draw.
- .4 Contractor to list and track each of the approved changes on separate lines on the progress draw.
- .5 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 PROGRESS DRAW

Electrical Contractor 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

General Instructions for Electrical Sections

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
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	

General Instructions for Electrical Sections

Total		----- xxx,xxx.xx	----- xxx,xxx.xx	----- xxx,xxx.xx
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† Inclusive of fixed per unit cost luminaires. Refer to luminaire schedule for luminaire fixed unit costs.

1.26 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.

1.27 Interruption Of Services

- .1 Any interruption of the electrical services to any part of the building shall come at a time agreeable to the Consultant. Make all necessary arrangements with those concerned and include for any overtime required to ensure that the interruption is held to a minimum.
- .2 Testing and operation of major equipment shall be approved by the Consultant to avoid excessive electrical utility charges. Such testing to be generally carried out after normal working hours or on weekends.
- .3 All such overtime work shall be carried out without additional cost to the Owners.
- .4 Modifications to existing electrical equipment, which will require shutdown, must be coordinated with the Owner and will only be permitted on weekdays from 10:00 pm to 6:00 am and on weekends from Friday at 7:00 pm to Sunday 6:00 pm. Exact weekends to be co-ordinated with the Owner. Consecutive weekends of shutdowns will not be allowed. Contractor to pay for all utility costs associated with shutdowns. Any work not associated with live equipment can be done during normal working hours. Work considered disruptive to the normal operation of the building will be done after normal business hours. Exact times to be co-ordinated with Owner.
- .5 Contractor to provide a minimum of 5 days written notice of a requirement for a shutdown. Contractor to include for separate meetings with the Owner and Consultant to discuss the shutdown in detail and to coordinate all the work being performed.
- .6 The Contractor is responsible for co-ordination and isolating of all existing services at all voltage levels required for the disconnections and connections to existing buildings. This includes shutting down and isolating existing low and medium voltage services. The owner will not perform any isolations for the contractor but will be present during the work. The contractor is to use qualified personnel for these shutdowns ensuring compliance with all applicable safety requirements.
- .7 The Contractor is responsible for any damages caused to existing systems when making connections.
- .8 The Contractor is to keep shutdowns of existing buildings to a minimum by scheduling the work and providing the required number of personnel to keep the shutdown to a minimum. This Contractor is to include for as many multiple teams of electricians as is feasible to keep the shutdown work to a minimum.

General Instructions for Electrical Sections

1.28 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 Consultant otherwise determines that the method shall be unit prices set out in the Contract.

- .2 Contractor shall provide the Consultant 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.

The detailed cost breakdown is to list material and labour separately for each item on the proposed change. The breakdown for contemplated change shall follow the requirements of Division 01.

- .3 The following shall not be included in the cost of the work but are covered by the allowance (mark-ups) for overhead and profit:

.1 The Contractor's 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 tools, etc., including 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.

.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. Consultant will provide a PDF electronic copy of change notice documentation.

.8 The cost of record, layout and working drawings and shop drawings.

.9 The cost of clean-up and disposal of waste material.

.10 Parking.

General Instructions for Electrical Sections

- .4 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 CCDC2-2008 GC 6.2.
- .5 In computing accounts for extras and credits for any Proposed Change, all credits shall be deducted from the total sum of the extras before mark-ups or charges for overhead and profit are added.
- .6 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 Owner immediately with any revised bonds or insurances.
- .7 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 Owner/Consultant.
- .8 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.
- .9 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 Contractors Association (NECA) labour units column 1(one). No additional factors will be accepted.
 - .2 The Owner and/or consultant reserve the right to renegotiate the labour rate. The hourly labour rate will be exclusive of overhead and profit. The labour rate will be inclusive of all labour burden charges including: payroll and administrative burdens, all government payroll burdens, variable labour factors and union or association funds. 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: all supervision, hand tools, warranties, storage, rentals, parking, clean-up, additional bonding, as-built drawings, material sorting/handling/hoisting, project financing, coffee break/rest periods, safety training including safety talks, WHMIS and the health and safety committee, non-productivity time and site office and consumables.
 - .3 At the request of the Owner or the consultant, the Contractor is to 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 Owner and the Consultant reserve the right to negotiate the hourly labour rate with the Contractor.

General Instructions for Electrical Sections

- .10 When pricing additional work for Proposed Changes, the Electrical Contractor 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 Contractor shall utilize these items in the valuation of the Change at no extra cost.

PART 2 - PRODUCTS

2.1 Not Used

PART 3 - EXECUTION

3.1 Not Used

END OF SECTION

Record Drawings

PART 1 - GENERAL

1.1 Work Included

- .1 Refer to Section 01 77 00 – CONTRACT CLOSEOUT PROCEDURES AND SUBMITTALS.

PART 2 - PRODUCTS

2.1 Not Used.

PART 3 - EXECUTION

3.1 Submission

- .1 Submit as-built documents in accordance with Section 01 77 00.

END OF SECTION

Record Drawings

PROJECT NAME: Xxx

ATTENTION: Xxx

PROJECT NO.: Xxx

DATE: YYYY-MM-DD

ISSUED BY: Xxx

Conditions for Limited Use of CAD Drawings

Authorization for limited use of the Computer-Aided Drafting (CAD) drawing files listed below is hereby granted, subject to the following conditions. Signing of this form constitutes acceptance and agreement with the conditions and limitations.

Copyright is reserved. The drawing and design contained in the CAD drawing file is at all times the exclusive property of the Architect/Engineer and shall not be used without the Architect/Engineer's written consent.

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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 AutoCAD 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.)

CD ROM or DVD or USB stick (please provide delivery address)

E-mail (please provide e-mail address)

A cheque in the above amount shall be payable to **Smith + Andersen**.

Please sign and fax back this form to Smith + Andersen (416-487-9104) acknowledging the above charges and Conditions for Limited Use of CAD Drawings.

Accepted by:

Signature

Name (print or type)

Company Name

P.O. #

Company Address

Phone #

c.c. Accounting - V.Mugabi; (Project Principal) – Smith + Andersen

Submittals/Shop Drawings

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.2 related work

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

PART 2 - PRODUCTS

2.1 Shop Drawings

- .1 Shop Drawings shall be organized by 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 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.
- .4 When requested, Shop Drawings shall be supplemented by data explaining the theory of operation – for example: lighting control sequence of operation – the Consultant may also request that this information be added to the maintenance and operating manual.
- .5 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 Consultant.

PART 3 - EXECUTION

3.1 Submission

- .1 As part of the Electrical Consultant 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 Consultant for time expended in these extra reviews.

END OF SECTION

Mounting Heights

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

PART 2 - PRODUCTS

2.1 Mounting Heights

- .1 Mounting heights and locations of all electrical wiring devices shall follow architectural elevations and details as precedent. Only if the elevation and location is not indicated on the architectural plans shall the proceeding mounting heights be used.
- .2 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
- .3 If mounting height of equipment is not specified or indicated, verify with the Consultant before proceeding with installation.
- .4 Unless indicated otherwise on the drawings or within the specifications, install electrical equipment at following heights.
 - .1 Local switches: 1050 mm.
 - .2 Wall receptacles:
 - .1 General: 450 mm.
 - .2 Above top of continuous baseboard heater: 200 mm.
 - .3 Above top of counters or counter splash backs: 175 mm.
 - .4 In mechanical rooms: 1200 mm.
 - .5 In equipment storage rooms: 900mm.
 - .3 Panelboards: 2000 mm to top of panel.
 - .4 Telephone and interphone outlets: 450 mm.
 - .5 Wall mounted telephone and interphone outlets: 1050 mm.
 - .6 Fire alarm stations: 1200 mm.
 - .7 Wall Mounted Fire alarm audible devices: 2300 mm.
 - .8 Television outlets not mounted behind a wall mounted television: 450 mm.
 - .9 Wall mounted speakers: 2100 mm.
 - .10 Clocks: 2100 mm.
 - .11 Handicap pushbuttons: 1050 mm.
 - .12 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.

Mounting Heights

- .13 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.
- .14 Wall mounted occupancy sensors: 1050 mm.
- .15 Wall mounted visible signal devices: entire lens shall be no less than 2000 mm and no more than 2400 mm.
- .16 Top of remote annunciator and passive graphic panels shall be no more than 1800mm above finished floor.
- .17 Wall mounted emergency telephone (Fireman's Handset): 1350 to 1500mm.

PART 3 - EXECUTION

3.1 Not Used

END OF SECTION

Wires and Cables 1000V

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04.00 – 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, Standard Method of Fire Test for Evaluation of Integrity of Electrical Power, Data, and Optical Fibre Cables, latest edition.
- .11 UL 2196, Standard for Tests for Fire Resistive Cables, latest edition.
- .12 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 04.00 – SUBMITTALS/SHOP DRAWINGS.

PART 2 - PRODUCTS

2.1 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.
- .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 or heat and moisture-resistant thermoplastic polyvinyl chloride (PVC) insulation with an outer nylon jacket rated T90 to CSA-C22.2 No.75 rated as follows:

Wires and Cables 1000V

- .1 Insulation rated at 1000V for 600V systems that are ungrounded or have a neutral grounding resistor to limit ground fault current
- .2 Insulation rated at 600V for the other 600V and 347/600V distribution systems not covered under item #1 above.
- .3 Insulation rated at 600V for all systems rated at 480V 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 RWU-90 wiring is to be used for underground installations.

2.2 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. Provide FT-6 jacket when TECK cables are run in return air plenum.

2.3 Variable Frequency Drive Cables

- .1 Variable frequency drives are also known as variable speed drives.
- .2 Cables to CSA-C22.2 No. 123 and CSA-C22.2 No. 174.
- .3 Conductors:
 - .1 Three (3) bare bonding conductor coppers sized to Table #16 of the Electrical Code.
 - .2 Circuit conductors: copper, size as indicated.
- .4 Insulation:
 - .1 Chemically cross-linked thermosetting polyethylene type RW90, rated 1000 V.
- .5 Inner jacket: polyvinyl chloride material.
- .6 Armour: interlocking aluminum.
- .7 Overall covering: thermoplastic polyvinyl chloride (PVC) material rated at a minimum of FT-4.

Wires and Cables 1000V

2.4 MINERAL-INSULATED CABLES

- .1 Where two (2) hour fire rating is indicated on the drawings, provide Mineral-Insulated cables.
- .2 Conductors: solid bare soft-annealed copper, size as indicated.
- .3 Insulation: compressed powdered magnesium oxide to form compact homogeneous mass throughout entire length of cable.
- .4 Overall covering: annealed seamless copper sheath, Type M1 rated 600 V, 250 C.
- .5 Outer jacket: PVC applied over sheath.
- .6 Two (2) hour fire rating.
- .7 Conform to requirements of CSA-C22.2 No. 124; and ULC S 139.
- .8 All mineral-insulated cable larger than #6 AWG shall be single conductor. For conductors #6AWG and smaller, multi-conductor mineral-insulated cable is acceptable.

2.5 fire rated MC 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: Black low smoke, zero halogen polyolefin, FT4 rated
- .5 Two hour fire rating.
- .6 Conform to requirements of CSA-C22.2 No. 123; UL 2196 and ULC S 139 with hose stream.

2.6 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.

2.7 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.

Wires and Cables 1000V

2.8 DIESEL LOCOMOTIVE CABLES (DLO)

- .1 Cable: to CSA-C22.2 No. 96 Portable Power Cables, rated to 2000V.
- .2 Conductor: stranded tinned annealed copper, size and number as indicated
- .3 Separator: Paper or polyester tape separates the conductor from the rubber insulation to aid in stripping.
- .4 Insulation: premium grade Ethylene Propylene Rubber (EPR), rated 90 deg. C.
- .5 Jacket: Black, heavy duty chlorinated polyethylene (CPE), sunlight resistant, rated at a minimum of FT-4.

2.9 Wiring Termination

- .1 Lugs, terminals, screws used for termination of wiring to be suitable for either copper or aluminum conductors.
- .2 Lugs, terminals, 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 conduit and cable runs. Size bonding conductor to applicable tables of the Canadian Electrical Code. Provide separate bonding conductors for each ground fault circuit interrupter circuits. All bonding conductors to be copper and insulated with a green coloured insulation.
- .2 All equipment, junction boxes, pull boxes, liquid tight flex, etc. to be bonded to ground through bonding conductors.
- .3 Provide separate neutral conductor for each 120 volt circuit for all circuits feeding receptacles and power outlets.
- .4 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.
- .5 All cable terminations to be compression type fittings for wire sizes greater than #8 AWG. All compression type fittings to be two-hole long barrel type with inspection / viewing window. Where mechanical screw type lugs are allowed by the Consultant, they will be suitable for quantity of parallel runs of wire that are to be terminated under.
- .6 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 3m. Contractor to receive written approval from the Consultant to run armoured cable further than 3m 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.
- .7 Branch circuit wiring to be upsized as follows to address voltage drop when:

Wires and Cables 1000V

- .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.
- .8 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 rated at the respective voltage.

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 TECK90 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 instructions.
- .3 Fastenings:
 - .1 One hole steel straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.
 - .2 Channel type supports for two or more cables.
 - .3 Galvanized threaded rods: 6 mm dia. minimum to support suspended channels.
- .4 Connectors:
 - .1 Watertight, approved for respective cables.
- .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.

3.4 INSTALLATION OF MINERAL-INSULATED and fire rated mc CABLES

- .1 Handling:
 - .1 Cable shall be uncoiled by rolling or rotating supply reel. Do not pull from coil periphery or centre.
- .2 Bending:
 - .1 Not less than six (6) times the cable diameter for cable not more than 250 kcmil.

Wires and Cables 1000V

- .2 Not less than twelve (12) times the cable diameter for cable diameter for cable more than 350 and 500 kcmil.
- .3 Splicing:
 - .1 All fire rated splices shall be made in the factory. In the event of a field splice is necessary, it must be made in the field by manufacturer's field technician.
- .4 Terminations:
 - .1 Field made terminations shall be made with cable manufacturer's termination kits only. Stripping tools, crimping and compression tools available from the manufacturer shall be used for proper cable termination.
 - .2 Connections to ferrous cabinets for single conductor cables shall incorporate brass plates. Installed 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, cables shall be run in groups having one of each phase in each group.
 - .2 Each set of paralleled conductors shall be separated by at least two single cable diameters.
- .6 Exposed or Surface Installations:
 - .1 Cable shall be secured directly to fire rated building structure using:
 - .1 Straps: 13 mm wide x 38 mm long by 0.75 mm thick stainless steel or copper straps. Each strap shall contain two 5 mm holes for securing with 5 mm by minimum 44 mm long steel anchors.
 - .2 Support 2 hr fire rated cables at 1 m intervals.
- .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.
 - .4 When penetrating a fire rated wall or fire rated floor, the cable must extend a minimum of 305mm beyond the fire rated wall or fire rated floor. The 305mm dimension can be in any direction as 305mm 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 All Wires and Cables to be tested on site as defined in Section 26 08 01.00 – TECHNICAL SERVICES DIVISION START-UP SERVICE and herein. Contractor to oversee all testing and correct any deficiencies noted.

Wires and Cables 1000V

3.6 INSTALLATION OF CONTROL CABLES

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

END OF SECTION

Grounding and Bonding

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 00 05.00 – REGIONAL SUPPLEMENTAL REQUIREMENTS.
- .2 Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .3 Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.2 References

- .1 CSA C22.2 No. 41– Grounding and Bonding of Equipment, latest edition.
- .2 CSA C22.1 – Canadian Electrical Code, Part 1, latest edition.
- .3 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 04.00 – SUBMITTALS/SHOP DRAWINGS.
- .2 Submit shop drawings for ground bars and ground rod inspection wells for engineer's review prior to manufacture.
- .3 Submit main system ground test report as a shop drawing for engineer's review. Include final reviewed report in the project O&M manuals.

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.

2.3 Lugs

- .1 All grounding connections to be made with compression type fittings and lugs with inspection / viewing window.

Grounding and Bonding

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 transformer vault(s), main electrical room(s) and generator 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 #2/0 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 Supply and install inspection box for each ground rod. Inspection box is to be suitable for installation in heavy traffic areas and is to come complete with a lockable lid and security key.
- .6 Connect to the ground bus all metal equipment enclosures, as well as all other metal parts such as mechanical pipes, ducts, waste lines, door frames, railings, grilles, fences, etc. with minimum #2/0 AWG bare copper conductors.
- .7 For solidly grounded systems, transformer neutrals, 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.
- .9 Terminate the following conductors at the ground bus system:
 - Service neutral -as indicated on drawings
 - Telecommunications -as per EIA/TIA standard 607-A (latest edition)

Grounding and Bonding

ground

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 #2/0 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 engineer'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 injury.
 - .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.
 - .18 Interface with the lightning protection system, if one is installed for this building.

Grounding and Bonding

3.2 TESTING

- .1 The contractor 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 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.2 Shop Drawings And Product Data

- .1 Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – 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 workmanlike installation.

PART 2 - PRODUCTS

2.1 Materials

- .1 Provide “U” type support Strut as manufactured by Unistrut.

PART 3 - EXECUTION

3.1 Installation

- .1 The Contractor to supply anchor bolts and base diagrams of equipment showing exact location for anchor bolts.
- .2 It shall be the responsibility of the electrical division to supply the Contractor with anchor bolts and base diagrams of equipment showing exact location of anchor bolts.
- .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 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.
- .5 Depending on type of structure, hangers shall be either clamped to steel beams or joists, or attached to approved concrete inserts.
- .6 Approved type expansion shields and bolts may be used for conduit up to 100 mm diameter where the pre-setting of concrete inserts is not practical. Submit Shop Drawings.
- .7 Suspension from metal deck shall not be allowed unless specifically accepted by the Consultant. Drawings of the proposed method of suspension must be submitted for review.
- .8 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.

Hangers and Supports

- .9 Suspending one hanger from another shall not be permitted.
- .10 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

PART 1 - GENERAL**1.1 Work Included**

- .1 Section 26 00 05.00 – REGIONAL SUPPLEMENTAL REQUIREMENTS.
- .2 Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .3 Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- .4 Section 26 05 53.00 – IDENTIFICATION.
- .5 Section 26 05 63.00 – ACCESS DOORS AND ACCESSIBILITY.

1.2 Reference

- .1 CSA 22.1 - Canadian Electrical Code - Part 1, 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 04.00 – SUBMITTALS/SHOP DRAWINGS.

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.
- .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.
- .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.

Splitters, Junction, Pull boxes and Cabinets

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 degree 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 53.00 – 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 00 05.00 – REGIONAL SUPPLEMENTAL REQUIREMENTS.
- .2 Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.2 References

- .1 CSA C22.1-Canadian Electrical Code, Part 1, latest edition.
- .2 National Building Code of Canada, latest edition.
- .3 CAN/ULC-S115, Fire Tests of Fire Stop Systems, latest edition.

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 347V 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.

2.3 Masonry Boxes

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

Outlet Boxes, Conduit Boxes and Fittings

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 12.7 mm and 19 mm conduit. Minimum size: 73 mm deep.

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.
- .5 Non-combustible electrical outlet boxes that penetrate a fire separation or a membrane forming part of an assembly required to have a fire-resistance rating, do not require fire stops provided,

Outlet Boxes, Conduit Boxes and Fittings

- .1 they do not exceed:
 - .1 100 cm² each in area, AND
 - .2 an aggregate area of 650 cm² 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 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 31.00 – SPLITTERS, JUNCTION, PULL BOXES AND CABINETS
- .3 Section 26 05 32.00 – 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.

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 oc.
- .4 Hot dipped galvanized threaded rods, 6 mm dia. minimum, to support suspended channels.

Conduits, Conduit Fasteners and Fittings

2.3 Conduit Fittings

- .1 Fittings: manufactured for use with conduit specified. Coating: same as conduit.
- .2 Factory "ells" 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 32mm 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. No conduits in cast in-place concrete or in slab conduits will be allowed unless written consent is received from the Consultant and Owner. Only once approved by the Consultant and Owner do the clauses contained within this section and the respective sections relating to conduits in cast in-place concrete or in slab conduits apply.
- .2 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .3 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.
- .4 Where vertically run conduit passes through a slab, Contractor to provide a 100mm high concrete pad with the pad extending 100mm on all sides of the conduit.
- .5 Use electrical metallic tubing (EMT) conduit except where specified otherwise.
- .6 Use epoxy coated conduit in corrosive areas.
- .7 Use rigid galvanized steel threaded conduit where conduit is subject to mechanical injury.
- .8 Use rigid PVC conduit underground or in corrosive areas and where indicated.
- .9 Use flexible metal conduit for connection to motors or vibrating equipment in dry areas, connection to recessed incandescent fixtures without a prewired outlet box, connection to surface or recessed fluorescent fixtures and work in movable metal partitions.

Conduits, Conduit Fasteners and Fittings

- .10 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.
- .11 Use explosion proof flexible connection for connection to explosion proof motors.
- .12 Install conduit sealing fittings in hazardous areas. Fill with compound.
- .13 Minimum conduit size for lighting and power circuits: NPS 21mm, unless otherwise noted on the drawings.
- .14 Install EMT conduit from a raised floor branch circuit panel to outlet boxes located in sub floor.
- .15 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.
- .16 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .17 Mechanically bend steel conduit over 19 mm dia.
- .18 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .19 Install fish cord in empty conduits.
- .20 Run two 27mm spare conduits up to ceiling space and two 27mm 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.
- .21 Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.
- .22 Dry conduits out before installing wire.
- .23 All cutting and patching of masonry/concrete floors, walls, and roof for electrical services shall be by this Division. Obtain approval from the Landlord and/or structural Consultant's before cutting any structural walls or floors. Cutting and drilling shall only be at times allowed by the Landlord. 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 Landlord and/or Structural Consultant.
- .24 Provide sleeves for all new conduit passing through floor and roof slabs, beams, concrete walls and slab to slab partitions, etc.
- .25 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.
- .26 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 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

Conduits, Conduit Fasteners and Fittings

- .27 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. Notify the Consultant no less than 48 hours prior to the event, so that the Consultant may witness.

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 25 mm and larger below slab and encased in 75 mm concrete envelope. Provide 50 mm of sand over concrete envelope below floor slab.

3.6 Conduits Underground

- .1 Slope conduits to provide drainage.

Conduits, Conduit Fasteners and Fittings

- .2 For all non-PVC conduits run underground, provide waterproof joints with heavy coat of bituminous paint.

END OF SECTION

Installation of Cables in Trenches and In Ducts

PART 1 - GENERAL**1.1 Work Included**

- .1 Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 08 01.00 – TECHNICAL SERVICES DIVISION START-UP SERVICES.
- .3 Section 33 71 19.00 - 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.

3.3 Field Quality Control

- .1 Perform tests in accordance with Section 26 08 01.00 – TECHNICAL SERVICES DIVISION START-UP SERVICES.

END OF SECTION

Identification

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 00 05.00 – REGIONAL SUPPLEMENTAL REQUIREMENTS.
- .2 Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .3 Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.2 References

- .1 CSA C22.1 - Canadian Electrical Code, Part 1, latest edition.

1.3 Shop Drawings And Product Data

- .1 Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

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 Allow for an average of fifty (50) to one hundred (100) letters per nameplate.
 - .5 Identification to be in English.
 - .6 Black nameplates for normal power.
 - .7 Red nameplates for emergency power.
 - .8 Blue nameplates for UPS Power.

Sample:

SWITCHBOARD AA
3000A, 600/347V, 3 PH, 4W, 50kA
FED FROM SWITCHBOARD AAA
MANUFACTURED IN MM/YYYY; SERIAL NUMBER ##-####

Identification

- .9 Wording on nameplates to be approved by Consultant prior to manufacture.
- .10 Nameplates for splitters, terminal cabinets, grid boxes, pull boxes, and junction boxes are to indicate the system and/or voltage characteristics.
- .11 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
- .12 Transformers: indicate capacity, primary and secondary voltages, and upstream source where Transformer is fed from.
- .13 Mechanical equipment: indicate equipment name and full circuit number including panel board identification.
- .14 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.
- .15 Automatic Transfer Switches (ATS): 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 ATS is fed, upstream emergency power source from which ATS is fed, month and year manufactured, and serial number.
- .16 Generators:
 - .1 Indicate kW rating, kVA rating, voltage, number of phases, number of wires, generator neutral grounding arrangement, year and month manufactured, and engine and alternator serial number.
 - .2 Indicate Maximum Site Design Load (as defined in CSA C282) in units of kW; engineering firm responsible for Maximum Site Design Load calculation; drawing number, issuance title (e.g. Issued for Construction, Electrical Contactor As-Built, Issued for CCN-E01, etc.), and issuance date which Maximum Site Design Load is based on. It is very important for future renovations and load additions that it is clear when the Maximum Site Design Load is from and what drawing it is based on.
 - .3 Sample nameplate:

Generator G1

600 kW / 750 kVA

600/347V, 3 PH, 4W, Wye solidly grounded

Connected to ATS-PHXA

MANUFACTURED IN MM/YYYY; SERIAL NUMBER ##-####

Identification

Maximum Site Design Load 420 kW

.17 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 Switchgear, Switchboards, Distribution Panels, and Panelboards
- .5 Automatic Transfer Switches
- .6 Generators
- .7 UPS equipment
- .8 Lighting control systems

.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 the Electrical Code.
- .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 or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15 m intervals.
- .3 Colours: 25 mm wide prime colour and 20 mm wide auxiliary colour.

	Colour
up to 250 V Normal Power	Green
up to 600 V Normal Power	Blue
up to 250 V Emergency Power	Black
up to 600 V Emergency Power	Orange
High Voltage, greater than 750 V	Large independent label clearly identifying the voltage
Telephone/Data	White
Fire alarm	Red

Identification

Other security systems
Controls

Yellow
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 12mm 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.

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 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.2 Shop Drawings And Product Data

- .1 Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- .2 Submit drawings showing size, type and location of all access doors, for review, before installation.

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.
- .2 Wherever possible, items requiring access shall be located in easily accessible areas (i.e. exposed or T-bar ceilings).

Access Doors and Accessibility

- .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 Consultant.
- .6 The final installed locations of all access doors shall be shown on the As-Built Record Drawings.

END OF SECTION

Electrical Power System Studies

PART 1 - GENERAL**1.1 Work Included**

- .1 Section 26 00 05.00 – REGIONAL SUPPLEMENTAL REQUIREMENTS.
- .2 Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .3 Section 26 05 04.00 – 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 contractor. 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. The studies shall also be performed to include the operation of the emergency power generation system.
- .3 Contractor to label and re-label with the appropriate Client approved label all equipment that is new or the calculated values have changed from what is currently shown.

1.4 Shop Drawings And Product Data

- .1 Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- .2 Completed electrical power system studies shall be bound and submitted to the Engineer. The study must be stamped and signed by a professional engineer in the applicable jurisdiction of the project.
- .3 Contractor providing electrical power systems study to allow for revisions/adjustments based on review and actual transformer impedances.
- .4 Provide a minimum of three (3) bound coloured copies to Owner and Engineer for review. Modify studies based on comments received and continue to re-issue until a final version is agreed upon.
- .5 Provide a copy of the working electronic file on a CD/USB Flash Drive 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 owner and can be used by the Owner for future system modifications.
- .6 Provide samples of the proposed arc flash labels. All labels to match the Owners standard labels.

Electrical Power System Studies

- .7 Contractor shall submit power system study at the same time as shop drawings for electrical distribution equipment, such that the Engineer 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, contractor shall submit at a minimum a preliminary short circuit study for review.

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.
 - .8 The contractor 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 engineer (architect) and recommendations made for improvements as soon as they are identified.

Electrical Power System Studies

.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 engineer (architect) and recommendations made for improvements as soon as they are identified.

.3 Power Factor Correction Study

- .1 A Power Factor Correction Study shall be performed to determine the appropriate level of compensation needed to achieve the desired power factor.
- .2 Impacts on harmonic and transient concerns shall be evaluated in order to determine the optimum size and configuration of the equipment.
- .3 The study shall make appropriate recommendations in order to provide proper operation of the electrical system.
- .4 The study shall be based on [load data collected from on-site measurements] [load data collected from historical information provided by the power monitoring system] [from previous utility bills] in order to characterize the power factor of the system over a period of time and under varying load conditions.
- .5 System loading tables shall be provided which include power factor data and estimated levels of power factor compensation provided.
- .6 Evaluation of system operation using the estimated levels of compensation will be provided with consideration to harmonic and transient concerns.

Electrical Power System Studies

- .7 Final levels of compensation will be determined and used as the base case condition for the harmonic and transient studies.
- .8 All conclusions, recommendations, and equipment specifications as a result of the Power Factor Correction Study will be summarized in the final report.
- .4 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 All equipment rated at 208V fed from a transformer less than 125kVA are not required to be included in the study. Equipment not included in the study is to receive a common arc-flash label that does not include equipment specific data.
 - .3 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 recommendations to reduce the incident energy levels even further at the risk of affecting the coordination to allow Owner and Consultant to review options and provide feedback.
 - .4 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.
 - .5 All electrical equipment to be identified with the incident energy, flash protection boundary and level of PPE required.
 - .6 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 Owner and Consultant.

2.2 Approved Electrical Power Systems Contractors

- .1 The power system studies shall be completed by qualified and experienced personnel.
- .2 Reference Section 26 00 05.00 – REGIONAL SUPPLEMENTAL REQUIREMENTS for a list of acceptable contractors.

PART 3 - EXECUTION**3.1 General**

- .1 Contractor 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 Technical Start-Up Services Contractor. Coordinate with this Contractor to ensure information is relayed accordingly.

Electrical Power System Studies

- .3 Review work on site to ensure equipment has been set up as per the coordination study. Have the Technical Services Start-up Contractor test systems at random to ensure the coordination study has been adhered to.
- .4 Submit a report and a letter reporting to the Engineer and Owner that the coordination study information has been followed.
- .5 Contractor to revise fuse sizes as identified in the report and modify the drawings to represent as-built conditions.

3.2 Labelling

- .1 Install arc flash labels on all equipment. Coordinate with the electrical contractor.

3.3 Training

- .1 Provide one day of in-depth training on arc-flash safety detailing the industry and code requirements including the details of the specific project for the Owner and the Owner's representatives.

END OF SECTION

Sleeves

PART 1 - GENERAL

1.1 Work Included

- .1 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 the 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.

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 Consultant.
- .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 Through all fire or smoke separations, after testing, the annular space between conduit sleeves shall be fire stopped.

Sleeves

- .5 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 structural engineer 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.
- .6 All sleeves are to extend 150mm above finished floor to accommodate a 100mm concrete pad. Contractor to pour the concrete pad with the pad extending 100mm on all sides of the sleeve.

END OF SECTION

Lighting Control Equipment - Low Voltage

PART 1 - GENERAL**1.1 Work Included**

- .1 Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.2 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 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 including Lighting Control Panels, Occupancy Sensors, and Daylighting Controls (if applicable) from a single supplier. Contractor is responsible for confirming that the panels and sensors interoperate as a single system.
- .3 Low voltage control system is to be designed to provide remote switching of lighting loads by use of:
 - .1 Low voltage momentary contact switches.
 - .2 Low voltage relays.
 - .3 Control transformers.
 - .4 Low voltage rectifiers.
 - .5 Manual and automatic program control.

1.3 Shop Drawings And Product Data

- .1 Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- .2 Submit manufacturer's data on lighting control system and components including shop drawings, detailed wiring diagrams, and cut sheets as required under related specification sections.

PART 2 - PRODUCTS**2.1 Materials**

- .1 Control system: by one manufacturer and assembled from compatible components.

2.2 Lighting control panels

- .1 Provide lighting control panels in the locations and capacities as indicated on the plans and schedules. Each panel shall be of modular construction and consist of the following components:

Lighting Control Equipment - Low Voltage

- .1 Enclosure/Tub shall be NEMA 2 sprinkler proof, sized to accept an interior with 1 - 8 relays, 1 - 24 relays and 6 four-pole contactors, or 1 - 48 relays and 6 four-pole contactors.
- .2 Cover shall be configured for surface or flush wall mounting of the panel as indicated on the plans. The panel cover shall have a hinged and lockable door with restricted access to line voltage section of the panel.
- .3 Interior assembly shall be supplied as a factory assembled component specifically designed and listed for field installation. The interior construction shall provide total isolation of high voltage (Class 1) wiring from low voltage (Class 2) wiring within the assembled panel. The interior assembly shall include intelligence boards, power supply, DIN rails for mounting optional Class 2 control devices, and individually replaceable latching type relays. The panel interiors shall include the following features:
 - .1 Removable, plug-in terminal blocks with screwless connections for all low voltage terminations.
 - .2 Individual terminal block, override pushbutton, and LED status light for each relay.
 - .3 Direct wired switch inputs associated with each relay and group channel shall support two- or three-wire, momentary or maintained contact switches or 24VDC input from occupancy sensors.
 - .4 Automatic support for occupancy sensor sequence of operation. Direct wired low voltage inputs automatically reconfigure when connected to an occupancy sensor head. Occupancy sensor shall switch lighting on and off during unoccupied periods but shall not turn lighting off during scheduled occupancy periods.
 - .5 Digital inputs (four RJ-45 jacks) shall support 1-, 2-, 3-, 4-, and 8-button digital switches and digital occupancy sensors.
 - .6 Isolated contacts within each relay shall provide true relay state to the electronics. True relay state shall be indicated by the on-board LED and shall be available to external control devices and systems.
 - .7 Automatically sequenced operation of relays to reduce impact on the electrical distribution system when large loads are controlled simultaneously.
 - .8 Group, channel, and pattern control of relays shall be provided through a simple keypad interface within the panel. Any group of relays can be associated with a channel for direct on/off control or pattern (scene) control via a simple programming sequence using the relay and channel override pushbuttons and LED displays.
 - .9 Relay group status for each channel shall be provided through bi-color operation of the LED indicators. Solid red indicates that all relays in the group are on, solid green indicates that the group is in a mixed state, and blinking green indicates that the relays have blink warned and are currently timing out.

Lighting Control Equipment - Low Voltage

- .10 Each relay and channel terminal block shall provide a 24V pilot light signal. It shall be possible to configure the system for support for any Class 2 pilot light voltage with the use of an auxiliary power supply.
- .11 Single-pole latching relays with modular plug-in design.

2.3 Low Voltage Relays

- .1 Electrically operated by momentary impulse, mechanically latched until de-activated.
- .2 Operating voltage: 24 V, ac.
- .3 Auxiliary contacts for pilot light.
- .4 Coloured pre-stripped leads.
- .5 Relays shall provide the following ratings and features:
 - .1 20 amp ballast at 347V
 - .2 20 amp tungsten at 120V
 - .3 20 amp resistive at 347V
 - .4 1.5 HP motor at 120V
 - .5 Minimum 14,000 amp short circuit current rating (SCCR) at 347V
 - .6 Individually replaceable, 13 mm KO mounting with removable Class 2 wire harness.
 - .7 Actuator on relay housing provides manual override and visual status indication, accessible from Class 2 section of panel.
 - .8 Dual line and load terminals each support two #12 - #10 solid or stranded conductors.
 - .9 Tested to 300,000 mechanical on/off cycles.
 - .10 Isolated low voltage contacts provide for true relay status feedback and pilot light indication.

2.4 Microprocessor Controller

- .1 The lighting control panel shall support digital communications to facilitate the extension of control to include interoperation with building automation systems and other intelligent field devices. Digital communications shall be RS485 master/slave token passing-based using the BACnet protocol or equivalent.
- .2 The panel shall have provision for an individual BACnet device ID. The device ID description property shall be writable via the network to allow unique identification of the lighting control panel on the network.
- .3 The panel shall support MS/TP MAC addresses in the range of 0 - 127 and baud rates of 9600k, 38400k and 76800k bits per second.
- .4 Lighting control relays shall be controllable as binary output objects in the instance range of 1 - 48. The state of each relay shall be readable and writable by the BAS via the object present value property.

Lighting Control Equipment - Low Voltage

- .5 Lighting control relays shall report their true on/off state as binary input objects in the instance range of 1 - 48.
- .6 The eight channel groups associated with the panel shall be represented by binary value objects in the instance range of 1 - 8. The occupancy state of each channel group shall be readable and writable by the BAS via the object present value property. Commanding 1 to a channel group will put all relays associated with the channel into the occupied mode. Commanding 0 or NULL shall put the relays into the unoccupied mode.
- .7 Setup and commissioning of the panel shall not require manufacturer-specific software or configuration tools of any kind. All configuration of the lighting control panel shall be performed using standard BACnet objects or via the on-board LCD display and user keypad. Provide BACnet objects for panel setup and control as follows:
 - .1 Binary output objects in the instance range of 1 - 48 (one per relay) for on/off control of relays.
 - .2 Binary value objects in the instance range of 1 - 8 (one per channel) for normal hours/after-hours schedule control.
 - .3 Binary input objects in the instance range of 1 - 48 (one per relay) for reading true on/off state of the relays.
 - .4 Analog value objects in the instance range of 1 - 48 (one per relay) shall assign relays to channel groups in the range of 1 - 8.
 - .5 Binary value objects in the instance range of 101 - 108 (one per channel group) shall assign the channel to follow auto-on or manual-on mode when transitioning to occupied.
 - .6 Analog value objects in the instance range of 101 - 108 (one per channel group) shall assign a blink warn time value to each channel. A value of 5 shall activate the blink warn feature for the channel and set a 5-minute grace time period. A value of 250 shall activate the sweep feature for the channel and enable the use of sweep type automatic wall switches.
 - .7 Analog value objects in the instance range of 211 - 208 (one per channel) shall assign an after-hours time delay value to the channel in the range of 1 - 240 minutes.
 - .8 Multi-state value objects in the instance range of 1 - 8 (one per channel) shall provide the state of the relays assigned to the channel. Valid states shall be ALL ON, MIXED, BLINK, and ALL OFF.
- .8 The description property for all objects shall be writable via the network and shall be saved in non-volatile memory within the panel.
- .9 The BO and BV objects shall support BACnet priority array with a relinquish default of off and after hours respectively.
- .10 The lighting control panel shall support schedule, group, and photocell control functions via the network as configured in the Manufacturer's Lighting Control Software or building automation system. The lighting control panel shall be fully compatible with building automation systems that are BACnet compliant.

Lighting Control Equipment - Low Voltage

2.5 user interface

- .1 Each lighting control panel shall be supplied with an integral user interface consisting of a keypad and associated OLED display screen. The user interface shall allow setup, configuration, and diagnostics of the panel without the need for software or connection of a computer. The user interface shall have the following functions as a minimum:
 - .1 Set network parameters including panel device ID, MS/TP MAC address, baud rate and max master range.
 - .2 Enter meaningful names for the panel, relays, and channels.
 - .3 View normal hours/after-hours status of each channel.
 - .4 Override the normal hours/after-hours mode for each channel.
 - .5 View the 16 priority array slots for each channel and relay.
 - .6 Program the schedule response for each channel as:
 - .1 Automatic-on or manual-on.
 - .2 Enable/disable blink warn.
 - .3 Enter override time delay as 0 (none) to 240 minutes.

2.6 Control Transformer

- .1 Power supply to lighting control panels shall be a multi-voltage transformer assembly with rated power to supply all electronics, occupancy sensors, switches, pilot lights, and photocells as necessary to meet the project requirements. Power supply to have internal over-current protection with automatic reset and metal oxide varistor protection.

2.7 Occupancy sensors

- .1 Provide digital occupancy sensors to control relays in locations as shown on the plans. Sensors shall be either passive infrared, ultrasonic, or dual technology as indicated. Sensors shall be either ceiling or wall mounded and connect to the panel using Cat 6 cable with RJ-45 terminations or manufacturer specific wiring. Digital occupancy sensors shall have the following features:
 - .1 Setup and calibration shall be digital and precisely repeatable from sensor to sensor.
 - .2 User interface with pushbuttons and illuminated LCD screen for setup and calibration.
 - .3 Ladder-free setup and calibration
 - .4 Sensitivity, 0 - 100% in 10% increments.
 - .5 Time delay, 1 - 30 minutes in 1 minute increments.
 - .6 Test mode with five-second time delay for simplified walk testing.

2.8 Rectifier

- .1 Silicon type: 24 V, ac, 60 Hz input, 7.5 A continuous duty, 20 A intermittent duty output.

Lighting Control Equipment - Low Voltage

2.9 Manual Control switches

- .1 Provide digital wall switches with 1, 2, 3, 4, or 8 buttons, in the colors indicated on the plans. Switches shall connect to the panel via standard Cat 6 cable with RJ-45 terminations or manufacturer specific wiring. Digital wall switches shall have the following features:
 - .1 Available colors: white, ivory, light almond, grey or black.
 - .2 Single gang device shall fit standard decorator opening and use standard wall plates.
 - .3 LED indicator on each button for status and locator function.
 - .4 Concealed configuration button with LED indicator for binding buttons to relays, no software or computer shall be required.
 - .5 Selectable function mode per button shall be momentary toggle (on/off), on only, or off only.
 - .6 Removable button assembly for field color change or substitution of engraved buttons.
 - .7 Two RJ-45 ports or manufacturer specific ports for connection to panel or other switches and/or occupancy sensors.
 - .8 Open topology digital network via Cat 6 wire or manufacturer specific wiring.

2.10 lighting programming and control interface

- .1 The lighting control system manager shall be a compact controller capable of hosting the schedule, photocell, and group relay control functions for a network of up to 96 lighting control panels. The lighting control system manager shall provide the following features:
 - .1 Provision for 1 to 3 separate network segments to facilitate efficient network wire routing.
 - .2 Web browser-based user interface.
 - .3 User interface accessible from most smart phone browsers when Internet connected.
 - .4 Login security access control restricting some users to view-only or other limited operations.
 - .5 Automatic discovery of the lighting control panels.
 - .6 Familiar navigation-tree-based browsing to individual lighting control panels.
 - .7 View/override current status of channels and relays.
 - .8 Assign relays to channels.
 - .9 Set channel operating parameters:
 - .1 Automatic-on or manual-on operation.
 - .2 Enable/disable blink warn.
 - .3 Override duration time, 0 (none) to 240 minutes.

Lighting Control Equipment - Low Voltage

- .10 Create and run schedules:
 - .1 Normal hours/after-hours schedules for channels.
 - .2 On/off schedules for relays.
 - .3 Support for a minimum of 100 unique schedules, each with up to four time events per day.
 - .4 Support annual schedules, holiday schedules and unique date-bound schedules.
- .11 Ethernet connectivity for user access via direct-wired connection, LAN/WAN, or Internet connection.
- .12 BACnet IP connectivity for connection to building automation systems.

2.11 Manufacturers

- .1 The following are acceptable manufacturers:
 - .1 Lutron – Quantum
 - .2 Cooper – Greengate
 - .3 Watt Stopper - Lighting Integrator
 - .4 Hubbell - LX Networked Lighting Controls

PART 3 - EXECUTION**3.1 Installation**

- .1 Locate and install equipment in accordance with manufacturer's recommendations and as indicated.

3.2 System Start Up and Commissioning

- .1 Manufacturer shall provide a factory authorized technician to confirm proper installation and operation of the lighting control panels, switches, and occupancy sensors.
- .2 The technician shall provide training on the lighting control features of the system and shall verify that the lighting control system is capable of communicating with the building automation system.
- .3 The system integrator or BAS vendor shall be responsible for all integration including the mapping of BACnet objects into the BAS logic, schedules and graphics.

3.3 Tests

- .1 Actuate control units in presence of Consultant to demonstrate lighting circuits are controlled as designated.
- .2 Demonstrate the operation of the system through the computer software and the BAS system.

Lighting Control Equipment - Low Voltage

3.4 Training

- .1 Provide four half days of training of the Owner and the Owner's maintenance staff on the operation and maintenance of the system.
- .2 Training to be recorded for use by Owner in the future.

END OF SECTION

Dry Type Transformers - 600V Primary

PART 1 - GENERAL**1.1 Work Included**

- .1 Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- .3 Section 26 05 53.00 – 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 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 04.00 – 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 substantial completion.

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 60Hz: 3.0% to 5.0% (up to 75 kVA), 4.0% to 6.0% (112.5kVA and above).
- .10 Provide minimum K-4, K-rated transformers unless otherwise indicated on the drawings.
- .11 Enclosure: Type 2 sprinkler proof, removable metal front panel.
- .12 Mounting: floor or wall, as indicated.
- .13 Transformer to meet CSA C802.2 efficiencies at 35% of rated load unless shown otherwise on drawings.
- .14 Finish: in accordance with Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2.2 Accessories

- .1 Provide analogue type winding temperature indicator with 2 sequence contacts for transformers of 225kVA 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 53.00 – IDENTIFICATION.
- .2 Label size: 6 mm letters.

2.4 Finish

- .1 Finish enclosure exterior in accordance with Section 26 05 01.00 – 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

Dry Type Transformers - 600V Primary

- .4 Eaton Cutler-Hammer
- .5 Atlas Transformers
- .6 Rex Power Magnetics

PART 3 - EXECUTION**3.1 Installation**

- .1 Mount dry type transformers as indicated. Transformers larger than 45kVA are to be floor mounted unless identified otherwise. Where a transformer larger than 45kVA 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

Switchboards

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- .3 Section 26 05 53.00 – IDENTIFICATION.
- .4 Section 26 08 01.00 – TECHNICAL SERVICES DIVISION START-UP SERVICE.
- .5 Section 26 28 21.00 – MOULDED CASE CIRCUIT BREAKERS.
- .6 Section 26 28 14.00 – FUSES LOW VOLTAGE.

1.2 Reference

- .1 CAN/CSA C22.2 No. 31 – Switchgear Assemblies, latest edition.
- .2 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 04.00 – 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.

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 Fuse or 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.

PART 2 - PRODUCTS

2.1 Switchboard

- .1 Ratings as identified on the drawings and/or schedules.
- .2 Switchboard breakers to have a minimum short circuit current rating of 22kA at 600V. Fused sections to have a minimum short circuit current rating of 100kA at 600V. Switchboard busing to be rated at a minimum of 65kA.
- .3 Enclosures to be dead-front, CSA Type 2 sprinklerproof 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 two hole long barrel compression lugs with inspection / viewing window for the main feeder terminations. Size as per the drawings.
- .9 Breakers and/or fuse sections shall be bolt-on.
- .10 Make provisions to extend the main bus to future cubicles on each end of the switchboard.

2.2 Circuit Breakers

- .1 Circuit breakers to be supplied as per Section 26 28 21.00 – MOULDED CASE CIRCUIT BREAKERS.
- .2 All breakers to be factory installed and tested.

2.3 Fusible Disconnects And Fuses

- .1 Fusible horsepower rated disconnect switch sized as indicated.
- .2 Provision for padlocking in on-off position by three padlocks.
- .3 Mechanically interlocked door to prevent opening when handle is in the ON position.
- .4 Fuse: size as indicated, class J, current limiting in fuse holders without adapters. Fuses to be supplied as per Section 26 28 14.00 – FUSES LOW VOLTAGE.
- .5 Quick-make, quick-break action.
- .6 ON-OFF switch position indication on switch enclosure cover.

2.4 Grounding

- .1 Copper ground bus extending full width of cubicles and located at bottom.

Switchboards

- .2 Provide two hole long barrel compression lugs with inspection / viewing window for the ground cable terminations. Size as per the drawings.

2.5 Infrared Windows

- .1 Provide infrared windows in the switchboard main incoming section, 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, UL/cUL listed, comply with IEEE Std. C37.20.2. Range, size, NEMA/IP and voltage rating suitable for the application.
- .5 Acceptable manufacturers;
 - .1 Hawk IR International Limited / Fluke,
 - .2 FLIR,
 - .3 Lumasense Technologies Inc.

2.6 Finishes

- .1 Apply finishes in accordance with Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Switchboard to be painted: baked grey enamel.

2.7 Equipment Identification

- .1 Provide equipment identification in accordance with Section 26 05 53.00 – IDENTIFICATION.
- .2 Label all branch feeders with names as indicated on drawings.

2.8 Factory Testing

- .1 Testing shall be witnessed by the Technical Service Start-Up Services Contractor.

Switchboards

- .2 Include in your bid for the complete cost of two people to attend the factory witness testing for the equipment. Cost to include but not limited to all travel, food and lodging costs.

2.9 Manufacturers

- .1 The switchboards shall be manufactured by:
 - .1 Schneider Electric.
 - .2 Eaton Cutler-Hammer.
 - .3 Siemens.

PART 3 - EXECUTION

3.1 Installation

- .1 Locate switchboard and secure in position. Install floor mounted switchboards on a 100 mm concrete housekeeping pad.
- .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.

3.2 Testing

- .1 Contractor to review and test that all wiring has been connected as per the manufacturer drawings.
- .2 Switchboard to be tested on site as defined in Section 26 08 01.00 – TECHNICAL SERVICES DIVISION START-UP SERVICE. 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 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- .3 Section 26 05 05.00 – MOUNTING HEIGHTS.
- .4 Section 26 05 53.00 – IDENTIFICATION.

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 04.00 – SUBMITTALS/SHOP DRAWINGS.
- .2 Drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.

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.
 - .1 120/208V panelboards – 10kA
 - .2 347/600V panelboards – 22kA
- .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.

Panelboards - Breaker Type

- .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.
- .12 Trim and door finish: baked grey enamel.
- .13 Enclosure to be CSA Type 2 sprinkler proof.
- .14 Surge Protection Device as required.
- .15 Series ratings may be acceptable. Panels to be labeled as such. Manufacturing to supply supporting data.

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 Owner.
- .6 Where breakers are identified to feed high intensity discharge (HID) lighting, provide breakers that are rated and designed for use with HID lighting.
- .7 Provide one breaker per designated breaker space. Multiple breakers contained in one housing or twin breakers are not acceptable.

2.3 Equipment Identification

- .1 Provide equipment identification in accordance with Section 26 05 53.00 – 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

Panelboards - Breaker Type

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 unistrut stand-offs or on fire rated plywood backboards. The plywood backboards are to be as per Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .3 Mount panelboards at height specified in Section 26 05 05.00 – MOUNTING HEIGHTS.
- .4 Connect loads to circuits.
- .5 Connect neutral conductors to common neutral bus with respective neutral identified.

END OF SECTION

Motor Control Centre

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 01 00.00 – OPERATING AND MAINTENANCE INSTRUCTIONS.
- .2 Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .3 Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- .4 Section 26 05 53.00 – IDENTIFICATION.
- .5 Section 26 08 01.00 – TECHNICAL SERVICES DIVISION STARTUP SERVICE.
- .6 Section 26 29 00.00 – MOTOR STARTERS TO 600V.

1.2 References

- .1 NEMA Rated Contractors and Motor Starters.
- .2 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 04.00 – SUBMITTALS/SHOP DRAWINGS.
- .2 Indicate:
 - .1 Outline dimensions.
 - .2 Configuration of identified compartments.
 - .3 Floor anchoring method and dimensioned foundation template.
 - .4 Cable entry and exit locations.
 - .5 Dimensioned, position and size of busbars and details of provision for future extension.
 - .6 Schematic and wiring diagrams.
 - .7 Size, capacity and labeling of all starters.
- .3 Provide certificates of compliance with the requirements as stated within the IBC and CBC and demonstrated the ability to function after the test.

1.4 Operation And Maintenance Data

- .1 Provide operation in accordance with Section 26 01 00.00 – OPERATING AND MAINTENANCE INSTRUCTIONS and maintenance data for motor control centre for incorporation into manual.
- .2 Include data for each type and style of starter.

Motor Control Centre

1.5 Source Quality Control

- .1 Provide manufacturer's type test certificates including short circuit fault damage certification up to short circuit values specified under bus bracing.
- .2 Consultant to witness standard factory testing of complete motor control centre including operation of switches, circuit breakers, starters and controls.
- .3 Manufacturer to provide proof of quality control program in accordance with CAN/CSA-Q9000.

PART 2 - PRODUCTS**2.1 Supply Characteristics**

- .1 600V, 60 Hz, wye connected, 3 phase, 3 wire, plus ground conductor.

2.2 General Description

- .1 Compartmentalized vertical sections with common power busbars.
- .2 Floor mounting, free standing, metal enclosed dead front enclosure.
- .3 Indoor CSA Type 2 sprinkler proof enclosure suitable for front mounting.
- .4 Class I Type C wiring.

2.3 Vertical Section Construction

- .1 Independent vertical sections fabricated from rolled flat steel sheets bolted together to form a rigid, completely enclosed assembly.
- .2 Each vertical section shall be divided into compartment units.
- .3 Each unit to have complete top and bottom steel plate for isolation.
- .4 Horizontal wireways, equipped with cable supports, across top and bottom, extending full width of motor control centre, isolated from busbars by steel barriers.
- .5 Vertical wireways c/w doors for load and control conductors extending full height of vertical sections, and equipped with cable tie supports. Installation wiring to units accessible with doors open and units in place.
- .6 Openings, with removable coverplates, in side of vertical sections for horizontal wiring between sections.
- .7 Incoming cables to enter at top or bottom as indicated on drawings.
- .8 Provision for outgoing cables to exit via top or bottom with terminals.
- .9 Removable lifting means.
- .10 Provision for future extension of both ends of motor control centre including busbars without need for further drilling, cutting or preparation in field.
- .11 Divide assembly for shipment to site, as required complete with hardware and instructions for re-assembly.

Motor Control Centre

2.4 Sills

- .1 Continuous 50 mm channel iron floor sills for mounting bases with 19 mm diameter holes for bolts.

2.5 Busbars

- .1 Main horizontal and branch vertical, three phase high conductivity tin plated copper busbars in separate compartment bare self-cooled, extending entire width and height of motor control centre, supported on insulators and rated:
 - .1 Main horizontal busbars rated as specified on MCC schedules, but no less than 600A.
 - .2 Branch vertical busbars as required to meet the connected load and 20% (300A minimum).
- .2 Branch vertical busbars for distribution of power to units in vertical sections.
- .3 No other cables, wires, equipment in main and branch busbar compartments.
- .4 Brace buswork to withstand effects of short-circuit current of 65 kA RMS symmetrical.
- .5 Bus supports: with high dielectric strength, low moisture absorption, high impact material and long creepage surface designed to discourage collection of dust.

2.6 Ground Bus

- .1 Copper ground bus extending entire width of motor control centre.
- .2 Vertical ground bus strap, full height of section, tied to horizontal ground bus, engaged by plug-in unit ground stab.

2.7 Motor Starters And Devices

- .1 Refer to Section 26 29 00.00 – MOTOR STARTERS TO 600 V and to Motor Control Schedule.

2.8 Starter Unit Compartments

- .1 Units EEMAC size 5 and smaller, circuit breaker units 225 A and smaller, plug-in type with self-disconnect. Guide rail supports for units to ensure that stabs make positive contact with vertical bus. Provision for units to be installed or removed, off load, while buses energized.
- .2 Unit mounting:
 - .1 Engaged position - unit stabbed into vertical bus.
 - .2 Withdrawn position - unit isolated from vertical bus but supported by structure. Terminal block accessible for electrical testing of starter.
 - .3 Provision for positive latching in either engaged or withdrawn position and padlocking in withdrawn position.
 - .4 Stab-on connectors free floating tin plated clips, self-aligning, backed up with steel springs.

Motor Control Centre

- .3 External operating handle of circuit switch interlocked with door to prevent door opening with switch in "on" position. Provision for 3 padlocks to lock operating handle in "off" position and lock door closed.
- .4 Hinge unit doors on same side.
- .5 Overload relays manually reset from front with door closed.
- .6 Pushbuttons and indicating lights mounted on door front.
- .7 Devices and components by one manufacturer to facilitate maintenance.
- .8 Pull-apart terminal blocks for power and control to allow removal of starter units without removal of field wiring.

2.9 Wiring Identification

- .1 Provide wiring identification in accordance with Section 26 05 53.00 – IDENTIFICATION.

2.10 Equipment Identification

- .1 Provide equipment identification in accordance with Section 26 05 53.00 – IDENTIFICATION.

2.11 Finishes

- .1 Apply finishes in accordance with Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Equipment to be painted: baked grey enamel.

2.12 Factory Testing

- .1 All standard factory testing are to be witnessed by the Technical Service Start-Up Services Contractor, the Owner and the Consultant. In addition, perform all other tests identified in this section and in Section 26 08 01.00 – TECHNICAL SERVICES DIVISION STARTUP SERVICE that are not included in the standard testing procedure.
- .2 Testing shall be witnessed by the Technical Service Start-Up Services Contractor.
- .3 Include in your bid for the complete cost of two people to attend the factory witness testing for the equipment. Cost to include but not limited to all travel, food and lodging costs.

2.13 Manufacturers

- .1 The following are acceptable manufacturers:
 - .1 Schneider.
 - .2 Eaton.
 - .3 Siemens.
 - .4 Allen-Bradley

Motor Control Centre

PART 3 - EXECUTION

3.1 Installation

- .1 Set and secure motor control centre in place on channel bases, rigid, plumb and square to building floor and wall.
- .2 Connect power to motor control centre. Provide wiring from motor control centre starter to motor through a manual disconnecting device if required by code.
- .3 Co-ordinate with Mechanical Division contractor to ensure overload ratings match motor nameplate.
- .4 Provide isolators using soft (maximum 40 durometer) multi-layer rubber pads sized for a minimum static deflection of 12.7 mm at no more than 2/3 of the manufacturers maximum load rating for the pad material.

3.2 Testing

- .1 Motor Control Centre to be tested on site as defined in Section 26 08 01.00 – TECHNICAL SERVICES DIVISION START-UP SERVICE. Contractor to oversee all testing and correct any deficiencies noted.
- .2 Contractor to review and test that all wiring has been connected as per the manufacturer drawings.

END OF SECTION

Surge Protective Device

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04.00 – 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.
 - .2 780 Standard for the Installation of Lightning Protection Systems, 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, third edition.
 - .6 Canadian Standards or (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 1000V and designated as follows:
 - .1 Type 2 – SPDs hard-wired to distribution equipment after the load side of the service equipment overcurrent device.

Surge Protective Device

- .2 Type 3 – Plug-in SPDs.
- .3 Type 4 – Component SPDs and component assemblies.

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 04.00 – 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 -40dB 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.

Surge Protective Device

1.6 delivery, storage and handling

- .1 Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of manufacturer's instructions shall be included with the equipment at time of shipment.

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 200kA 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 120V system and 120% for 220 and 240V systems, and 125% for 347 and 600V 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

Surge Protective Device

Single Split Phase	•	•	•	•
High Leg Delta	•	•	•	•

- .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 20kA 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, MCCs, 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.

Surge Protective Device

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.

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, MCCs, 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 24V 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 < 46V.
- .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 2 sprinklerproof enclosure, unless otherwise noted.

Surge Protective Device

- .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 Advanced Protection Technologies
 - .2 Eaton Cutler-Hammer
 - .3 International Innovative Systems
 - .4 Schneider Electric
 - .5 Siemens
 - .6 Surge-Pure

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 contractor 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 non-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.
- .6 The installing contractor shall comply with all applicable codes.

END OF SECTION

Electronic Metering

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01.00 - GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- .3 Section 26 05 34.00 – CONDUITS, CONDUIT FASTENERS AND FITTINGS.
- .4 Section 26 05 21.00 – WIRE AND CABLE 1000V.

1.2 Standards

- .1 Except as noted by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations of the Canadian Electrical Manufacturer's Association, CSA and Measurement Canada.
- .2 The system shall be bench certified/approved by Measurement Canada for legal trade under the "Electricity and Gas Act" of Canada.
- .3 At the completion of installation, the system shall be field reviewed to verify compliance with Measurement Canada Specifications.

1.3 Shop Drawings And Product Data

- .1 Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- .2 Submit shop drawings and manufacturers data for the component items shown and specified under this section of the specification.
- .3 Do not supply any equipment to this project prior to shop drawing review by the Consultant.
- .4 Shop drawings will be stamped and signed by the contractor prior to submittal, allow a minimum of one week for review of the shop drawings submitted.
- .5 At the completion of the Project, As-Built Drawings will be submitted by the System Supplier/Manufacturer, who will prepare a complete manufacturer's manual including but not limited to all as-built wiring diagrams and all required Measurement Canada certifications and test results including equipment bench test and suite to breaker installation verification.

1.4 Description Of System

- .1 Work under this section is subject to the requirements of Section 26 05 01.00 - GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Provide computerized metering in accordance with the Contract Documents. The system to come complete with all parts necessary to operate this system.
- .3 Remote sub-metering panels shall be used for electricity consumption and display in a digital format and in real numbers.

Electronic Metering

- .4 The metering panels shall monitor a minimum of 12 three phase four wire customers or 18 two phase three wire loads.
- .5 The units to be mounted in a single CSA Type 2 sprinkler proof enclosure either located next to a panel or built into the raceway on the side of a panel.
- .6 Metering panels communicate over their own Local Area Network, which can either report direct to an onsite computer, or to remote computers using telephone or Ethernet/WAN/Internet communications.

PART 2 - PRODUCTS**2.1 General**

- .1 Provide a fully digital electrical measurement system for multi-tenant buildings incorporating complete metering, at several voltages and amperages. The system shall have four major components: a) the meter/communications modules, b) a set, per metered service, of current transformers or transducers sized to the load to provide the metering "node", c) potential transformers (if applicable) for line voltage measurement and d) communications interface to allow download of meter data to a remote computer for billing purposes. The metering panel must have its own local display for reading the meters connected to it.
- .2 Local area network communications shall interface with one of the following for remote data collection: Telephone (POTS connectivity), LAN Ethernet, WAN Ethernet, Internet, BACnet or other building automation connectivity, or future.

2.2 Meters

- .1 Installed near each tenant's main switch or circuit breakers. Meters to accurately measure electricity that each tenant used and stores the information in non-volatile, solid state memory. The metering panels shall be networked together to allow remote computerized access for remote meter reading and automated bill generation.
- .2 The meter shall be able to be used on poly-phase services. Wiring includes: connection of the meters to the line voltage, connection of the through-type current transformers/transducers installed at the circuit breakers, connection of network communications (wired or, if applicable, wireless communications devices).
- .3 Application Voltages:
The metering panel will accommodate all approved North American Distribution voltages up to 600 Volts. For higher voltages, potential transformers shall be used.
- .4 Operating Frequency: 50/60 Hz.
- .5 Power Factor Range: 0.5 to 1.0 lead/lag.
- .6 Power Supply Requirements: Self-powered.
- .7 Current Ranges: 100/200/400 Amps or 5/10 AMP interface (services over 400A or critical loads)
- .8 Accuracy: +/- 0.5% of 100% registration @ 1.0 pf, 1% to 100% load to meet: Measurement Canada.

Electronic Metering

- .9 Operating Temperature Range: -40 degrees to +55 degrees C.
- .10 Dimensions: Component specific. Multi-customer metering panels shall provide a more compact installation than a socket-type meter installation.
- .11 Meters and their elements must conform to the Measurement Canada "Standard Drawings for Electrical Metering Installations" to ensure accurate metering. All configurations shall come with current transformers/transducers required in the "Standard Drawings".

2.3 Current Transformers/Transducers

- .1 Provide all current transformers/transducers associated with the metering system.
- .2 Loads up to 400 amps shall have precision current transformers/transducers with an accuracy exceeding that specified in Measurement Canada approval.
- .3 Loads above 400 amps shall have Current Transformers rated ANSI Class 0.3 at a burden B0.1 connected to a precision Current Transformer compatible with the metering equipment.

2.4 Potential Transformers

- .1 The Potential transformers, if required, shall be mounted in a separate enclosure rated for the size and capacity necessary to feed the number of meters shown as per the drawings and rated by the manufacturer. Potential transformers must be Measurement Canada approved for revenue metering (independently or as part of system approval).
- .2 Potential transformers shall be factory assembled and come complete with electrical disconnects and fuses mounted in a separate enclosure.

2.5 Pulse Totalizer Panel

- .1 The pulse totalizer panels shall be designed to reside on the same communication network as the electricity metering panels enabling the system to monitor meters that are equipped with pulse or dry contact outputs including gas and water meters supplied by the electrical contractor, and installed by the mechanical contractor.
- .2 Each pulse totalizer panel shall be capable of counting pulse inputs from eight (8) independent sources such as up to 10 pulses per second (10 Hz).
- .3 Each pulse totalizer panel shall be capable of storing up to 35 days of 15 minute interval data including date and time stamp for all 8 channels.
- .4 Each pulse totalizer panel shall be able to communicate through the data network connecting all the metering panels.
- .5 Each pulse totalizer panel shall be able to measure the pulse outputs from the water and gas meters provided by the electronic metering supplier described below:

Electronic Metering

- .1 Water meters: Water meters for each suite DCW and DHW supply manifold shall be 12mm diameter. Meter to be complete with pulse output per gallon for a total water usage, and display of water usage at the meter. Output at meter can be digital or dial. Meter shall be suitable for both DCW and DHW up to 60 deg. C. Meters shall be constructed in conformance with AWWA standard C712-02, ANSI/NSF 61 and NIST 44-2006 Section 3.36. Meters shall be compatible with the Sub Meter Management system. Turn over meters to the Mechanical Contractor for installation in the piping system. Wiring of meter to be provided by Electrical Division. Water meters for the domestic hot water tanks where shown shall be similar to the suite water meters, but shall be sized to suit the total DHW recovery. Refer to Domestic Hot Water Heater Schedule.
- .2 Gas Meters: Gas meters shown downstream of main gas meter shall be provided by the Electrical Contractor. Meter to be complete with pulse output for a total gas usage, and display gas usage at the meter. Output at meter can be digital or dials. Wiring of meter to be provided by Electrical Division. Meters shall be equal to American Meters AC-250 and shall be compatible with the Sub Meter Management metering system. Turn over meters to the Mechanical Contractor for installation in the piping system.

2.6 System Software

- .1 Provide a Windows™ based simplified user interface for system operation.
- .2 Revenue legal metering measurements shall be received from all sub-metering sensors and stored in a central Data Collection Unit (DCU) or PC in comma separated variable (CSV) file format.
- .3 To monitor, acknowledge and control communications with the remote metering points and to log any disruption of the communication link or unauthorized system access or tampering.
- .4 To permit the user to view instantaneous readings of voltage, current, power, phase angle, present and peak demand for any electricity meter.
- .5 To permit the user to view instantaneous readings present usage (totalized) or demand (last 15 minute interval) for any mechanical meter.
- .6 Provide the ability to export data into Reporting Applications (e.g. Web and Excel VBA).
- .7 To include service menus for diagnostic monitoring of the metering equipment and through either a modem and telephone link or Internet access to permit remote diagnostics by the manufacturer's service technicians. Security access control shall permit remote diagnosis to be locked out.
- .8 Provide appropriate interface for the computer containing this software to allow a computer to connect directly into electronic metering network and to read all the information on the network.

Electronic Metering

2.7 Billing Software

- .1 Shall provide menu driven generation of energy bills in a format similar the format provided by the local Utility Supplier. Shall permit energy cost calculations that utilizes information from account bill received from the local Utility Supplier, allowing for the incorporation of co-incident demand charges and time of use rates allocated to each tenant.
- .2 Shall permit multiple metering points to be allocated to a single tenant file in order to totalize a number of metering points and energy costs to a single tenant account.
- .3 Shall permit reconfiguration of tenant accounts through menu selection.
- .4 Shall list all tenant accounts including the tenant history file.
- .5 Shall access the actual metering measurements used in deriving each Tenant's invoice.
- .6 Provide billing data within a format compatible with standard accounting packages.

2.8 Wiring

- .1 Provide all wiring in conduit as required to operate the entire system. Wiring to be provided as per manufacturer's instructions. All power wiring to be in conformance with the electrical code.

2.9 Manufacturers

- .1 The following are acceptable manufacturers:
 - .1 CARMA Industries Inc.
 - .2 Intellimeter Canada Inc.
 - .3 Schneider Electric

PART 3 - EXECUTION**3.1 Meter Installation**

- .1 It is recommended that all metering equipment is installed in electrical closets or electrical rooms whenever possible.
- .2 Remove sub-panel/breaker-panel cover.
- .3 Wire bending space should be in compliance with Canadian Electrical Code Section 12. Verify that Current Transformers/Transducers, Power Taps, and wiring can be installed without crowding the subpanel.
- .4 Verify that the Current Transformers/Transducers can be installed with a minimum 1/2 inch clearance to uninsulated live parts in subpanel, and without bearing against dead metal parts.
- .5 Verify that power is 120V, 120/280V, 120/240V, 240/416V or 416V, 277/480V or 480V, 347/600V or 600V. Verify that neutral is available if applicable.
- .6 Provide a dedicated 15A, 120VAC circuit for each panel and equipment from the nearest available panel. Provide a new breaker in the respective panel.

Electronic Metering

- .7 Verify that the meter is the right size and voltage for the installation.
- .8 Secure metal conduit to sub-panel. Use insulating bushing. Reliable grounding is required. Locknuts must be tightened enough to pierce paint in cabinet.
- .9 Secure meter enclosure in or on wall, according to location, and connect conduit using locknut. Attach the enclosure to a wall stud using screws to provide equivalent support.
- .10 Install CT's and PT's per manufacturer's recommendations.
- .11 Interconnect all metering panels with wiring in conduit as per manufacturer's instructions. Provide connection of Metering Panels to remote accesses connection: telephone, Ethernet connection, etc.
- .12 Replace sub-panel/breaker-panel covers.
- .13 Contact Electrical Safety representatives for verification of compliance to governing electrical codes.
- .14 Contact Measurement Canada or accredited service provider for installation verification. Installation verification shall include a tenant-to-breaker check. Electrical subcontractor must be available for verification support.

3.2 Calibration And Maintenance Service

- .1 All meters shall be Measurement Canada bench verified, and manufacturer will provide all Inspection/Verification Certificates within as-built documentation in order to provide a complete operational system.
- .2 The manufacturer shall provide pricing for billing services, on a per meter price, for collection of tenant sub-metered energy for return to building management or local distribution company (LCD) to apply against facility energy costs.
- .3 The manufacturer shall detail remote connectivity requirements (telephone, High-Speed Internet, etc.). Building owner/property manager shall provide necessary remote connectivity to allow for remote billing services, if required.
- .4 Manufacturer will include all required Measurement Canada installation inspections in pricing. All appropriate equipment is to be labelled with the respective certification labels.
- .5 Manufacturer to register the system with Measurement Canada and work with the Owner to obtain all required information to do so.
- .6 After the specified Measurement Canada approval period (seal period typically 6 years), the manufacturer shall provide options for maintaining Measurement Canada Approval. This may include, but not limited to: Onsite Re-verification or removal of existing equipment and replacement with Measurement Canada verified equipment.
- .7 The manufacturer shall provide pricing to the Owner for system maintenance, repair and/or replacement service to the extent that covered by the warranty.

3.3 Warranty

- .1 All equipment shall be free from defect in materials and workmanship under normal use and service for the period of twenty four (24) months from the date of acceptance. .

Electronic Metering

END OF SECTION

Wiring Devices

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- .3 Section 26 05 05.00 – MOUNTING HEIGHTS.
- .4 Section 26 05 53.00 – IDENTIFICATION.
- .5 Section 26 51 13.00 – LIGHTING EQUIPMENT.

1.2 Shop Drawings And Product Data

- .1 Submit shop drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

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 Architect/Consultant.
- .3 Toggle operated locking fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads.

2.2 Receptacles

- .1 All receptacles to be specification grade.
- .2 Duplex specification 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 Hospital grade receptacles:

Wiring Devices

- .1 Hospital grade with green dot symbol, tamper-resistant, extra heavy duty, modular plug-in type, 15 ampere, 125 V, 2-pole, 3-wire U-ground duplex receptacles complete with front circuit identification area.
- .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 contact.
- .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 USB Duplex receptacles shall be decora style complete with two 5-15R receptacles and two USB ports for peripheral device charging. USB ports shall be able to provide 3.6A combined @ 5VDC.
- .6 Other receptacles with ampacity and voltage as indicated.
- .7 Receptacles to be coloured as follows:
 - .1 Normal Power – Colour to be selected by Architect/Consultant.
 - .2 Emergency/Essential Power – Red.
 - .3 Isolated Ground – Orange.
 - .4 Switched – Gray.
 - .5 UPS – Blue.
- .8 All dwelling 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.
- .9 Electrical Contractor 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.

2.4 Dimmers

- .1 Dimmers shall be 600W, 1500W, 2000W.

Wiring Devices

- .1 Full range, continuously variable control of light intensity.
- .2 Vertical slider allowing the light level to be set by the user.
- .3 Slide to Off.
- .4 Capable of operating at rated capacity.
- .5 Power failure memory.
- .6 Dimmers shall be available for direct control of incandescent, magnetic low voltage, electronic low voltage, fluorescent, and LED.
- .2 Incandescent dimmers.
 - .1 Direct control of up to a full 20A lighting circuit.
- .3 Electronic (solid-state) Low Voltage (ELV) transformer dimmers (incandescent).
 - .1 Circuitry designed to control the input of Electronic (solid state) Low Voltage transformers.
 - .2 Control up to 600W of Electronic Low Voltage load.
 - .3 Reset-able overload protection when capacity is exceeded.
- .4 Magnetic Low-Voltage (MLV) transformer dimmers.
 - .1 Designed to control and provide a symmetrical AC wave form to input of magnetic low voltage transformers per UL 1972 section 5.11.
 - .2 Direct control of up to 1500VA of Magnetic Low Voltage load.
 - .3 Dimmer shall be suitable to control dimming ballast as specified in Section 26 51 13.00 – LIGHTING EQUIPMENT.
- .5 LED dimmers.
 - .1 Slide to Off only. Must match driver and LED requirements.
- .6 Manufacturers
 - .1 Lutron Maestro Series.
 - .2 Leviton True Touch Series.

2.5 Special Wiring Devices

- .1 Pilot lights as indicated, with neon type 0.04 W, 125 V lamp and red plastic lens flush type.

2.6 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.

Wiring Devices

- .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 Mount toggle switches at height specified in Section 26 05 05.00 – 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 05.00 – MOUNTING HEIGHTS or as indicated.
 - .3 Where split receptacle has one portion switched, mount vertically and switch upper portion.
 - .4 Install hospital grade receptacles in all patient care areas in healthcare applications.
- .3 Dimmers:
 - .1 Install dimmers as indicated. Provide suitable clearances in multi-gang boxes as recommended by the manufacturer to maintain the dimmer rating.
 - .2 Coordinate the dimmer selection with the ballast/driver to be controlled, to ensure compatibility.
- .4 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.
- .5 Labelling
 - .1 Provide labels with panel name and circuit number on all receptacles in conformance with Section 26 05 53.00 – IDENTIFICATION.

Wiring Devices

END OF SECTION

Fuses - Low Voltage

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04.00 – 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 04.00 – 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, I_{2t} (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.

PART 2 - PRODUCTS

2.1 Fuses General

- .1 Fuse type references L1, L2, J1, R1 etc. have been adopted for use in this specification.
- .2 Fuses: product of one manufacturer.
- .3 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.

Fuses - Low Voltage

- .1 Type J1, time delay, capable of carrying 500% of its rated current for 10 s minimum.
- .2 Type J2, fast acting.
- .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 01.00 – 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.

Fuses - Low Voltage

- .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 Circuit Breakers

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04.00 – 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 04.00 – 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.

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.

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.

Moulded Case Circuit Breakers

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 Moulded case circuit breaker to operate by means of a solid-state trip unit with associated current monitors and self-powered shunt trip to provide inverse time current trip under overload condition and long time, short time, instantaneous tripping for phase and ground fault short circuit protection.

2.6 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.
 - .4 on-off locking device.
 - .5 handle mechanism.

2.7 Manufacturers

- .1 The following are acceptable manufacturers:
 - .1 Schneider Electric
 - .2 Eaton Cutler-Hammer
 - .3 Siemens

PART 3 - EXECUTION**3.1 Installation**

- .1 Install circuit breakers as indicated.

END OF SECTION

Disconnect Switches - Fused and Non-Fused

PART 1 - GENERAL**1.1 Work Included**

- .1 Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- .3 Section 26 05 53.00 – 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 04.00 – SUBMITTALS/SHOP DRAWINGS.

PART 2 - PRODUCTS**2.1 Disconnect Switches**

- .1 Fusible or non-fusible, horsepower rated disconnect switch in CSA Type 2 sprinkler proof enclosure, size as indicated.
- .2 Provision for padlocking in on-off switch position by three locks.
- .3 Mechanically interlocked door to prevent opening when handle in ON position.
- .4 Fuses: size as indicated, class J, current limiting, in accordance with Section 26 28 14.00 – FUSES - LOW VOLTAGE.
- .5 Fuse-holders: suitable without adaptors, for type and size of fuse indicated.
- .6 Quick-make, quick-break action.
- .7 ON-OFF switch position indication on switch enclosure cover.

2.2 Equipment Identification

- .1 Provide equipment identification in accordance with Section 26 05 53.00 – 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.

Disconnect Switches - Fused and Non-Fused

.3 Siemens.

PART 3 - EXECUTION

3.1 Installation

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

END OF SECTION

Motor Starters to 600V

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- .3 Section 26 05 53.00 – IDENTIFICATION.
- .4 Section 26 08 01.00 – TECHNICAL SERVICES DIVISION START-UP SERVICE.

1.2 References

- .1 IEC 947-4-1, Part 4: Contactors and motor-starters, latest edition.
- .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.
- .3 Appendix A – Loose Starter Schedule
- .4 Appendix B – MCC Schedule

1.3 Shop Drawings And Product Data

- .1 Submit shop drawings and product data in accordance with Section 26 05 04.00 – 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.

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.
 - .4 Control transformer.

Motor Starters to 600V

- .5 Operating coil.
- .6 Fuses.
- .7 Indicating lamp bulbs used.

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 HRC type 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 secondary.
 - .2 Primary voltage as indicated.
 - .3 120V 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 or long life (10000 hour) incandescent type.
- .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.
- .6 All starters shall have identification for each wire and terminal for external connection, within starter, with permanent number marking identical to diagram.

Motor Starters to 600V

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 600V

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.

Motor Starters to 600V

- .4 One timing relay.
- .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 [manual] [automatic] 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.

Motor Starters to 600V

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.
 - .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 2 sprinkler proof enclosure, size as indicated.
- .2 Equipment to be painted: baked grey enamel.

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 Division Contractor to ensure correct fuses and overload devices elements installed.

3.2 Field Quality Control

- .1 Perform tests in accordance with Section 26 08 01.00 – TECHNICAL SERVICES DIVISION START-UP SERVICE and manufacturer's instructions. Contractor to oversee all testing and correct any deficiencies noted.

Motor Starters to 600V

- .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

Lighting Equipment

PART 1 - GENERAL

1.1 WORK INCLUDED

- .1 Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04.00 – SUBMITTALS – SHOP DRAWINGS.
- .3 Section 26 05 21.00 – WIRES AND CABLES 1000V.
- .4 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.

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 consultant reserves the right not to accept any alternates or substitutions. If alternates or substitutions are entertained, then it is the responsibility of the Contractor/Supplier to provide all 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. 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 Owner. Rather than replacing the luminaires, the consultant may accept the installation of additional luminaires by the Contractor at no cost to the Owner in order to achieve the required light levels.
- .2 Accompanying the request for a luminaire or lamp substitution, the contractor 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 04.00 – SUBMITTALS/SHOP DRAWINGS.

Lighting Equipment

- .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, voltage and mercury content.
- .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. LED Drivers must have a 50,000 hours warranty.
- .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.
- .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.

1.5 Fixed per unit cost luminaires

- .1 Listed in the luminaire schedule are a fixed per unit cost for certain luminaire types. Electrical contractor is responsible for completing a take-off of the drawings to determine quantity of each luminaire type and use the listed fixed unit price to calculate the total cost per luminaire type. The total cost for all luminaires shall be carried in the bid for the electrical contract. Provide a breakdown of the total cost, per luminaire type, that is carried under the electrical contract. All luminaires are to be included in the electrical contract including all luminaires identified with fixed unit costs. The electrical contractor is to include fixed per unit cost luminaires in Light Fixtures – Materials in the standard progress draw breakdown defined in Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 The fixed per unit cost excludes applicable taxes and includes lamps and distributor markups. Electrical Contractor 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 luminaires. Show the applicable taxes as a separate line item.

1.6 Warranty

- .1 The manufacturer shall provide a one-year warranty against defects in material and workmanship for 12 months after initial start-up.
- .2 LED's, Drivers, Lamps and ballasts showing signs of premature failure shall be replaced at no cost to the owner

Lighting Equipment

PART 2 - PRODUCT**2.1 General**

- .1 All products must be CSA or CUL approved.

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 Incandescent, tungsten halogen, high intensity discharge, compact fluorescent and linear fluorescent lamps shall be manufactured by Osram/Sylvania, GE, Philips or Venture unless indicated otherwise on luminaire schedule. 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 owner.
- .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.
 - .3 LED's shall be manufactured by Luxeon or equal. Colour temperature shall be as indicated on the luminaire schedule. Lamps are to be binned with no visible colour variance (3100K to 3300K maximum range). 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 owner. 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 owner. Additional electrical costs, associated with higher Wattage temporary luminaires, must be reimbursed with interest to the owner 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.

Lighting Equipment

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 experience 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 3V through 55V.
 - .2 Adjustment of LED current from 200mA to 1.05A at the 100 percent control input point in increments of 1mA
 - .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 120V through 277VAC at 60Hz.
- .9 Driver should 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 0.5V and 0.65V 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%

Lighting Equipment

- .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 10V Analog Control Protocol, Class 2, capable of sinking 0.6 ma per driver at a low end of 0.3V. Limit the number of drivers on each 0-10V control output based on voltage drop and control capacity.
- .16 Must meet ESTA E1.3 for RGBW LED drivers

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 Fluorescent luminaires designed for continuous, seamless and tandem mounting shall only be constructed with four foot lamps. Two and three foot lamps are not acceptable unless indicated on drawings or luminaire schedule.
- .6 All poles are to come complete with internal vibration dampeners to accommodate wind conditions to avoid damage due to wind-induced vibrations.

Lighting Equipment

- .7 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.
- .8 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.
- .9 The supply and installation of fixed per unit cost and 'cash allowance' luminaires shall comply with all standards set forth in Electrical Specifications. Electrical Contractor 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.
- .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 'C' denote compact fluorescent type.
 - .2 Designations beginning with the letter 'D' denote incandescent or halogen type.
 - .3 Designations beginning with the letter 'F' denote fluorescent type.
 - .4 Designations beginning with the letter 'H' denote high intensity discharge type.
 - .5 Designations beginning with the letter 'L' denote LED type.
 - .6 Designations beginning with the letter 'J' denote Induction type.
 - .7 Designations beginning with the letter 'X' denote exit sign.

PART 3 - EXECUTION**3.1 INSTALLATION**

- .1 It is the responsibility of the contractor to obtain the information related to the luminaire and luminaire trim finishes/colours from the Interior Designer or Architects 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
- .2 The contractor 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 contractor according to equipment manufacturer's instructions.
- .3 The Electrical Contractor 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 900mm above grade in parking lots and a minimum 150mm 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.

Lighting Equipment

- .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 Architect's Drawings. Coordinate exact locations on site. Refer to Architect's drawings for dimensions of coves and valences. Fluorescent staggered coves must have a minimum of two inches overlap.
- .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 Contractor 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 owner. 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 Owner if cut-out is too large.
- .17 Connect luminaires to lighting circuits.
- .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 Consultant.
- .19 Modular wiring systems shall be employed only where indicated or with approval of the Consultant.
- .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 owner, architect or Consultant.
- .21 Lamps are to be installed after luminaire is cleaned. All fluorescent lamps shall be run through a minimum of 12 hours initial start to increase the lamp life and all lamps shall be run through a minimum of 100 hours initial start prior to any dimming.

Lighting Equipment

.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 owner.

.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 Consultant/Architect, 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 Owner.

END OF SECTION

Unit Equipment for Emergency Lighting

PART 1 - GENERAL**1.1 Work Included**

- .1 Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- .3 Section 26 05 21.00 – WIRE AND CABLES 1000V.
- .4 Section 26 05 34.00 – CONDUITS, CONDUIT FASTENERS AND FITTINGS.

1.2 References

- .1 CSA or cUL listed for Canadian application, UL and ETL listed to UL924 – AC inverter system for emergency power supply, latest edition.
- .2 CSA or cUL listed to C22.2-No.107.1-M91 – Standard for Commercial and Industrial Power Supply Equipment; ANSI C62-41; ANSI C62.45 (Cat. A&B), latest edition.
- .3 FCC Rules and Regulations 47 Part 15, Subpart J, Class A - Certified Compliance, latest edition.
- .4 Systems comply with CEC, OESC, OSHA and Life Safety Code, latest edition.
- .5 Installation shall comply with Building Materials Evaluation Committee (BMEC), latest edition.
- .6 Shall be certified by the Canadian Construction Materials Committee (CCMC), latest edition.
- .7 UL 1778 Standard for Uninterruptable Power Supply Equipment, latest edition.
- .8 ANSI C62.41-1980 Recommended Practice on Surge Voltages in Low Voltage Power Circuits, latest edition.
- .9 NEMA PE1 – Uninterruptible power supply, latest edition.
- .10 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 04.00 – 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.

Unit Equipment for Emergency Lighting

- .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.

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, 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

Unit Equipment for Emergency Lighting

- .10 Internal Maintenance bypass
- .11 Static bypass switch
- .12 Microprocessor controlled logic and control panel with alarm indicators and digital metering display
- .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
- .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.

Unit Equipment for Emergency Lighting

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: 60Hz \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.

Unit Equipment for Emergency Lighting

- .8 Current harmonics: <9% THD, with 12 pulse rectifier and input factor
- .9 Input transient protection: ANSI C62.41.
- .2 ELI Module Output
 - .1 Voltage and number of output wires: as shown on electrical single line diagram
 - .2 Frequency: 60Hz
 - .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: 60Hz $\pm 0.01\%$ free running
 - .11 Phase-lock window: 60Hz, $\pm 4\%$
 - .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

Unit Equipment for Emergency Lighting

- .13 Fault clearing capability:
 - .1 Static bypass: 1000% for ½ cycle (non-repetitive)
- .14 Crest factor: 3:1 maximum
- .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: 396VDC
 - .5 Min. discharge voltage: 295VDC
 - .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 ±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 circuitThe 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.

Unit Equipment for Emergency Lighting

- .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.
- .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

Unit Equipment for Emergency Lighting

- .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.
- .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.

Unit Equipment for Emergency Lighting

- .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.
- .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

Unit Equipment for Emergency Lighting

- .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
- .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.

Unit Equipment for Emergency Lighting

- .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
- .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.

Unit Equipment for Emergency Lighting

- .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
 - .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.

Unit Equipment for Emergency Lighting

- .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 sprinkler proof indoor 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 workmanship:
 - .1 Workmanship 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.

- .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

Unit Equipment for Emergency Lighting

- .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 Beghelli – Boreaus BKW,
- .2 Lumacell – IPS, 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 local and national electrical codes.
- .2 Install on flat floor only.
- .3 Tie-in general trouble and running alarms into fire alarm panel.
- .4 The inverter to be tested on site as defined in Section 26 08 01.00 – TECHNICAL SERVICES DIVISION START-UP SERVICE and herein. Contractor to oversee all testing and correct any deficiencies noted.

3.2 test reports

- .1 Submit all test reports as part of the O&M manuals.

3.3 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

Security System

PART 1 - GENERAL

1.1 Work Included

- .1 Section 26 05 01.00 – 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 contractor.

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 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- .3 Section 26 05 34.00 - CONDUITS, CONDUIT FASTENERS AND FITTINGS.
- .4 Section 26 08 01.00 - TECHNICAL SERVICES DIVISION STARTUP SERVICE.

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.

1.3 System Description

- .1 All equipment and components shall be new, and the manufacturer's current model.
- .2 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.
- .3 Elevator shafts will have a weather proof heat detector located in the pit along with an ionisation smoke detector located at the top of the shaft.
- .4 Emergency power feed from generator(s) or inverter(s) shall have two supervisory zones each, monitoring Generator Running and Generator General Trouble.
- .5 Fully supervised, microprocessor-based, fire alarm system, utilizing digital techniques for data control and digital, and multiplexing techniques for data transmission.
- .6 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.
- .7 Zoned, non-coded single stage or two stage, as indicated.
- .8 Modular in design to allow for future expansion.
- .9 Operation of system shall not require personnel with special computer skills.
- .10 System to include:

Multiplex Fire Alarm System

- .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 Data Gathering Panels/Transponders with stand-alone capabilities.
- .3 Power supplies.
- .4 Initiating/input circuits.
- .5 Indication/output circuits.
- .6 Auxiliary circuits.
- .7 Wiring.
- .8 Manual and automatic initiating devices.
- .9 Audible and visual signalling devices.
- .10 End-of-line resistors.
- .11 Local and remote annunciators.
- .12 Printer and event log memory chip.
- .13 Historic event recorder.
- .14 Isolation modules.
- .15 Central alarm monitoring.
- .16 Programmed features.

1.4 Requirements Of Regulatory Agencies

- .1 System components shall be listed by ULC/CSA and comply with applicable provisions of the National Building Code, the Local/Provincial 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 04.00 – 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.
 - .5 Step-by-step operating sequence, cross referenced to logic flow diagram.

Multiplex Fire Alarm System

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 CD/DVD or 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 Maintenance

- .1 Provide one year's free maintenance with two inspections by manufacturer during warranty period. Inspection tests to conform to CAN/ULC-S536. Submit inspection report to Owner.

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.

1.10 Commissioning

- .1 Testing and commissioning of the integration of all life safety and fire protection systems shall be required. The testing of the integrated systems shall include, but not limited to the following systems:
 - .1 Fire Alarm
 - .2 Mass Notification
 - .3 Elevators

Multiplex Fire Alarm System

- .4 Emergency Generators and/or Inverters
- .5 Audio/Visual
- .6 Lighting Control
- .7 Notification (i.e. "Fire Do Not Enter" signage, etc.)
- .8 Sprinkler
- .9 Standpipe
- .10 Fire Pumps
- .11 Water Supplies and/or Control Valves
- .12 Freeze Protection
- .13 Fixed Fire Suppression
- .14 Cooking Equipment Fire Suppression
- .15 Hold-Open Devices
- .16 Electromagnetic Locks
- .17 Smoke Control
- .18 Hazardous Protection Monitoring
- .19 Smoke Alarms

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.
- .3 Audible signal devices: to ULC-S525.
- .4 Visual signal devices: to CAN/ULC-S526.
- .5 Control unit: to CAN/ULC-S527.
- .6 Manual pull stations: to CAN/ULC-S528.
- .7 Thermal detectors: to CAN/ULC-S530.
- .8 Smoke detectors: to CAN/ULC-S529.
- .9 Smoke alarms: to CAN/ULC-S531.

2.2 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 remote annunciator.

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- .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 Cause air conditioning and ventilation fans to shut down or to function to provide required control of smoke movement.
- .6 Cause fire doors and smoke control doors, if normally held open, to close automatically.
- .7 Cause elevators to return to floor of egress, or to alternate floor, as required.
- .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.
- .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.

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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 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.
- .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 Data Gathering Panels (DGP's) /Transponders

- .1 Fire control modules: distributed throughout building complex in separately enclosed units (DGP'S) and interconnected to central control unit utilizing multiplex data transmission techniques.

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- .2 Fire alarm integrated DGP's: microprocessor based, provide interface between standard alarm input/output devices and central control unit.
- .3 Each DGP: circuitry with ability to detect failure in communication with CCU resulting from faults in communication wiring. In event of loss of communication with CCU, DGP capable of operating in stand-alone mode. In this mode, DGP capable of reacting to connected input devices, and apply stand-alone programming to determine state of connected outputs. Stand-alone programming instructions: independent of, but capable of executing same type of algorithms as that of CCU.
- .4 Each DGP: self-contained unit, with integral power supply, battery charger and standby batteries. Short circuit, over voltage, and brown-out monitoring to protect powered components by automatically switching to standby batteries whenever trouble condition exists in power supply.
- .5 Addressable DGP's:
 - .1 DGP's are to be of the addressable type which provide two-way data communication with up to 128 addressable devices/interface modules, utilizing digital poll/response protocol communication format. Each addressable device: uniquely identified by own address, set at time of installation.
 - .2 Addressable DGP's must have stand-alone operating capability.
 - .3 Interface modules: facilitate connection of non-addressable devices (e.g. flow switch) to addressable DGP; provided in different types for connection to monitoring devices (e.g. flow/tamper switch), signalling devices (e.g. bells, horns), and control functions (e.g. fan shutdown, door release); communicate with addressable DGP over minimum number of wires (specified by manufacturer).
 - .4 Possible to connect all 3 types of addressable interface modules (monitoring, signal and control) to same addressable communication loop.
 - .5 Possible to connect variable-sensitivity addressable smoke detectors together with other addressable devices to same addressable communication loop.

2.5 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.

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- .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 24hrs with capability of maintaining alarm activation for a minimum of 2 hrs, immediately following 24 hrs of supervision.

2.6 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".
- .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.

2.7 Alarm Output Circuits

- .1 Alarm output circuits are to be connected to signals, wired in class B 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 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 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.

2.8 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 capture:

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- .1 Elevator recall to main floor, from general alarm condition.
- .2 Elevator top of shaft detection signal to elevator controller.
- .3 Elevator bottom of pit detection signal to elevator controller.
- .4 Elevator machine room detector signal to elevator controller.
- .5 Elevator alternate floor signal from alarm signal at the egress floor smoke detector.
- .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.

2.9 Wiring

- .1 All fire alarm system wiring must be new.
- .2 Twisted copper conductors: 300 V CSA FAS minimum 105°C with FT4 rating and in mechanical protection i.e. EMT or flex as specified under Section 26 05 34.00 - 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.
- .7 All output circuits are to be wired in a Class B configuration, unless otherwise shown on the drawings.
- .8 All wiring between junction boxes and water flow switch, pressure switch, or supervisory switches will be in liquid tight flexible conduit.

2.10 Manual Alarm Stations

- .1 Addressable manual pull station.
 - .1 Pull lever, break glass rod, semi-flush wall mounted type, single stage, or 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 Provide two pole for direct disconnect of magnetic locking devices local to the devices.

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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: ionization and 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 Ionization and 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.
 - .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:

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- .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 Consultant.
- .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.
- .8 Smoke alarms: ionization and photo electric.
 - .1 Twistlock plug-in type with fixed base.
 - .2 Wire-in base assembly with integral red and green LEDs for alarm/normal status.
 - .3 Silence button to silence nuisance alarms.
 - .4 Test button to verify circuitry and alarm operation.
 - .5 Electrical Rating: 120VAC, 60Hz and Battery Backup
 - .1 Battery capacity to provide power for minimum 7 days in normal condition, followed by 4 minutes of alarm.
 - .6 Visual strobe light with the following performance requirements:
 - .1 The flash rate shall not exceed two flashes per second (2 Hz) nor be less than one flash every second (1 Hz) throughout the listed voltage range of the appliance.
 - .2 Maximum pulse duration shall of 0.2 seconds with a maximum duty cycle of 40 percent, where the pulse duration is defined as the time interval between initial and final points of 10 percent of maximum signal.
 - .3 Shall be clear or nominal white and shall be minimum 175 cd but not exceed 1000 cd (effective intensity).
 - .4 The strobe light shall be synchronized where multiple smoke alarm strobe lights are installed within the same area and/or viewpoint.
- .9 Combination Smoke/Carbon Monoxide alarms:
 - .1 Smoke Detection: ionization.
 - .2 Twistlock plug-in type with fixed base.
 - .3 Wire-in base assembly with integral red and green LEDs for alarm/normal status.
 - .4 Silence button to silence nuisance alarms.
 - .5 Test button to verify circuitry and alarm operation.
 - .6 Electrical Rating: 120VAC, 60Hz and Battery Backup
 - .1 Battery capacity to provide power for minimum 7 days in normal condition, followed by 4 minutes of alarm.

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2.12 Audible Signal Devices

- .1 Bells: flush or surface mounted, as indicated, single stroke, polarized, 24 V dc, 150 mm or 250 mm, as indicated.
 - .1 Vibrating type, gongs of special alloy steel, 24 V dc, 150 mm or 250 mm, as indicated.
- .2 Signal chimes: heavy duty, single stroke, 24 V dc, with solid striking plunger and resonating chamber.
- .3 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 100db at 3m.
 - .3 Frequency response: 400 to 4000 Hz.
- .4 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 40mA @ 24Vdc, Low output 20mA @24Vdc.

2.13 Visual Alarm Signal Devices

- .1 Strobe 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.
 - .4 Operating on 20-24 V dc.
 - .5 Field adjustable for 15cd or 75cd unless specified otherwise.

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.

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- .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 Minimum wiring configuration with main panel.

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.

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 a Digital Voice Access Channel (DVAC) line for central monitoring unless noted otherwise on drawings.
 - .1 Monitoring of the system shall consist of alarm and supervisory.
 - .2 Provide a demarcation point for the utility connection between the DVAC line and fire alarm panel, refer to CAN-ULC-S524 appendix E.
 - .3 Voice channel shall be capable of interfacing with a VOIP voice channel complete with Cellular voice backup in case of VOIP voice line failure.

2.19 Programmed Features:

- .1 By-pass feature for signalling devices:

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- .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 Remote Terminal

- .1 CRT screen: 120 V, 60 Hz, to incorporate 100% solid state circuitry, with 30 cm screen and front mounted controls for brightness, contrast, vertical and horizontal hold and power ON/OFF switch.
- .2 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.
 - .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.

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- .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.
 - .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 Owner, the Consultant 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, magnetic door locks and door hold open devices.

2.22 STI Steel Web Stoppers, Detector Covers.

- .1 Provide STI 9600 series detector cover for areas where sporting events or similar activities avail.

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2.23 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 Chubb Edwards.
 - .2 Simplex.
 - .3 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. Installation of duct type detectors will be complete with sampling tubes.
- .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 Install end-of-line devices.
- .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 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.

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- .2 Where mechanical/sprinkler contractor makes revisions to the base design, electrical contractor shall coordinate any revisions to fire protection system directly with the mechanical/sprinkler contractor at no cost to the owner and update as-built drawings accordingly.
- .13 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.
- .14 Connect fire suppression systems to control panel.
- .15 Splices are not permitted.
- .16 Provide necessary raceways, cable and wiring to make interconnections to terminal boxes, annunciator equipment and CCU, as required by equipment manufacturer.
- .17 Ensure that wiring is free of opens, shorts or grounds, before system testing and handing over.
- .18 Identify circuits and other related wiring at central control unit, annunciators, and terminal boxes.
- .19 Install smoke and smoke/CO alarm in accordance with CAN/ULC-S553.
 - .1 Where more than one smoke (or smoke/CO) alarm is installed within a dwelling unit, interconnect the wiring such that actuation of one smoke (or smoke/CO) alarm will cause all the smoke (or smoke/CO) alarms within the dwelling unit to sound.

3.2 Field Quality Control and commissioning

- .1 Perform tests and verification in accordance with Section 26 08 01.00 - TECHNICAL SERVICES DIVISION STARTUP SERVICE.
- .2 The installing contractor 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.
 - .4 Perform complete commissioning of the integration of all life safety and fire protection systems as a whole to ensure the proper operation and inter-relationship between the systems.

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- .1 Testing and commissioning of the integrated systems must be done as a complete installed assembly; individual component testing or partially installed assembly testing is not acceptable.
 - .2 Follow the testing methodology for verifying and documentation of operation as outlined in CAN/ULC-S1001.
 - .3 Provide an Integrated Systems Testing Report as recommended in Appendix B of CAN/ULC-S1001. Include report with fire alarm test and verification reports.
- .3 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.

END OF SECTION

Excavation and Backfill for Electrical Work

PART 1 - GENERAL**1.1 Work Included**

- .1 Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- .3 Section 31 00 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 04.00 – SUBMITTALS/SHOP DRAWINGS.
- .2 Provide Shop Drawings indicating proposed method of bedding and backfilling.

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.

PART 3 - EXECUTION**3.1 Installation**

- .1 All excavation and backfilling for all services shall be in accordance with Site Work Division.
- .2 Protection:

Excavation and Backfill for Electrical Work

- .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 00.00 – 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

PART 1 - GENERAL**1.1 Work Included**

- .1 Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- .2 Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.2 References

- .1 Canadian Standards Association (CSA)
 - .1 CAN/CSA-A5, Portland Cement, latest edition.
 - .2 CSA-A23.1, Concrete Materials and Methods of Concrete Construction, latest edition.
 - .3 CSA G30.3, Cold-Drawn Steel Wire for Concrete Reinforcement, latest edition.
 - .4 CSA G30.5, Welded Steel Wire Fabric for Concrete Reinforcement, latest edition.
 - .5 CSA G30.18, Billet-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.

1.3 Shop Drawings And Product Data

- .1 Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- .2 Submit Shop Drawings for precast maintenance chambers.
- .3 Submit Shop Drawings for ground rod details for cable rack grounding.

PART 2 - PRODUCTS**2.1 PVC Ducts**

- .1 PVC ducts, type DB1, 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.

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.

Concrete Encased Duct Banks and Maintenance Chambers

- .3 Cement: to CAN/CSA-A5, Type 30.
- .4 Steel welded wire fabric mesh reinforcing: to CSA G30.3.
- .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 300mm 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.

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.

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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.
- .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.

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- .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. Notify the Consultant no less than 48 hours prior to the event, so that the Consultant may witness.
- .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.
- .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.

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3.3 REVIEWS

- .1 Review of duct and duct clean out will be witnessed by the Consultant prior to placement of concrete.

END OF SECTION

ATTACHEMENT A
LUMINAIRE SCHEDULE

