MECHANICAL SPECIFICATION

UNIVERSITY OF TORONTO SCARBOROUGH CAMPUS
2024-09 SW247, SW526, SW545 & SW546 Interior Renovation

DATE:
May 1st, 2025

Issued For Tender & Permit

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1. General

1.1. WORK INCLUDED

1.1.1. 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.

1.1.2. 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

1.2.1. 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.

1.2.2. 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.

1.2.3. 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

1.3.1. These instructions apply to and form a part of all Mechanical Sections.

1.4. REGULATIONS

1.4.1. Work shall be performed in accordance with codes, rules, regulations, by-laws and requirements of the authorities having jurisdiction.

1.4.2. The plumbing and drainage systems shall comply with regulations respecting plumbing made under the Ontario Building Code, and Drainage Act except as modified by rules, regulations and by- laws of authorities having jurisdiction.

1.4.3. Natural gas systems shall be in accordance with the Gas Protection Act and Installation Code of Natural Gas Burning Appliances and Equipment Code CANB-149.

1.4.4. These specifications are supplementary to the requirements above.

1.4.5. Drawings and specifications should not conflict with the above regulations but where there are apparent discrepancies the Contractor shall notify the University's Representative.

1.5. PERMITS, FEES INSPECTION

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

1.6. EXAMINATION OF SITE

1.6.1. Before submitting Bids, 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.

1.7. DRAWINGS, CHANGES AND INSTALLATION

1.7.1. 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.

1.7.2. 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 University's Representative to make reasonable changes required to accommodate conditions arising during the progress of the work, at no extra cost to the University.

1.7.3. 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.

1.7.4. Certain Details indicated on the Drawings are general in nature and specific labelled detail references to each and every occurrence of use are not indicated, however, such details shall be applicable to every occurrence.

1.7.5. 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 University's Representative. No piping shall be concealed in outside walls.

1.7.6. 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 University's Representative.

1.7.7. 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.

1.7.8. 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 University.

1.7.9. Leave areas clear of piping and ducts where space is indicated as reserved for future equipment and equipment for other Trades.

1.7.10. Adequate space and provisions shall be left for removal of coils and servicing of equipment, with minimum inconvenience to the operation of systems.

1.7.11. Where equipment is shown to be 'roughed-in only' obtain accurate information from the University's Representative before proceeding with the work.

1.7.12. 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 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 University.

1.7.13. 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 University's Representative) 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 University's Representative prior to rough-in. All mechanical and sprinkler services shall be located precisely.

1.7.14. Prepare dimensioned layouts of each room prior to rough-in for review by University. Do not proceed with any work until the University's Representative has reviewed the layout.

1.8. INSTALLATION, INTERFERENCE AND SETTING DRAWINGS

1.8.1. Installation, interference and setting Drawings dimensioned and to scale, shall be submitted for review by the University's Representative, as may be required or requested by the University's Representative 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 University's Representative.

1.8.2. 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.

1.8.3. 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.

1.8.4. 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 University's Representative 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.

1.8.5. 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.

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

1.9. MATERIALS

1.9.1. Make and quality of materials used in the construction of this work shall be subject to the approval of the University's Representative.

1.9.2. 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.

1.9.3. 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 OTHER DIVISIONS

1.10.1. Particular attention must be paid to the proximity of electrical conduit and cable to mechanical piping and equipment.

1.10.2. Pipes transporting hot fluids shall be installed at least 150 mm (6 in.) away from pipes carrying cold fluids, unless approval from the University's Representative is obtained to install services closer than 150 mm (6 in.).

1.10.3. Electrical conduits shall not touch or be supported from piping or ductwork.

1.10.4. 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 University.

1.10.5. 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.

1.10.6. The Prime Contractor shall confirm the available voltage for all single phase and three phase motors or other similar electrically driven equipment with the Electrical contractor prior to ordering the equipment. Any discrepancy between the requirements identified within the Contract Documents and those of the Electrical contractor shall be reported to the University's Representative 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 University.

1.11. TEMPORARY USE OF EQUIPMENT

1.11.1. Where the mechanical systems are operated during construction, the Contractor shall maintain the system and equipment in proper operating condition.

1.11.2. Prior to application for substantial performance of the work as certified by the University's Representative, 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 University.

1.12. EXISTING SERVICES AND EQUIPMENT

1.12.1. All changes and connections to existing services shall be made only in a manner and at a time approved by the University's Representative 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.

1.12.2. 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.

1.12.3. 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.

1.12.4. Where connections are made to existing services, existing insulation shall be made good under this Division.

1.13. PROVISION FOR FUTURE EXPANSION

1.13.1. 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.

1.14. INTERRUPTION OF SERVICES

1.14.1. Any interruption of the mechanical services to any part of the building shall come at a time agreeable to the University's Representative. Make all necessary arrangements with those concerned and include for any overtime required to ensure that the interruption is held to a minimum.

1.14.2. Testing and operation of major equipment shall be approved by the University's Representative to avoid excessive utility charges. Such testing to be generally carried out after normal working hours or on weekends.

1.14.3. All such overtime work shall be carried out without additional cost to the Contract.

1.15. METRIC CONVERSIONS

1.15.1. 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.

1.15.2. Conform to the Canadian Metric Practice Guide CSA-CAN3-2234-1-89.

1.16. EXISTING CONDITIONS

1.16.1. Visit the site and examine the existing conditions affecting the work of this Division.

1.16.2. No claim for extra payment shall be made for extra work made necessary by circumstances encountered due to conditions which were visible upon, or reasonably inferable from an examination of the site prior to submission of the Bid.

1.16.3. Be aware that there may be asbestos fibres present in various finishes or on various surfaces, in certain areas of the building. Arrange work so as not to disrupt these materials, or take full and necessary means to protect all personnel from contact with them, in a way to be approved by the University. Include all costs associated with any remedial work, with the Bid.

1.17. DEMOLITION

1.17.1. The Demolition Drawings show the general scope of the demolition and not exact details or total extent. For exact details and total extent each service must be carefully checked on site. Before removing services follow the service through to ensure other areas of the building are not affected. Open shafts, walls and ceilings as required to examine the services.

1.17.2. If there are no isolating valves readily available to isolate sections of pipe that requires removal, add valves as required. Co-ordinate with the University's Representative to shut-down the system. Install caps on all services. Add cap to all valves at the termination point of existing services.

1.17.3. Where valves are removed, remove valve tags, revise existing charts and hand tags over to University.

1.18. SCHEDULE, ACCESS, PROTECTION AND CLEAN-UP

1.18.1. The construction schedule places restrictions on the duration of construction within areas and the duration of shut-down of equipment. Refer to the Project Manual for all requirements.

1.18.2. Access to the site is limited to location and time of day. Access to areas of the building is limited to location and time of day. Refer to the Project Manual and conform to all requirements.

1.18.3. Refer to the security and protection requirements in the Project Manual and conform to all requirements. In particular no open flames shall be used without prior written approval of the University. There shall be no smoking, and the site shall be kept clean at all times.

1.19. HOUSEKEEPING PADS, CURBS AND SUPPORT PIERS

1.19.1. 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.

1.19.2. 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 University's Representative. 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

1.20.1. 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.

1.21. HOISTING FACILITIES

1.21.1. This Division shall provide its own hoisting facilities.

1.21.2. Hoisting facilities provided by Prime Contractor will be available for Subcontractors use at no cost. If hoist facilities are inadequate then Sub-Contractors must provide his own. Sub-Contractors must inform Prime Contractors of requirements before tender closing date.

2. Products

2.1. NOT USED

3. Execution

3.1. NOT USED

END OF SECTION 21 05 00.00

1. General

1.1. ABBREVATIONS

1.1.1. 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
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	-	Electricall y 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
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 Ace
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
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 21 05 01.00

1. General

1.1. WORK INCLUDED

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

1.2. RELATED WORK SPECIFIED ELSEWHERE

1.2.1. Refer to requirements of Project Manual.

1.3. PRINTS

1.3.1. Contractor will track/mark-up on drawings to mark project progress, changes and deviations and provide completed as-builts accordingly.

2. Products

2.1. NOT USED

3. Execution

3.1. DOCUMENTATION REQUIREMENTS

3.1.1. As the project progresses mark all changes and deviations from that shown on the drawings to the white prints.

3.1.2. After review and approval of service lines in trenches, take as-built measurements, including all depths, prior to commencement of backfilling operations. It will not be sufficient to check off line locations. Take and record definitive measurements for each service line. Show locations and inverts of buried piping on the drawings and dimensioned from grid co-ordinates.

3.1.3. Keep drawings up-to-date during construction and in addition to field measurements include change orders, site instructions and all other changes. Drawings shall be available for review at all times.

3.1.4. On completion of the work, forward to the University's Representative the two sets of drawings indicating all such changes and deviations for review by the University's Representative.

3.1.5. After the drawings have been reviewed, transfer all as-built mark-ups from prints to the USB using latest release of AutoCAD software. Submit prints/plots of drawings after information has been transferred to USB for review by the University's Representative.

3.1.6. Final as-built prints/plots shall not contain markings or corrections by hand (i.e. marker, pen, pencil, etc.). Drawings containing mark-ups shall be revised on computer and printed/plotted.

3.1.7. The project will remain incomplete and a holdback will be retained until satisfactory as-built drawings and USBs are provided.

3.1.8. The Contractor may request from the University's Representative the most current mechanical drawings on AutoCAD, USB format (at a nominal charge of $500.00).

3.1.9. The AutoCAD documents shall meet all the University's Representative's requirements.

3.2. CADD REQUIREMENTS

3.2.1. A complete list of layer names and brief description of each layer's use shall accompany all files.

3.2.2. Fonts for text shall be AutoCAD standard. Custom fonts, shape files, etc., are not to be used.

3.2.3. Final as-built drawings shall be returned on USB.

3.2.4. Each USB shall be clearly labelled with University's Representative, Contract number, file names and Drawing number. If a complete listing exceeds the label size provide a "readme.txt" file in ASCII format with each USB. A printed copy of the readme file shall accompany each USB.

3.2.5. All drawings shall be in the same units as issued on Bid Documents.

3.2.6. Provide a complete list of symbol (block) names with a description of each symbol.

3.2.7. Special effort shall be made to ensure that drafting is accurate: i.e. appropriate lines are indeed horizontal and vertical; lines that should intersect do but not over-intersect and ensure that entities are placed on correct layers.

END OF SECTION 21 05 02.00

1. General

1.1. WORK INCLUDED

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

1.2. RELATED WORK SPECIFIED ELSEWHERE

1.2.1. Comply with requirements of Project Manual for Submittals except as amended below.

2. Products

2.1. SHOP DRAWINGS

2.1.1. 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.

2.1.2. 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.

2.1.3. 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.

2.1.4. When requested, Shop Drawings shall be supplemented by data explaining the theory of operation – for example: a variable speed motor control – the University's Representative may also request that this information be added to the maintenance and operating manual.

2.1.5. 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 University's Representative.

3. Execution

3.1. SUBMISSIONS

3.1.1. Each Shop Drawing or catalogue sheet shall be stamped and signed by the Contractor to indicate that he has checked the Drawing for conformance with all requirements of the Drawings and Specifications, that he has co-ordinated this equipment with other equipment to which it is attached and/or connected and that he has verified all dimensions to ensure the proper installation of equipment within the available space and without interference with the work of other trades. Ensure that electrical co-ordination is complete before submitting Drawings for review.

3.1.2. Installation of any equipment shall not start until after final review of Shop Drawings by the University's Representative has been obtained.

3.1.3. Provide all necessary copies required for the trades, suppliers or other Consultants.

END OF SECTION 21 05 03.00

1. General

1.1. WORK INCLUDED

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

1.2. SUMBITTALS

1.2.1. 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.

2. Products

2.1. MATERIALS

2.1.1. 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.

2.1.2. 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.

2.1.3. 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.

.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.

2.1.4. 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.

2.1.5. 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

2.1.6. 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

2.1.7. 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.

2.1.8. Thermometers shall be Trerice, Taylor, Weksler, Winters or Ashcroft.

2.1.9. Pressure gauges shall be Trerice, Ashcroft, Morrison, Winters or Weksler.

2.1.10. Manometers shall be Airflow Developments or Dwyer.

2.1.11. Gauge glasses shall be Pyrex Red Line 12 mm (1/2 in.) equipped with leakproof pet cocks and ball check valves.

3. Execution

3.1. INSTALLATION

3.1.1. Locate all thermometers and pressure gauges so as to assure easy reading from the floor or platform.

3.1.2. Where direct reading instruments cannot be satisfactorily located use a remote instrument.

3.1.3. Locate remote instruments next to the point of the reading, on wall or structure.

3.1.4. Each remote or panel mounted instrument shall have an engraved lamacoid nameplate identifying the system and service.

3.1.5. Insert pipeline thermometer into tanks, equipment tappings or in pipeline using screwed tees or forged steel couplings, welded into the lines.

3.1.6. Duct thermometers shall be attached to duct using sheet metal screws through thermometer flange.

3.1.7. Insert pressure gauges into equipment tappings or in pipelines using screwed tees or forged steel couplings welded into the lines.

3.1.8. 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

3.1.9. 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.

3.1.10. For control valves with by-pass located thermometer in common pipe to allow for manual temperature control.

3.1.11. 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

3.1.12. 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.

3.1.13. 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.

3.1.14. 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.

3.1.15. Provide pressure gauges in the following areas:

.1 In and out of each pump

.2 In and out of all pressure reducing valves

.3 On each steam, hot water supply and hot water return header

.4 Air cushion tank or expansion tank

.5 Each fire standpipe at highest fire hose cabinet

.6 In and out of each heat exchanger, condenser, cooler or type of other heat exchanger

.7 And where specifically shown

3.1.16. Valved connections for pressure gauges shall be installed on each side of coils.

3.1.17. 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.

3.1.18. 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.

END OF SECTION 21 05 19.00

1. General

1.1. WORK INCLUDED

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

2. Products

2.1. MATERIALS

2.1.1. 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.

2.1.2. 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.

2.1.3. 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.

2.1.4. Supply flow meters to cover the complete operating ranges of all systems and charts for all these conditions.

2.1.5. All components shall be rated at 121 deg. C. (250 deg. F.) at 1725 kPa (250 psi).

2.1.6. High temperature hot water meters shall be permanently installed and pressure and temperature ratings increased as required.

3. Execution

3.1. INSTALLATION

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

END OF SECTION 21 05 20.00

1. General

1.1. WORK INCLUDED

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

1.1.2. Piping and equipment provided under the Mechanical Division shall be complete with all necessary supports and hangers required for a safe and workmanlike installation.

1.1.3. 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 University's Representative. 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 University's Representative.

2. Products

2.1. MATERIALS

2.1.1. Provide hangers and supports manufactured by Anvil International or E. Myatt & Co.

2.1.2. 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.

2.1.3. 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.

2.1.4. 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.

.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 University's Representative prior to proceeding with this arrangement.

2.1.5. Roof supports for pipe or duct runs greater than 30 ft. shall be Thaler Roof Specialities.

2.1.6. 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.

2.1.7. 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

2.2.1. 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.

2.2.2. 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.

2.2.3. Each constant support hanger shall be individually calibrated prior to shipment to support the exact loads specified.

2.2.4. 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%.

2.2.5. 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.

2.2.6. 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.

3. Execution

3.1. INSTALLATION

3.1.1. 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.

3.1.2. 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 University's Representative. 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.

3.1.3. All drilling for hangers, rod inserts and work of similar nature shall be done by this Division.

3.1.4. 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.

3.1.5. 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 University's Representative. Make adjustments as necessary to satisfy the requirements of the University.

3.1.6. 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.

3.1.7. 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 University's Representative. Make adjustments as necessary to satisfy the requirements of the University.

3.1.8. Suspension from metal deck shall not be allowed unless specifically accepted by the University's Representative. Drawings of the proposed method of suspension must be submitted for review.

3.1.9. 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.

3.1.10. Hanger rods shall be subject to tensile loading only. Suspended piping shall be supported by adjustable hanger rods sized as follows:

Pipe Size	Hanger Rod Diameter
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.)

3.1.11. 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.

3.1.12. Hanger spacing for plumbing and drainage services shall be in accordance with the plumbing code.

3.1.13. Hanger spacing for fire protection services shall be in accordance with the N.F.P.A. codes.

3.1.14. 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.

3.1.15. Suspending one hanger from another shall not be permitted.

3.1.16. 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.

3.1.17. For hot water or steam piping 38mm (1-1/2 in.) and smaller, use line size hangers.

3.1.18. 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.

3.1.19. 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 (1in.) 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

3.1.20. 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.

3.1.21. Unless otherwise specified or shown, all pipes supported from below shall be mounted on pipe rolls or pipe slides.

3.1.22. 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.

3.1.23. Unless otherwise specified or shown, vertical pipes shall be supported at least every fourth floor or every 12 m (40 ft.) maximum.

3.1.24. Pipe slides shall be pre-engineered type. Structural or fabricated tees shall be welded to the pipe or to the protection saddle as shown.

3.1.25. Install resilient hangers in accordance with Section 21 05 48.00

3.1.26. – VIBRATION AND NOISE CONTROL.

3.1.27. Install additional seismic supports in accordance with Section 23 05 49.00 – SEISMIC RESTRAINT SYSTEMS.

3.1.28. Other means of support shall be as shown or as specified hereunder.

3.1.29. 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 University’s Representative. 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 21 05 29.00

1. General

1.1. WORK INCLUDED

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

1.2. SUBMITTALS

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

2. Products

2.1. MATERIALS

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

2.1.2. All vibration isolation devices shall be Vibro-Acoustics or Kinetics Noise Control and shall be one manufacturer throughout the project.

2.1.3. 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.

2.1.4. 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.

2.1.5. Provide silencers in accordance with the Silencer Schedule.

2.1.6. Provide vibration isolation with integral seismic restraint for equipment intended to provide restraint from seismic and wind forces. Housings shall be capable of withstanding the applicable design forces for the specific installation. Installation shall be in accordance with Section 23 05 49.00 – SEISMIC RESTRAINING SYSTEMS.

2.2. INTERNAL ACOUSTIC DUCT LINING

2.2.1. Fiberglass duct liner shall be manufactured by Certainteed, Owens-Corning, Knauf Insulation, or Johns Manville.

2.2.2. Natural fibre duct liner shall be manufactured by Bonded Logic.

2.2.3. Duct lining shall have a minimum density of 24 kg/m3 (1.5 lbs/ft3).

2.2.4. Duct liner shall comply with the requirements of NFPA 90A and the “Duct Liner Materials Standard” of the Thermal Insulation Manufacturer’s Association.

2.2.5. 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.

2.2.6. All acoustical duct lining shall incorporate means to prevent fiber entrainment in the air stream.

2.2.7. The following ductwork shall be internally lined:

.1 All return air transfer ductwork.

.2 All ductwork specifically identified on the Drawings.

2.3. ACOUSTICAL DUCT AND PIPE LAGGING

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

2.3.2. 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/m^3 (1 lbs/ft^3) and shall have a minimum STC rating of 28.

2.3.3. 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.).

2.3.4. 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.

2.3.5. 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.

2.4. SILENCERS

2.4.1. 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”

2.4.2. 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.

2.4.3. 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.

2.4.4. 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.

2.4.5. No-media silencers shall contain no absorptive media of any kind. Attenuation shall be

achieved with controlled impedance membranes and broadly tuned resonators.

2.4.6. 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.

2.4.7. 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.

2.4.8. 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.

2.4.9. 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.

2.4.10. 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.

2.4.11. 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.

2.4.12. 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.

2.4.13. 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 University's Representative, 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.

2.5. ACOUSTIC PLENUMS

2.5.1. 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.

2.5.2. 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)	7	13	23	28	30	21	16	13

2.5.3. 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

2.5.4. Acoustical plenums shall have maximum pressure drop of 0.17 in wg.

2.5.5. 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.

2.5.6. 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.

2.5.7. Doors and windows shall have a transmission loss equal to the plenum panels.

2.5.8. 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.).

2.5.9. Unless specified otherwise, acoustical plenums shall be lined with 50 mm (2 in.) thick duct liner.

3. Execution

3.1. INSTALLATION

3.1.1. Obtain one copy of all Shop Drawings of equipment to be isolated showing weights, shaft centres and all dimensions.

3.1.2. On system start-up, inspect the complete installation and provide a report in writing.

3.1.3. Furnish concrete bases, including concrete fill, on springs or other vibration isolation materials for mechanical isolation.

3.1.4. 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.

3.1.5. Furnish and install neoprene mounting sleeves for hold-down bolts to prevent any metal to metal contact.

3.1.6. 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.

3.1.7. 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.

3.1.8. 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.

3.1.9. Piping, ductwork, conduit or mechanical equipment shall be supported from building structure, not hung from or supported on other equipment, pipes, or ductwork.

3.1.10. 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.

3.1.11. 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.

3.1.12. All wiring connections to mechanical equipment on isolators shall be made with a minimum long flexible conduit installed in a slack “U” shape.

3.1.13. Elastomeric isolators that will be exposed to temperatures below 0 deg. C. (32 deg. F.) shall be fabricated from natural rubber instead of neoprene.

3.1.14. Springs shall be designed and installed so that ends of springs remain parallel and all springs installed with adjustment bolts.

3.1.15. Springs shall be sized to be non-resonant with equipment forcing frequencies or support structure natural frequencies.

3.1.16. Fans and air handling units shall be levelled with fans operating before the flexible connectors are attached.

3.1.17. 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

3.2.1. 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.

3.2.2. 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.

3.2.3. 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.

3.2.4. 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.

3.2.5. 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.

3.2.6. 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.

.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.

3.2.7. 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.

3.2.8. 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.

3.2.9. 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.).

3.2.10. 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.)

.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.

3.2.11. 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 (2 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.

3.2.12. 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.

3.2.13. Vertical in-line pumps ceiling hung shall be supported by Type SPNH spring isolators. Refer to Mechanical Standard Details.

3.2.14. 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.

3.2.15. 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.

3.2.16. 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.

3.2.17. 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.

3.2.18. 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.

3.2.19. Flexible piping connectors shall be installed to connect piping of diameter 50 mm (2 in.) or greater to reciprocating or rotating equipment.

3.2.20. 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.

3.2.21. No rigid connections between equipment and the building structure shall be made that degrades the specified noise and vibration control system.

3.2.22. 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 University's Representative's attention prior to installation. If not brought to the attention of the University's Representative prior to installation corrective work necessitated by conflicts shall be at the Contractor's expense.

3.2.23. 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.

3.2.24. Except as noted elsewhere in this specification, outside the Mechanical Room all HVAC, compressed air, and domestic hot and cold water pipes with an inner diameter less than or equal to 50 mm (2 in.) shall be isolated from the structure with sponge neoprene, felt or glass /mineral fibre sleeves between the pipe and pipe clamp or with Type WP pads between the clamp and the structure. When compressed, the sleeve shall be not less than 3 mm (1/8 in.) in thickness.

3.2.25. All piping outside the Mechanical Room with inner diameter greater than 50 mm (2 in.) shall be supported on Type SPNM isolators or suspended by Type SPNH isolators. Where piping is ganged on a trapeze the piping shall rest on the trapeze, which shall be isolated from the structure by the appropriate isolators. Neoprene pipe riser guides shall be used where lateral restraint is required.

3.2.26. Any pipe crossing an acoustical joint shall have a twin-sphere neoprene flexible connector at the joint, with the exception of piping associated with fire protection, natural gas and compressed gases, and shall be suspended by Type SPNH isolators as follows:

.1 Pipes with inner diameters less than 50 mm (2 in.) shall be suspended by Type DDNH isolators for a minimum distance of 6m on each side of the joint.

.2 Pipes with an inner diameter of 50 mm (2 in.) or greater shall be suspended on Type SPNH isolators for a minimum distance of 6m on the non-isolated structure and for the entire pipe length on the isolated structure.

3.2.27. 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.

3.2.28. 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.

3.2.29. 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

3.3.1. 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.

3.3.2. Silencers for all venturi valves, variable air volume boxes, and fan powered variable volume boxes shall be as scheduled in the Silencer Schedule. Refer to Drawings for specific number required. The Silencer Schedule only indicates type. Receive from VAV box manufacturer dimension and sound data. Adjust silencers as required to match box discharge size. Adjust silencer as required to ensure insertion loss necessary to meet the room noise criteria.

3.3.3. Silencers shall have outside dimensions that match the connecting duct size unless indicated otherwise.

3.3.4. Submittals shall include certified test data on dynamic insertion loss, self-noise power levels, and pressure drop for reverse or forward flow. Silencer performance must have been substantiated by laboratory testing according to ASTM E477-06a 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.

3.3.5. The certification of the pressure drop, insertion loss and generated noise data shall be based upon tests of the same silencer for all measurements.

3.3.6. For specific silencers indicated on the Silencer Schedule, the manufacturer shall provide acoustic analysis for approval showing that this silencer will reduce mechanical fan noise to acceptable levels in the occupied space. Use sound power levels of actual equipment to be installed on project. Analysis shall include breakout noise calculations.

3.4. ACOUSTIC PLENUM

3.4.1. 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.

3.4.2. 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.

3.4.3. 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.

3.4.4. 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.

3.4.5. Acoustic plenums shall not be used as intake and exhaust air plenums that are directly connected to an exterior louver and where water may infiltrate the plenum.

3.5. ACOUSTICAL LINING OF DUCTS

3.5.1. Other ductwork shall be acoustically lined where shown on the Drawings.

3.5.2. 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.

3.5.3. 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 21 05 48.00

1. General

1.1. WORK INCLUDED

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

1.2. PRODUCTS

1.3. MATERIALS

1.3.1. Paint shall be compatible with the surface material to be painted.

1.3.2. Color code shall conform to CAN/CGSB 24.3-92 and ANSI A131-1981.

1.3.3. Pipe covering shall be SMS, Brady, and Seton equal to SMS Coil-Mark system pipe markers.

1.3.4. 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.

2. Execution

2.1. INSTALLATION

2.1.1. After completion of insulation and/or painting, all piping and ductwork shall be marked to show the service and direction of flow.

2.1.2. 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.

2.1.3. All pipe identification shall be installed in accordance with the manufacturer's recommendations.

2.1.4. 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.

2.1.5. 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.

2.1.6. Adhesive labels are not acceptable.

2.1.7. Gas piping shall be painted yellow for the entire length and identified with pipe identification markers. Banding shall not be accepted.

2.1.8. All electric traced piping shall have additional identification to show it is traced.

2.1.9. Identify ductwork with 50 mm (2 in.) stencils using black or white ink to contrast the surface being identified.

2.1.10. Identification location for ductwork shall conform to the guidelines for pipe and shall indicate flow medium, function, and direction.

2.1.11. Contractor shall ensure stenciling is performed in a neat, quality manner.

END OF SECTION 21 05 53.00

1. General

1.1. WORK INCLUDED

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

1.1.2. Nameplates for systems such as thermostatic controls, are covered in the Articles specifying the equipment.

1.1.3. Every piece of equipment shall have a nameplate.

1.2. SUBMITTALS

1.2.1. Submit samples of nameplates before installation.

2. Products

2.1. MATERIALS

2.1.1. 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.

2.1.2. The nameplates shall have the equipment type and name as indicated in the Equipment Schedules.

2.1.3. The nameplates shall have the service and area of the building served (e.g. Chilled Water – South Zone).

3. Execution

3.1. INSTALLATION

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

END OF SECTION 21 05 54.00

1. General

1.1. WORK INCLUDED

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

1.2. SUBMITTALS

1.2.1. Submit samples of charts and numbering system before installation.

2. Products

2.1. MATERIALS

2.1.1. 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.

2.1.2. 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.

2.1.3. For all other valves on standpipe and sprinkler system not required to have laminated number and nameplates, provide plastic tags as specified above.

2.1.4. Abbreviations and colour code shall be as shown on Standard Details.

3. Execution

3.1. INSTALLATION

3.1.1. Tags and nameplates shall be attached to the valve body or handle with brass hooks or chains.

3.1.2. 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.

3.1.3. Provide separate charts for all fire system nameplates and tags.

3.1.4. For extension and/or alterations to existing systems, provide new charts conforming in appearance to the existing charts.

3.1.5. Co-ordinate valve identification with pipe and ductwork identification.

3.1.6. 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”.

3.1.7. Charts shall be set in metal picture frames with a clear acrylic front and fastened securely where directed by University’s Representative.

3.1.8. All valve tag numbers for all systems shall be shown on the As-Built Drawings.

END OF SECTION 21 05 55.00

1. General

1.1. WORK INCLUDED

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

1.1.2. Submit Drawings showing size, type and location of all access doors, for review, before installation.

2. Products

2.1. MATERIALS

2.1.1. Access doors shall be Acudor.

2.1.2. Doors shall be with a 18 U.S. gauge, stainless steel door panel, rust resistant concealed hinges, flanged frame, and screwdriver operated lock. Acudor Model AS-9000.

2.1.3. 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.

2.1.4. 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 AS-9000.

2.1.5. 24 in. x 24 in. doors shall be used.

3. Execution

3.1. INSTALLATION

3.1.1. 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.

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

3.1.3. Group items in order to minimize the number of access doors required.

3.1.4. Each access door shall be installed to provide complete access to equipment for maintenance and servicing.

3.1.5. Make any changes to locations of access doors as directed by the University's Representative.

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

END OF SECTION 21 05 63.00

1. General

1.1. WORK INCLUDED

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

1.2. RELATED WORK SPECIFIED ELSEWHERE

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

2. Products

2.1. MATERIALS

2.1.1. Sleeves passing through stud partitions shall be 0.75 mm (0.0299 in. - 22 G.S.G.) steel.

2.1.2. Sleeves passing through concrete or masonry partitions shall be Schedule 40 steel pipe.

2.1.3. Sleeves passing through floors in finished areas and concealed spaces may be sheet metal or

2.1.4. 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.

2.1.5. 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 fo 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.

.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.

2.1.6. Firestopping and smoke seals shall be by Hilti, Tremco/Royal Quickstop, or 3M.

2.1.7. Escutcheons shall be satin finish stainless steel or satin finish chrome or nickel plated brass, with non-ferrous set screws. Do not use stamped steel split plates. Split cast plates with screw locks may be used. For escutcheons for plumbing fixtures refer to Section 22 42 00.00 - FIXTURES AND TRIM.

2.1.8. 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.

2.1.9. 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.

2.1.10. 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.

3. Execution

3.1. INSTALLATION

3.1.1. 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.

3.1.2. 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 University's Representative.

3.1.3. Provide sleeves for all service penetrations through walls, partitions, floor slabs, plenums and similar barriers.

3.1.4. 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.

3.1.5. 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.

3.1.6. 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.

3.1.7. 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.

3.1.8. Provide escutcheons at all penetrations of piping into finished areas, and at insulated pipes, make the escutcheons large enough to fit around the insulation.

3.1.9. Counter flash vertical duct penetrations through roof at intersection of roof curb and duct.

END OF SECTION 21 05 83.00

1. General

1.1. WORK INCLUDED

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

1.1.2. 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.

1.1.3. 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 the Project Manual.

1.1.4. Cutting and Patching shall be in accordance with requirements of the Project Manual.

2. Products

2.1. MATERIALS

2.1.1. All services and materials used for the cutting and patching shall meet all requirements specified in the Project Manual, and shall be carried out by professional workers experienced in the cutting and patching work to be done.

3. Execution

3.1. INSTALLATION

3.1.1. Locate all openings in non structural elements requiring cutting and patching in cooperation with the requirements of the Project Manual in a timely manner to avoid unnecessary cutting. All openings shall be shown on Drawings and submitted to the University's Representative for review. No holes through structure shall be permitted prior to review by the University's Representative.

3.1.2. Core drilling for individual services shall be by this Division. Cut all openings no larger than is required for the services.

3.1.3. Locate all openings in structure elements requiring cutting and patching and x-ray the structure to obtain University 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.

.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.

3.1.4. Obtain written approval from the University before cutting or core drilling any openings or holes.

3.1.5. Patch all openings after services have been installed to match the surrounding finishes.

END OF SECTION 21 05 88.00

1. General

1.1. WORK INCLUDED

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

1.1.2. Provide shop drawings with technical data on all types of insulation to be installed.

1.1.3. 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 University's Representative.

2. Products

2.1. MATERIALS

2.1.1. 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.

2.1.2. 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.

2.1.3. Extruded polystyrene insulation for ducts exterior to the building shall be Dow Weathermate Styrofoam insulation board.

2.1.4. 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.

2.1.5. Foamglass insulation shall be Pittsburgh-Corning.

2.1.6. 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.

2.1.7. Insulation jacket for services and ductwork exterior to the building shall be Flexclad-400 field applied U.V. protective, water and weather-resistant, pre-fabricated, self-adhering, sheet-type protective membrane, white.

2.1.8. As an option to canvas, insulation jacket for ductwork in the mechanical penthouse can be Flexclad-400 field applied U.V. protective, water and weather-resistant, pre-fabricated, self-adhering, sheet-type protective membrane, white.

2.1.9. 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.

2.1.10. High temperature insulation shall be Roxul SturdiRock molded, non-combustable, mineral wool fibre pipe insulation.

2.1.11. Corner beads and channels at floor line shall be 0.4 mm (28 ga.) galvanized sheet metal.

2.1.12. Fire retardant lagging coating shall be Chil-Seal CP-50 by Childers Products Company or Monsey Bakor equivalent.

2.1.13. Vapour barrier dam shall be Chil-perm CP30 with fibreglass cloth reinforcing.

2.1.14. 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.

2.1.15. 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.

2.1.16. Aluminum Jacket shall be 0.51mm (24 B&S Gauge - 0.0201 in) this sheet, embossed finish, with longitudinal slip joints and 50mm (2 in.) laps, die shaped fitting covers with factory applied moisture barrier.

2.1.17. 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.

3. Execution

3.1. INSTALLATION

3.1.1. Install insulation in accordance with the manufacturer’s printed installation instructions unless noted otherwise.

3.1.2. 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.

3.1.3. Apply insulation to clean, dry surfaces only while ambient temperature is at least 10 deg. C. (50 deg. F.).

3.1.4. Commence application of insulation following required testing of piping, ductwork, and apparatus where such items are to be covered.

3.1.5. Recover all insulation, where exposed to view and not concealed in ceiling spaces or pipe spaces with a PVC jacket and preformed PVC elbows and fittings sealed with adhesive. PVC shall not be used on steam piping or piping services that will be painted.

3.1.6. Cover all piping insulation external to the building and where specifically shown with field applied mesh reinforced mastic.

3.1.7. Ground source system piping shall be considered as a dual temperature service.

3.1.8. 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 water piping

.3 Glycol piping

.4 Dual temperature piping

.5 Condenser water pipe piping

.6 and exterior ductwork

3.1.9. Terminate insulation on pipes passing through fire rated walls or floors, and fit tight to the fire stop material.

3.1.10. 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, sections, or insulation blankets. 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.

3.1.11. On piping systems specified to be insulated, include insulation on valves, flanges, couplings and unions.

3.1.12. Do not use staples to secure joints of insulation jackets.

3.1.13. Hot Services

.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 with removable insulation blankets.

.3 Apply glass fibre or mineral fibre (RN to check) 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 High pressure steam piping 204 deg. C. (400 deg. F.) and less shall be covered with fibre glass or mineral fibre pipe insulation. Steam piping over 204 deg. C. (400 deg. F.) shall be covered with calcium silicate applied in two layers with staggered joints and wired on. Finish shall be 2 coats of cement covering and recovered with canvas. Refer to the table following for required insulation thicknesses.

.6 Insulate all hot gas piping in conditioned spaces with preformed glassfibre insulation. Cover exterior piping with field applied mesh reinforced mastic.

3.1.14. 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 larger

Provide foamglass, Thermo-12 or calcium silicate insulation inserts the full length of shields at all hangers and supports.

.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 lines with 12 mm (1/2 in.) flexible elastomeric insulation. Cover exterior piping with field applied mesh reinforced mastic.

3.1.15. Chilled water, spray coil and domestic pumps. Adhere 25 mm (1 in.) thick flexible elastomeric insulation.

3.1.16. 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.

3.1.17. 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 carrying chilled condensate to closest branch or main.

.4 All piping passing through high humidity area

.5 Sanitary drainage pipe from barrier free lavatories

3.1.18. 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.

.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.

3.1.19. 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 Silencers and fan capacity monitors. Insulate to suit the service and location.

3.1.20. 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.).

3.1.21. 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.

3.1.22. Chillers. Insulate in accordance with the manufacturer's printed insulation instructions, and insulate all components shown or noted in the instructions. Insulate evaporator, water heads, suction connections and auxiliary water piping of centrifugal water chillers. Use 25 mm (1 in.) thick flexible elastomeric insulation. Insulate auxiliary water piping as per chilled water piping. Provide removable sections of insulation at all components that require servicing, and secure with stainless steel straps.

3.1.23. 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.

3.1.24. Shell and coil 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 gasketted 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 shell and coil heat exchangers.

3.1.25. 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.

3.1.26. 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	Insulation Conductivity Conductivity [W(m-K)] [h-cu.ft. – deg. F. (Btu-in.)]	Mean Rating Temp deg. C. (deg. F.)	Runouts Up to 50 (2)	Nominal Pipe Diameter – mm (in.) 25 (1) and less	32-50 (1-1/4 to 2)	65-100 (2-1/2 to 4)	125-150 (5-6)	200 (8) and up
Heating Systems (Steam, Steam Condensate, Heating Glycol and Heating Water)								
Above 177 Above (350)	0.049 (0.34)	121 (250)	38 (1.5)	65 (2.5)	65 (2.5)	75 (3.0)	87 (3.5)	87 (3.5)
122-177 (251-350)	0.045 (0.31)	93 (200)	38 (1.5)	50 (2.0)	65 (2.5)	65 (2.5)	87 (3.5)	87 (3.5)
94-121 (201-250)	0.043 (0.30)	66 (150)	25 (1.0)	38 (1.5)	38 (1.5)	50 (2.0)	50 (2.0)	87 (3.5)
61-93 (141-200)	0.042 (0.29)	52 (125)	25 (1.0)	25 (1.0)	25 (1.0)	38 (1.5)	38 (1.5)	38 (1.5)
41-60 (105-140)	0.040 (0.28)	38 (100)	25 (1.0)	25 (1.0)	25 (1.0)	25 (1.0)	38 (1.5)	38 (1.5)

Domestic and Service Hot Water Systems [c]								
41 and greater	0.040	38	25	25	25	38	38	38
(105) and greater	(0.28)	(100)	(1.0)	(1.0)	(1.0)	(1.5)	(1.5)	(1.5)
Cooling Systems (Chilled Water, Chilled Glycol, Brine and Refrigerant)								
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	24	25	25	38	38	38	38
Below (40)	(0.27)	(75)	(1.0)	(1.0)	(1.5)	(1.5)	(1.5)	(1.5)

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

[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 21 07 00.00

1. General

1.1. WORK INCLUDED

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

2. Products

2.1. NOT USED

3. Execution

3.1. INSTALLATION

3.1.1. 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.

3.1.2. 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.

3.1.3. 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.

3.1.4. Any unpainted steel surfaces, installed for longer than one year prior to the completion date, shall be prime coated under this Division.

3.1.5. 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.

3.1.6. All equipment installed or stored on site shall be maintained in accordance with manufacturers recommended instructions (i.e. rotate shafts on fans, pumps, etc).

3.1.7. 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.

3.1.8. All cleaning and protective measures shall be in accordance with the SMACNA – IAQ Guidelines for Occupied Buildings under Construction.

END OF SECTION 21 08 02.00

1. General

1.1. WORK INCLUDED

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

1.1.2. Comply with all requirements of Section 21 05 02.00 – RECORD DRAWINGS.

1.1.3. Comply with all requirements of Section 21 05 03.00 – SHOP DRAWINGS.

1.1.4. Comply with all requirements of Project Manual.

2. Products

2.1. REQUIREMENTS FOR MANUALS

2.1.1. 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 USB.

2.1.2. 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)”.

2.1.3. Terminology used in all the Sections shall be consistent.

2.1.4. 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.

2.1.5. Volume One shall contain a section with all necessary warranty information.

2.1.6. Each binder shall have a complete index for all volumes.

2.1.7. Each binder shall be no more than half filled.

2.1.8. 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.

2.1.9. There shall be a separate section for all Insurance Certificates, Test Certificates, Verification Forms and Test Forms.

2.1.10. All relevant information relating to a system or product shall be contained within one binder.

2.1.11. The manual sections shall follow the specification sections.

2.1.12. 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

2.2.1. Equipment data shall contain:

.1 Operating instructions

.2 Operating conditions such as temperature and pressure

.3 Location of equipment

.4 Maintenance instructions and schedules for one year routine

.5 Recommended list of spare parts

.6 Lubrication schedule

.7 A trouble shooting table showing where to look for problems under various conditions of malfunction

.8 All wiring diagrams

.9 Equipment operating curves

.10 Equipment nameplate data and serial numbers

2.2.2. 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.

2.2.3. Sub-Contractor manuals are required for:

.1 BAS

.2 Water and air balancing

2.2.4. 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

2.3.1. Instruct the University's representative in all aspects of the operation and maintenance of systems and equipment.

2.3.2. Comply with all requirements of Section 21 08 00.00 – COMMISSIONING, for duration of tests.

2.3.3. Instruct the University for a minimum of five (5) working days.

2.3.4. Arrange for and pay for the services of engineers and other manufacturer's representatives

required for instruction on the systems and the equipment as requested by the University's Representative and/or the University.

2.3.5. 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, University's Representative, etc.), system or equipment involved and signature of the University'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.

2.3.6. Review information with the University's representative to ensure that all information required has been provided.

2.3.7. Mechanical equipment and systems included in the instruction requirements are:

.1 Heating water generators and associated equipment

.2 Automatic controls and instrumentation

.3 Noise and vibration

.4 Heating water distribution systems

.5 Steam distribution systems and condensate

.6 Air handling distribution and components

.7 Humidification systems

2.4. TRIAL USAGE

2.4.1. The University 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 University 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.

3. Execution

3.1. NOT USED

END OF SECTION 21 08 03.00

1. General

1.1. WORK INCLUDED

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

2. Products

2.1. MATERIALS

2.2. FINISHED AREAS

2.2.1. 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.

2.2.2. 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.

2.2.3. 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.

2.2.4. 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

2.3.1. 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.

2.3.2. Cleanouts at the base of each vertical stack and rain water leader shall be either Daisy or Barrett type.

3. Execution

3.1. INSTALLATION

3.1.1. Cleanouts in furred ceiling spaces shall extend up through floor slab above, except where the University's Representative gives specific approval to its location in the ceiling space.

3.1.2. Cleanouts shall be installed in horizontal drains at each change of direction and as required.

END OF SECTION 22 05 76.00

1. General

1.1. WORK INCLUDED

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

2. Products

2.1. MATERIALS

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

2.2. FINISHED AREAS

2.2.1. Floor drains in finished areas shall be all coated cast iron body, flashing clamp with seepage openings and adjustable 127 mm (5") diameter nickel bronze 6.35 mm (1/4") thick strainer, secured with S.S. screws, 100 mm (4") throat on strainer. Drain shall be complete with trap primer connection. J.R. Smith 2005A, Zurn ZN-415-B5, Mifab F1100C-5-1, Watts FD-100-C-A5-1.

2.2.2. 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.

2.2.3. 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.

2.2.4. 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.

2.2.5. 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

2.3.1. 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.

2.3.2. 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.

2.3.3. 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.

2.3.4. Floor drains in floating floor areas shall be cast iron body, drainage flange, nominal 200 mm (8 in.) dia. heavy-duty strainer, movement compensator and vibration isolator. J.R. Smith 9340, Zurn Z-556-FS, Mifab F1600C-4, Watts FD-620-C.

2.3.5. Funnel floor drains in floating floors shall be similar to floor drains in floating floors but with nominal 75 mm x 225 mm (3 in. x 9 in.) oval funnel. J.R. Smith 9340-3591, Zurn Z-556-FS-FO, Mifab F1600C-4-G-50, Watts FD-620-C-G-50.

2.3.6. 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

2.4.1. Provide floor drains in air plenums on the suction and discharge side of fans with deep seal traps.

2.4.2. 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.

2.4.3. Provide a running trap and cleanout for each pit drain.

3. Execution

3.1. NOT USED

END OF SECTION 22 13 19.13

1. General

1.1. WORK INCLUDED

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

2. Products

2.1. MATERIALS

2.1.1. Pipes and fittings shall be in accordance with the following unless specified otherwise by local authorities.

2.1.2. 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 etc.

.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.

.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 1380 kPa (200 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.

2.1.3. 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.

.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.

2.1.4. 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.

2.1.5. 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.

2.1.6. 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.

2.1.7. Vent stack covers shall be equal to Thaler Metal Industries SJ-24/SJ-25 and shall be 1100-0T 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.

2.1.8. Buried storm and sanitary inside the building shall be Class 4000 grey cast iron soil pipe, black bituminous coating, fittings and means of joining to meet the requirements of CAN/CSA B70. Mechanical couplings for drain, waste, vent pipe and sewer pipe to meet the requirements of CAN/CSA B602. Bituminous fibre, vitrified clay, ABS and PVC pipe are not acceptable.

2.1.9. 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.

2.1.10. 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.

2.1.11. Sump and sewage pump discharge shall be Schedule 40 galvanized steel pipe with galvanized malleable iron fittings or Type “L” copper.

2.1.12. Laboratory drains and vents shall be in accordance with Section 22 63 53.00 – LABORATORY LIQUID SYSTEM.

2.1.13. Field tile shall be vitrified clay pipe or No-Co-Rode pipe.

2.1.14. 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 BGS, 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.

2.1.15. Back-flow preventers for connection to wall hydrants, hose bibbs, hot water heating systems, and similar uses, shall be Watts No. 9 or 909 or Hersey-Beeco with C.S.A. listing.

2.1.16. 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).

2.1.17. 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.

2.1.18. 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.

2.1.19. 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.

.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.

2.1.20. 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.

2.1.21. Backwater valves shall be by J.R. Smith, Zurn, Mifab, or Watts. Valves shall be complete with cast iron body and bolted cover, bell inlet, spigot outlet, bronze double fulcrum top hung revolving flap and bronze valve seat.

.1 Unit up to 300 mm (12 in.) below grade, shall be complete with access cover at grade and extension sleeve between cover and valve casing.

.2 Unit more than 300 mm (12 in.) below grade, shall be complete with minimum 600 mm (24 in.) dia. galvanized steel, concrete or vitrified clay tile access pit with 600 mm (12 in.) dia. heavy duty scoriated manhole cover and frame.

2.1.22. 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.

2.1.23. 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.

2.1.24. 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).

2.1.25. 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).

2.1.26. Storm drainage piping from manhole outside building to creek, drainage course, may be corrugated galvanized steel using Armco standard round corrugated steel culvert.

2.1.27. Thermostatic mixing valves

.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.

3. Execution

3.1. INSTALLATION

3.1.1. Valves shall be provide 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.

3.1.2. 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.

3.1.3. Drain valves shall be installed at each low point in the piping systems and at each tank.

3.1.4. Blow-off valves shall be provided on each 65 mm (2-1/2 in.) strainer and larger.

3.1.5. Globe valves shall be installed as shown and in each bypass.

3.1.6. Back-flow preventers shall be installed for connections to wall hydrants, hose bibbs, 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 bibbs 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.

3.1.7. Check valves shall be installed as shown and where required to prevent backflow.

3.1.8. 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.

3.1.9. 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.

.1 Design data of the American Concrete Pipe Association as distributed by the Ontario Concrete Pipe Association.

.2 Cast iron soil pipe and fittings handbook of the cast iron soil pipe institute.

.3 Sewer pipe manual of Canron.

.4 Sewer Design & Construction of the Water Pollution Control Federation.

.5 The Blue Brute and Ring Tite PVC gravity sewer pipe installation Guide by Manville.

3.1.10. Pipe passing under a driveway or parking lot with less than 1.5 m (5 ft.) of cover shall be encased in 150 mm (6 in.) of 13800 kPa (2000 psi) concrete on top, bottom and sides.

3.1.11. 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.

3.1.12. PC4 joiting 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.

3.1.13. Connections between copper and steel pipe shall be made with brass or bronze fittings where other type of connection is not specified in regulations.

3.1.14. All piping shall run parallel with closest wall.

3.1.15. Piping in walk-in pipe spaces shall be installed as close to one wall as possible.

3.1.16. 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. The water pressure at fixture level on the first floor is N kPa (N psig).

3.1.17. 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.

3.1.18. Vent stack covers shall be properly sized for each vent penetrating the roof. Mechanical Division shall supply vent stack covers for installation and flashing by the roofing contractor.

3.1.19. Refer to Section 22 63 53.00 – LABORATORY LIQUID SYSTEM.

3.1.20. 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.

3.1.21. Provide a thermostatic mixing valve on discharge of domestic hot water systems.

END OF SECTION 22 11 13.00

1. General

1.1. WORK INCLUDED

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

1.1.2. Systems shall be installed in accordance with all applicable codes, including C.S.A. Z.305.1 and C.S.A.Z.32.3.

1.1.3. Conform to the requirements of TSSA.

2. Products

2.1. MATERIALS

2.2. LABORATORY (NATURAL) GAS

2.2.1. Conform with Section 23 11 23.00 – NATURAL GAS PIPING SYSTEM.

2.3. PIPE AND FITTINGS (EXCEPT NATURAL GAS)

2.3.1. Pipes shall be seamless Type K or L (A.S.T.M. B-88) hard temper copper tubing or standard weight (Schedule 40) brass pipe. Soft temper copper tubing shall be used underground.

2.3.2. Fittings shall be wrought copper, brass or bronze for solder or brazed connections for copper tubing and screw type brass, or bronze, or copper brazing type fittings for brass pipe. Any system in excess of 15 psig and larger than 19 mm (3/4 inch) shall meet the requirements of TSSA. Soldered joints are not acceptable and shall be brazed.

2.3.3. Exhaust pipes from vacuum pumps up through to roof may be Schedule 40 steel pipe with welded fittings and flexible connections to compressor. Vent through roof shall have weather proof rain cap.

2.4. IN-LINE VALVES

2.4.1. In-line valve assemblies shall be located as shown and as required by code, and shall be full flow, double seal, ball type with bronze body, Buna-N seals and O ring packing, chrome plated brass ball and designed for working pressures up to 2070 kPa (300 psig). Only one quarter turn of the handle shall be required to operate the valve from the open to closed position. Valves shall be provided with Type K or L copper tube extensions for making connection to the pipeline. All valves shall be serviceable in the line and supplied clean and prepared for service. Colour coded gas identification labels shall be provided for each valve.

2.4.2. In-line valve assemblies shall be Ohio Series 207-6000.

3. Execution

3.1. INSTALLATION

3.2. LABORATORY (NATURAL) GAS

3.2.1. Conform with Section 23 11 23.00 – NATURAL GAS PIPING SYSTEMS.

3.2.2. Conform with Section 22 44 00.00 – LABORATORY FURNITURE AND FIXTURES. Gas cocks in laboratory furniture are installed by the Laboratory Furniture and Equipment Supplier. This Division shall pipe the natural gas and connect to the gas cocks.

3.2.3. Each laboratory gas piping outlet shall be complete with shut off valves, dirt/drip pocket and threaded metal plug or nipple cap. Install in readily accessible area.

3.2.4. Shafts containing gas piping shall be vented at high and low level in accordance with CAN1-B149.1 and CAN1-B149.2.

3.2.5. Each laboratory shall have a shut-off valve in recessed cabinet. Clearly identify shut-off valves by means of signs.

3.3. PIPING AND FITTINGS (EXCEPT NATURAL GAS).

3.3.1. Coordinate connections with laboratory furniture and equipment section for required outlets in laboratory furniture. This Division shall pipe the air and vacuum piping and connect to the outlets.

3.3.2. Install flexible connection at piping connection to compressors.

3.3.3. Install shut-off valves at outlets, major branch lines and elsewhere as indicated.

3.3.4. Install quick-coupler chucks and pressure gauges on drop pipes.

3.3.5. Install unions to permit removal or replacement of equipment.

3.3.6. Install tees in lieu of elbows at all changes in direction of piping. Install plug in all open ends of tees.

3.3.7. Grade piping at 1% slope minimum.

3.3.8. Make branch connections from top of main.

END OF SECTION 22 63 13.53

1. General

1.1. WORK INCLUDED

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

2. Products

2.1. MATERIALS

2.1.1. Pipes and fittings shall be in accordance with the following unless specified otherwise by local authorities.

2.1.2. All drainage Laboratory drainage systems are shown on the Drawings.

2.1.3. All cleanouts and manholes on the laboratory drainage and venting system shall be same material as the piping and shall be specifically labelled as acid resistant.

2.2. LABORATORY DRAINAGE SYSTEM – PVDF

2.2.1. The laboratory drainage and venting system above and below grade shall be PVDF pipe as manufactured by Orion under the trade name Blueline. Where laboratory drain branches enter mains of standard material, the manufacturer's recommended adapter from the polypropylene pipe to the standard material shall be used. Vent termination through roof shall be polypropylene.

2.2.2. The laboratory drainage and vent system shall meet the requirements of CSA-B181.3-M86 Polyolefin Laboratory Drainage Systems and CSA-B182.1-M92 Plastic Drain and Sewer Pipe and Pipe Fittings. Flame requirements shall be based on ASTM D635.

2.2.3. Obtain and submit for review a list of chemicals to confirm suitability of pipe material and liners.

2.3. PURIFIED WATER DISTRIBUTION SYSTEM – PVC (NON SANITARY)

2.3.1. Purified water system include: reverse osmosis water, deionized water, and distilled water.

2.3.2. The purified water distribution system shall be Schedule 40 [80] (in accordance with ASTM D1785), PVC piping as manufactured by IPEX.

2.3.3. The purified water distribution system shall meet the requirements of CSA-B137.2-M89 and CSA-B137.3-M90. The PVC piping and fittings shall be U.L.C. approved with a flame spread rating less than 25 when tested in accordance with the CAN4-S102.2 standard.

2.3.4. Connection to valves, meters, pumps and other fittings shall be made with the manufacturer's

recommended adapters.

2.3.5. Self draining diaphragm valves, zero dead leg valves and ball valves shall be of a construction specifically for use in purified water systems.

2.3.6. Hangers shall be specifically manufactured for hanging this polypropylene piping system.

3. Execution

3.1. INSTALLATION

3.2. LABORATORY DRAINAGE

3.2.1. The installation and testing of the laboratory drainage system shall be in accordance with Canadian Plumbing Code, Ontario Plumbing Code and local authorities having jurisdiction.

3.2.2. Refer to Section 22 44 00.00 – LABORATORY FURNITURE AND FIXTURES.

3.2.3. Supply and install complete laboratory drainage and independent laboratory venting system to roof termination consisting of the following materials:

3.2.4. The extent of laboratory drainage lines is shown on Drawings.

3.2.5. PVDF or PVC piping system shall be used for the entire laboratory drainage and venting system (current manufacturer's installation instructions) from the connection to the laboratory equipment or fixture to the acid neutralization tanks or termination of vent pipe to open air. Polypropylene or PVC shall not be used for vertical risers and piping in ceiling spaces acting as a return air plenum. Piping in risers and ceilings shall be glass piping.

3.2.6. Pipes penetrating a fire separation shall be sealed by a fire stop system than, when subject to the fire test method in CAN4-S115-M has an FT rating not less than the fire rating resistance of the fire separation. Refer to Section 21 05 83.00 – SLEEVES AND ESCUTCHEONS.

3.2.7. Install all glass piping system in strict accordance with the current manufacturer's installation instructions. Make glass-to-glass connections with compression type bead to bead and bead to plain end couplings with encapsulating outer shell. Particular care shall be taken to ensure that glass piping or fittings are not installed in direct contact with concrete. Rigid fibreglass insulation or other padding approved by the manufacturer shall be used. Any glass piping or fitting which comes into contact with concrete shall be discarded and replaced with new glass piping.

3.2.8. Install polypropylene pipe system in strict accordance with the current manufacturer's installation instructions. Make polypropylene-to-polypropylene by electrical fusion coils made of conductive metal wire coated with polypropylene and molded into a flame retardant polypropylene fusion collar. Spacing of hangers and joining technique is extremely important and shall be rigidly adhered to.

3.2.9. Install PVC pipe system in strict accordance with the current manufacturer's installation instructions. Make PVC-to-PVC connections using PVC solvent cement. Spacing of hangers and joining technique is extremely important and shall be rigidly adhered to.

3.2.10. Allow for expansion and contraction of piping as detailed in the current manufacturer's installation instructions.

3.2.11. Refer to Section 22 11 13.00 – PIPE, VALVE AND FITTINGS (PLUMBING SYSTEMS) for additional installation requirements of buried piping.

3.2.12. 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.

3.2.13. Test in accordance with all applicable plumbing codes.

3.3. PURIFIED WATER DISTRIBUTION SYSTEM

3.3.1. The entire purified water distribution system shall meet the quality standards outlined for the purified water system equipment in Section 22 67 19.00 – DOMESTIC WATER TREATMENT.

3.3.2. Refer to Section 22 44 00.00 – LABORATORY FURNITURE AND FIXTURES and Section 22 42 00.00 – FIXTURES AND TRIM for details on fittings.

3.3.3. Installation of the purified water system shall accommodate continuous flow through the piping with no dead legs (loop ends).

3.3.4. Supply and install complete purified water system consisting of the following materials:

3.3.5. The extent of the purified water distribution system is shown on Drawings.

3.3.6. PVC piping systems shall be used for the entire purified water system except for vertical risers and piping in ceiling spaces acting as a return air plenum. Make PVC-to-PVC connections using PVC solvent cement. Sani-Pro K piping system, stainless steel tubing system, or glass piping system shall be used for vertical risers and for piping in ceiling spaces acting as return air plenums.

3.3.7. Install purified water distribution pipe systems in strict accordance with the manufacturer's current installation instructions.

3.3.8. After installation piping shall be tested water tight at 1034 kPa (150 psig). Tests shall be witnessed by Engineer's Representative.

The pure water shall be drained, refilled and flushed, tested and sterilized until it meets the requirements outlined for the purified water system equipment in Section 22 67 19.00 – DOMESTIC WATER TREATMENT. Follow the manufacturer's current installation instructions for the recommended procedure.

END OF SECTION 22 63 53.00

1. General

1.1. WORK INCLUDED

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

1.1.2. The Contractor shall include for all costs to administer and obtain bids from the acceptable Independent Companies and shall submit unopened bids for review and selection by the University's Representative.

1.1.3. 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.

1.1.4. 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.

1.1.5. The following systems shall be tested and balanced:

.1 Chilled water distribution

.2 Heat exchangers and glycol heating systems

.3 Steam/condensate systems

.4 Glycol fill systems

.5 Plumbing systems

1.1.6. The Contractor shall provide a schedule for all testing and balancing.

1.2. QUALITY ASSURANCE

1.2.1. The balancing of the water and air systems shall be performed by the same balancing company.

1.2.2. Balancing companies shall be members of A.A.B.C. or N.E.B.B.

1.2.3. Acceptable balancing companies are limited to the following:

.1 Flowset

2. Products

2.1. NOT USED

3. Execution

3.1. THE CONTRACTORS TESTING AND BALANCING

3.1.1. Test all plumbing systems in accordance with all applicable plumbing codes.

3.1.2. 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.

3.1.3. 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 University's Representative .

3.1.4. 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.

3.1.5. Where multiple branch domestic hot recirculation or drinking fountain chilled water lines are installed, the flow in these shall be balanced to ensure hot or chilled water, as applicable, at all fixtures.

3.1.6. 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.

3.1.7. 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.

3.1.8. 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.

3.1.9. Co-ordinate with the Independent Company to ensure all necessary valves for balancing the system are installed.

Notify the University's Representative 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 University.

3.1.10. Ensure that all cooling coil drain pans drain freely and that no standing water remains.

3.1.11. Ensure access is provided to all valves and equipment that requires servicing.

3.1.12. 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.

3.1.13. 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.

3.1.14. The Contractor shall provide copies of all Shop Drawings requested by the Independent Company.

3.2. THE INDEPENDENT COMPANY'S TESTING AND BALANCING

3.2.1. The University's Representative in consultation with the Contractor, shall appoint an Independent Company to measure and report to the University's Representative. The Independent Company shall submit a proposal to the University's Representative 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

3.2.2. 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.

3.2.3. 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.

3.2.4. 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.

3.2.5. 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.

3.2.6. Adjust bleed-off from cooling tower, evaporative condensers, spray coils and similar equipment to prevent lime deposits. Record bleed-off rate.

3.2.7. 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 23.00 – BUILDING AUTOMATION SYSTEM / SEQUENCE OF OPERATION. If the Independent Company fails to co- ordinate with Section 23 09 23.00 – BUILDING AUTOMATION SYSTEM / SEQUENCE OF OPERATION 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 University.

3.2.8. 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.

3.2.9. Co-ordinate with the Contractor to ensure that all necessary valves for control and balancing are installed in all locations required. Notify the University's Representative 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 University.

3.2.10. 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.

3.2.11. At the time of final inspection, recheck in the presence of the University's Representative random selections of data recorded in the certified report. Points or areas for recheck shall be selected by the University's Representative and be approximately 10% of the report data.

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

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

3.2.14. 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 University.

3.2.15. Following final acceptance of the certified reports by the University's Representative , 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.

3.2.16. 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 University's Representative.

END OF SECTION 23 05 93.13

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)

1. General

1.1. WORK INCLUDED

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

1.1.2. This Section is split into two Sections of work, the Contractors testing and balancing and the Independent Company's testing and balancing.

1.1.3. The Contractor shall include for all costs to administer and obtain bids from the acceptable Independent Companies and shall submit unopened bids for review and selection by the University's Representative.

1.1.4. 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.

1.1.5. 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.

1.1.6. 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)

1.1.7. Read, fully understand and comply with all requirements of the Section 21 08 00.00 – COMMISSIONING.

1.1.8. The Contractor shall provide a schedule for all testing and balancing.

1.2. QUALITY ASSURANCE

1.2.1. The balancing of the water and air systems shall be performed by the same balancing company.

1.2.2. Balancing companies shall be members of A.A.B.C. or N.E.B.B.

1.2.3. Acceptable balancing companies are limited to the following:

.1 Flowset

2. Products

2.1. NOT USED

3. Execution

3.1. THE CONTRACTORS TESTING AND BALANCING

3.1.1. 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.

3.1.2. Refer to Section 23 31 13.00 – DUCTWORK AND SPECIALITIES for pressure ratings of ductwork and systems.

3.1.3. 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.).

3.1.4. 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.

3.1.5. 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.

3.1.6. 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.

3.1.7. Co-ordinate with the Independent Company to ensure all necessary manual dampers and splitter dampers for balancing the systems are installed. Notify the University's Representative 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 University.

3.1.8. The testing equipment shall be itemized in the test reports and shall be approved by the Independent Company and the University's Representative before any tests are undertaken. Calibration of the test equipment must be confirmed and approved by the Independent Company before any tests are undertaken.

3.1.9. Ensure access is provided to all fire dampers and equipment that requires servicing.

3.1.10. 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.

3.1.11. 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.

3.1.12. The Contractor shall provide copies of all Shop Drawings requested by the Independent Company.

3.1.13. 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

3.2.1. The University's Representative in consultation with the Contractor, shall appoint an Independent Company to measure and report to the University's Representative. The Independent Company shall submit a proposal to the University's Representative 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

3.2.2. Co-ordinate with the Contractor to ensure that all necessary manual and splitter dampers for balancing are installed in all locations required. Notify the University's Representative 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 University.

3.2.3. 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).

3.2.4. 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.

3.2.5. The Contractor will provide new filters, etc. required for the measurements. Cost of filters shall be paid for out of the allowance.

3.2.6. 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.

3.2.7. 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 23.00 – BUILDING AUTOMATION SYSTEM / SEQUENCE OF OPERATION. If the Independent Company fails to co-ordinate with Section 23 09 23.00 – BUILDING AUTOMATION SYSTEM / SEQUENCE OF OPERATION 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 University.

3.2.8. 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.

3.2.9. Ensure all thermostats and controls are set to give specified conditions and include settings is report.

3.2.10. For additional information on variable volume boxes refer to Section 23 36 16.00 - VARIABLE VOLUME BOXES.

3.2.11. 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.

3.2.12. 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.

3.2.13. 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.

3.2.14. At the time of final inspection, recheck in the presence of the University's Representative random selections of air quantities and fan data recorded in the certified report. Points or areas for recheck shall be selected by the University's Representative 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 if rejected, rebalance all systems, submit new certified reports and make a reinspection, all at no additional cost to the University.

3.2.15. Following final acceptance of the certified reports by the University's Representative, 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.

3.2.16. 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 University's Representative.

Submit a sample to the University's Representative for review.

END OF SECTION 23 05 93.23

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)

1. General

1.1. WORK INCLUDED

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

1.1.2. All gate, globe and check valve shall be approved under Canadian Interprovincial Regulations for the Construction and Inspection of Boilers, Tanks, and Appurtenances.

1.1.3. Provide submittal drawings in accordance with Section 21 05 03.00 – SHOP DRAWINGS for all valves, appurtenances, and grooved components.

1.1.4. 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.

2. Products

2.1. MATERIALS

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

2.2. STEAM UNDER 860 KPA (125 PSIG)

2.2.1. Pipes 300 mm (12 in.) and larger, black steel ASTM A53, 9.5 mm (0.375 in.) wall, plain ends, ANSI B36.10.

2.2.2. Pipes 65 mm (2-1/2 in.) to 250 mm (10 in.) ASTM A53, Schedule 40, plain ends, ANSI B36.10.

2.2.3. Pipes 50 mm (2 in.) and smaller, black steel ASTM A53, Schedule 40, threaded, ANSI B36.10.

2.2.4. Fittings 300 mm (12 in.) and larger, black steel ASTM A234, 9.5 mm (0.375 in.) wall, butt-welding ends, ANSI B16.9.

2.2.5. Fittings 65 mm (2-1/2 in.) to 250 mm (10 in.) black steel ASTM A234, Schedule 40, butt-welding ends, ANSI B16.9.

2.2.6. Fittings 50 mm (2 in.) and smaller, cast iron ASTM A126, 860 kPa (125 psi) WSP, threaded, ANSI B16.4.

2.2.7. Flanges 65 mm (2-1/2 in.) and larger, forged steel ASTM A181, 1035 kPa (150 psi) WSP, ANSI B16.5.

2.2.8. 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.

2.2.9. Flange accessories for steam under 860 kPa (125psig):

.1 Gasket, 1.5 mm (1/16 in.) Asbestos free, inorganic fibres with nitrile binder suitable for 750 Deg. F. (400 Deg. C.) continuous maximum temperature at 10320 kPa (1500 psi), equal to Garlock 706.

.2 Bolts, square head machine with hexagonal nut, steel ASTM A307, ANSI B18.2.

2.2.10. Strainers 65 mm (2-1/2 in.) and larger, cast iron 860 kPa (125 psi) WSP, flanged.

2.2.11. Strainers 50 mm (2 in.) and smaller, cast iron 1720 kPa (250 psi) WSP, threaded.

2.2.12. Gate valves 65 mm (2-1/2 in.) and larger, cast iron 860 kPa (125 psi) WSP, bronze mounted, O.S. and Y, ANSI B16.1 flanges, shall be Crane #465-1/2, Jenkins #454J, Toyo 421 or Kitz 72.

2.2.13. 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.

2.2.14. Globe valves 65 mm (2-1/2 in.) and larger, cast iron 860 kPa (125 psi) WSP, bronze mounted, renewable composition disc, ANSI B16.5 flanges, shall be Crane #351, Jenkins #2342J, Toyo 400A or Kitz 76.

2.2.15. Globe valves 50 mm (2 in.) and smaller, bronze 1035 kPa (150 psi) WSP, renewable composition disc, threaded shall be Crane #7TF, Jenkins #106BJ, Toyo 221 or Kitz 09.

2.2.16. Check valves 65 mm (2-1/2 in.) and larger, 1030 kPa (150 psi) WSP, dual flapper design with carbon steel body and stainless steel check, renewable disc and seat for flanged installation, shall be Velan-Proquip model BDD10-1B or DUO CHEK II G15SPF-201, or Mueller Sure Check 72-DHH-T-H-X.

2.2.17. 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.

2.2.18. Drain valves for blow-off of sediment from strainers, pipe drainage and tank drainage, shall be 19 mm (3/4 in.) size 250 WSP or 4130 kPa (600 psi) WOG ball valve with bronze body, stainless steel ball and stem, multifilled seats and packing, male threaded garden hose end, brass cap and chain shall be Apollo 70-140-64.

2.2.19. Vacuum breakers shall be swing check valves with disc set 15 degrees from vertical or may be similar to Watts No. 36S.

2.2.20. Ball valves 50 mm (2 in.) and smaller, 1720 kPa (250 psi) WSP, bronze body, threaded ends, shall be Apollo 70-140-04-64 complete with 60 mm (2-1/4 in.) stem extensions.

2.3. LOW TEMPERATURE AND/OR PRESSURE WATER

2.3.1. 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).

2.3.2. Pipes 300 mm (12 in.) and larger, black steel ASTM A53, 9.5 mm (0.375 in.) wall, plain ends, ANSI B36.10.

2.3.3. Pipes 65 mm (2-1/2 in.) to 250 mm (10 in.) ASTM A53, Schedule 40, plain ends, ANSI B36.10.

2.3.4. Pipes 50 mm (2 in.) and smaller, black steel ASTM A53, Schedule 40, threaded, ANSI B36.10.

2.3.5. Pipes 100 mm (4 in.) and smaller, alternative for entire system for heating water, chilled water and condenser water in hard-tempered copper ASTN B88, Type L, plain ends. All joints made with 95-5 tin-antimony or tin-silver solder.

2.3.6. 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.

2.3.7. Fittings 300 mm (12 in.) and larger, black steel ASTM A234, 9.5 mm (0.375 in.) wall, butt-welding ends, ANSI B16.9.

2.3.8. Fittings 65 mm (2-1/2 in.) to 250 mm (10 in.) black steel ASTM A234, Schedule 40, butt-welding ends, ANSI B16.9.

2.3.9. Fittings 50 mm (2 in.) and smaller, cast iron ASTM A126, 860 kPa (125 psi) WSP threaded, ASNI B16.4.

2.3.10. 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.

2.3.11. Fittings alternative for entire system for heating water, chilled water and condenser water: wrought copper or cast bronze, solder, joint, ANSI B16.22.

2.3.12. 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.

2.3.13. Flange accessories for heating water and condenser water:

.1 Gasket, 1.5 mm (1/16 in.) Synthentic 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.

2.3.14. Flange accessories for chilled water, gasket, cloth inserted rubber ring, bolts, square head machine with hexagonal nut, steel ASTM A307, ANSI B18.2.

2.3.15. Strainers 65 mm (2-1/2 in.) and larger, cast iron 860 kPa (125 psi) WSP, flanged.

2.3.16. Strainers 50 mm (2 in.) and smaller, cast iron 1720 kPa (250 psi) WSP, threaded.

2.3.17. Strainers 50 mm (2 in.) and smaller, for copper pipes bronze 860 kPa (125 psi) WSP, threaded. Mueller #351M.

2.3.18. 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.

2.3.19. 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.

2.3.20. 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.

2.3.21. 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.

2.3.22. Butterfly valves maybe used as an alternative to gate valves only and shall be iron body, one-piece alloy steel shaft, top and bottom bearings, bronze disc or iron disc with stainless steel trim, resilient elastomer replaceable seat with integral reinforcing ring or keyed to body. Body with threaded lugs. Bubble-tight shut-off to 1035 kPa (150 psi) pressure in either direction when the piping and connecting flange is removed from one side of the valve.

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.

Butterfly valves shall be shall be DeZurik Model BGS, Keystone Model 222-784, Bray Series 31, Challenger Model 20-CN4E, Apollo 143, Kitz 6122EL/G, Centerline 200, or Crane 44.

2.3.23. 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.

2.3.24. 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.

2.3.25. Check valves 65 mm (2-1/2 in.) and larger ANSI Class 150, 1030 kPa (150 psi) WSP, dual flapper retainerless design with carbon steel body and stainless steel check, renewable disc and seat for flanged installation, shall be Velan-Proquip model BDD10-1B or DUO CHEK II H15SMF-201, Mueller 72-DHH-3-H.

2.3.26. 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.

2.3.27. 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.

2.3.28. As an alternative on vertical in-line pumps suction elbow may be combination elbow and strainer. Strainer perforations shall be as specified for Y strainers. Blow-off valves shall be provide in all sizes. Sizes of elbow strainer shall suit the pump suction size. Elbow shall be cast iron. Elbow shall be sized to suit pipe.

2.3.29. 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.

2.3.30. 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.

2.3.31. 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.

2.3.32. 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.

2.3.33. As an alternative to Standard Details (MSD-7654 and MSD-7655) for reheat coil installation provide Tour-Anderson Series 78K Koil-Kit complete with 78K-STADK flow balancing valve, 78-UP union plus air vent and PT port, and 78K-SBV with 20 mesh Y-strainer/ball valve & PT port. Automatic air vent piped to drain shall be used if branch take-off is above the main.

2.4. GROOVED PIPE AND FITTINGS

2.4.1. 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).

2.4.2. Grooved pipe and fittings may be used for hot water, chilled water, and condenser water systems.

2.4.3. Pipes 50 mm (2 in.) to 250 mm (10 in.) black steel ASTM A53, Schedule 40 cut or roll grooved.

2.4.4. Pipes 300 mm (12 in.) and larger black steel ASTM A53, 9.5 mm (0.375 in.) wall, cut or grooved.

2.4.5. 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

.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

2.4.6. Fittings 50 mm (2 in.) to 250 mm (10 in.) cast ductile iron ASTM A536 grade 65-45-12 or malleable iron ASTM A47.

2.4.7. 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 University's Representative.

.1 350 mm (14 in.) and larger shall be complete with Victaulic 'AGS' grooved ends.

2.4.8. Branch connections: ductile iron ASTM A535 or malleable iron ASTM A47; Victaulic Style 920, 921 or 72.

2.4.9. Flanges; ductile iron ASTM A536 or malleable iron ASTM A47 for sizes 50 mm (2 in.) to 600 mm (24 in.); Victaulic Style 741.

2.4.10. 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.).

2.4.11. 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). Vicatulic Series 700.

2.4.12. 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.

2.4.13. 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, duel 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.

2.4.14. Strainers 50 mm (2 in.) to 300 mm (12 in.): ductile iron ASTM A536 with type 304 stainless steel screen. Victaulic Style 730/732.

2.4.15. As an alternative on vertical in-line pumps, suction elbow may be suction diffusers. Victaulic 731-I.

2.4.16. All grooved products, including couplings, fittings, valves and specialty items shall be Victaulic.

2.4.17. For other system components refer to Low Temperature and/or Pressure Water Article.

2.5. CONDENSATE SYSTEM

2.5.1. Pipes 65 mm (2-1/2 in.) and larger, black steel ASTM A53, Schedule 80, plain ends, ANSI B36.10.

2.5.2. Pipes 50 mm (2 in.) and smaller, black steel ASTM A53, Schedule 80, threaded ANSI B36.10.

2.5.3. Fittings 65 mm (2-1/2 in.) and larger, black steel ASTM A234, Schedule 80, butt welding ends, ANSI B16.9.

2.5.4. Fittings 50 mm (2 in.) and smaller, cast iron ASTM A126, 1720 kPa (250 psi) WSP, threaded ANSI B16.4.

2.5.5. Flanges, unions, strainers, gate valves, globe valves and check valves as specified for steam under 860 kPa (125psig).

2.5.6. Flange accessories for condensate system:

.1 Gasket, 1.5 mm (1/16 in.) Asbestos free, Aramid fibres with nitrile binder suitable for 205 deg. C. (400 deg. F.) continuous maximum temperature at 6880 kPa (1000 psi), equal to Garlock Blue-Gard 3000.

.2 Bolts, alloy steel ASTM A193, ANSI B16.5, nuts, hexagonal, steel ASTM A307.

2.6. WELDING

2.6.1. 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

2.6.2. 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.

2.6.3. 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.

2.6.4. 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.

2.6.5. 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.

2.6.6. 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.

2.6.7. 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.

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

2.7. REQUIREMENTS

2.7.1. 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.

2.7.2. 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 pie of 1.5 m/s (5 ft./s). For 50 mm (2 in.) and larger pipe size all heads retaining the basket shall be bolted. For 38 mm (1-1/2 in.) and smaller pipe heads shall be gasketted with straight threads.

2.7.3. 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.

2.7.4. 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.

2.7.5. Strainers shall be Colton Industries or Mueller.

2.7.6. Air vents shall be Bell and Gosset, Taco, Sarco, or Maid-O-Mist.

2.7.7. 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

3. Execution

3.1. INSTALLATION

3.1.1. For pipe 65 mm (2-1/2 in.) and larger, use flanges, and for smaller pipe, use unions at all valves and equipment.

3.1.2. 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.

3.1.3. 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.

3.1.4. 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.

3.1.5. Provide vacuum breakers on all equipment having modulating steam control valves and locate between valve and equipment, unless directed otherwise by equipment manufacturer.

3.1.6. 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.

3.1.7. Make reduction in steam main size with eccentric reducing coupling.

3.1.8. 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.

3.1.9. Pitch all lines 25 mm in 12 m (1 in. in 40 ft.–0 in.) unless shown otherwise.

3.1.10. 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

3.1.11. Carefully ream threaded joints and join with compound on the male thread only. Re-tighten flanged connections after the installation has been brought up to its service. Following testing, apply insulation. Take care not to overstress the material during construction.

3.1.12. 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.

3.1.13. 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 asbestos blankets.

3.1.14. Arrange piping to permit ease of equipment removal. Provide flanges or unions on all pipe connections to each piece of equipment.

3.1.15. Connect all multi-row water coils in counter flow.

3.1.16. 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.

3.1.17. Connect bases of all pumps with packed glands to drain with 12 mm (1/2 in.) O.D. copper tubing.

3.1.18. 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.

3.1.19. Provide strainers upstream of each pump suction, steam control valve and steam trap not preceded by a control valve, and where shown.

3.1.20. Provide butterfly valves where shown; these are permitted in lieu of gate valves in sizes 65 mm (2-1/2 in.) and larger.

3.1.21. 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 University's Representative.

3.1.22. 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.

3.1.23. 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 safety absorb the expansion of the main.

3.1.24. Install all control devices, valves and any other appurtenances as directed by the controls and/or BAS trades.

3.1.25. Make connections between copper and steel with brass or bronze fittings.

3.1.26. 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.

3.1.27. 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.

3.1.28. 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.

3.1.29. 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.

3.1.30. Install flow balancing valves in the following locations:

.1 at each heating, chilled or condenser water riser, or main floor branch

.2 each heating water and cooling water coils including unit heaters, fan coils and force flow heaters.

.3 Each heat exchanger

.4 Each wall fin, radiant ceiling or similar heating device

.5 Each pump pressure differential line

.6 Each main building or secondary heating or cooling circuit

.7 And where shown

END OF SECTION 23 21 13.23

1. General

1.1. WORK INCLUDED

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

1.2. SUBMITTALS

1.2.1. 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.

2. Products

2.1. MATERIALS

2.1.1. 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.

2.1.2. Glycol system solution shall be 40% by volume of factory, pre-mixed solution of inhibited propylene glycol. Propylene glycol shall be Dow Chemical Co “Dowfrost”, Interstat Chemical Co. P-323” or Recochem Inc. “Recofreeze PG”.

2.1.3. Alcohol Anti-freeze solution shall be 20% by volume of Anchem Sales “Ancool-100”

2.1.4. 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.

3. Execution

3.1. INSTALLATION

3.1.1. All systems shall have been hydrostatically tested prior to cleaning.

3.1.2. 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.

3.1.3. All coils shall be disconnected and flow shall be by-passed.

3.1.4. A temporary pump shall be installed in the system and shall be capable of pumping adequate discharge at adequate head.

3.1.5. A temporary heater shall be installed in the system and shall be capable of maintaining the circulating water temperature as required for chemical treatment.

3.1.6. 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.

3.1.7. 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.

3.1.8. Take samples of system from a series of representative drains as directed by the University's Representative. 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 University's Representative for verification prior to final filling.

3.1.9. 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

3.1.10. 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.

3.1.11. The Contractor shall supply the University's Representative 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 form the water treatment supplier within one week of presentation to the University's Representative.

END OF SECTION 23 25 26.00

1. General

1.1. WORK INCLUDED

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

1.1.2. 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 University's Representative. Make adjustments as necessary to satisfy the requirements of the University. 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 University's Representative.

2. Products

2.1. MATERIALS

2.1.1. Expansion joint, guides and anchors: United Flexible, Flexonics or Hydroflex, specifically design for the system in which they are installed.

2.1.2. Expansion joints for 75 mm (3 in.) diameter pipe and larger: packless bellows type with equalizing rings, stainless steel bellows, limit stops, internal telescoping sleeves and carbon steel schedule with bevelled welding ends, or flanged to suit installation.

2.1.3. Expansion joints for 65 mm (2-1/2 in.) diameter pipe and smaller: packless bellows type with stainless steel bellows, anti-torque device, limit stops, guides and threaded pipe ends.

2.1.4. Furnish an A.S.M.E. inspection and data report furnish with each expansion joint, for the following working pressures and temperatures

	Working Pressure kPa (psig)	Temperature deg. C. (deg. F.)
Steam or condensate, Above….Floor	…..	…..
Condensate, Below….Floor	…..	…..
Chilled Water, Above…Floor	…..	…..
Chilled Water, Below…Floor	…..	…..

2.1.5. Unless otherwise specified, expansion joints shall have a sufficient number of corrugations to absorb the expansion between anchors in the pipe plus not less than 25% safety factor for a temperature range from -17.8 deg. C. (0 deg. F.) ambient temperature to the maximum operating temperature of the pipe.

3. Execution

3.1. INSTALLATION

3.1.1. Provide for the expansion and Contraction of all pipes, and install with sufficient flexibility to prevent end thrust and movements caused by thermal expansion or Contraction causing detrimental distortion or damage of connected equipment. Provide offsets between mains and equipment of sufficient length to safety absorb the expansion of the main.

3.1.2. During operation, the chilled water supply temperature will be C deg. C. (C deg. F.). If expansion joints in chilled water lines are installed at a time when the ambient air temperature is above C deg. C. (C deg. F.) they shall be precompressed in accordance with manufacturer's installation instructions.

3.1.3. Guides shall be as shown and shall be located as follows:

.1 distance from expansion joint to first guide shall be maximum 4 pipe diameters.

.2 distance from first to second guide shall be maximum 14 pipe diameters

.3 Maximum spacing between additional guides:

3.7 m for 65 mm (12 ft. for 2-1/2 in.) pipe

7.3 m for 75 mm and 100 mm (24 ft. for 3 in. and 4 in.) pipe

11 m for 125 mm and 150 mm (36 ft. for 5 in. and 6 in.) pipe

14.6 m for 200 mm (48 ft. for 8 in.) pipe

18.3 m for 250 mm (60 ft. for 10 in.) pipe

22 m for 300 mm and 350 mm (72 ft. for 12 in. and 14 in.) pipe

3.1.4. Anchors shall be as shown

END OF SECTION 23 26 13.00

1. General

1.1. WORK INCLUDED

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

2. Products

2.1. MATERIALS

2.1.1. Pipe connectors, where shown, for water, shall be Hydroflex Hose, Flexonics or Vibro-Flo or corrugated metal with braided sheath.

2.1.2. Corrugated metal and sheath shall be of bronze or stainless steel with threaded ends for 50 mm (2 in.) pipe size and smaller and flanged ends for larger sizes.

2.1.3. Total length of connector shall vary from a minimum of 300 mm (12 in.) for 25 mm (1 in.) deflection, and up to 350 mm (18 in.) for 50 mm (2 in.) or greater deflection.

2.1.4. Minimum working pressure at 21.1 deg. C. (70 deg. F.) shall be 1200 kPa (175 psi) based on maximum working pressure not exceeding burst pressure.

3. Execution

3.1. NOT USED

END OF SECTION 23 26 16.00

1. General

1.1. WORK INCLUDED

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

1.2. SUBMITTALS

1.2.1. 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.

1.2.2. Samples: Submit samples as required.

1.2.3. Submit marked up prints showing detailed locations of all devices mounted in or on ductwork, dimensioning their locations.

2. Products

2.1. MATERIALS

2.1.1. Fabricate all ductwork unless specifically noted otherwise, of galvanized sheet steel with Z180 coating to A.S.T.M. A653/A653M-98.

2.1.2. Sealing compound: Minnesota Mining and Manufacturing or other approved manufacturer. Duct tape shall be Duro-Dyne or other approved manufacturer.

2.1.3. Flexible ducting:

.1 Flexible fabric ducting shall be Flexmaster Fabriflex FAB-4. ULC listing S110.

.2 Flexible metal ducting shall be Flexmaster Triple-Lock Aluminum Flexible ducting T/L. ULC listing S110

.3 Acoustic flexible metal ducting shall be Flexmaster Triple-Lock Acoustic Flexible ducting T/L-A-T/L consisting of performated aluminum inner core, 38 mm (1-1/2 inch) insulation, and aluminum outer covering. ULC listing S110.

.4 Thermal flexible metal ducting shall be Flexmaster Triple-Lock Acoustic Flexible ducting ULC listing S110.

2.1.4. Access Ports shall be Lawson-Taylor or other approved manufacture of 32 mm (1-1/4 in.) dia. ports.

2.1.5. 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.

2.1.6. 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 labeled. Fire dampers in supply air ducts shall be rated 'Dynamic' and shall have the blades clear of the air stream. Fire dampers shall be Ruskin, Nailor Industries or Controlled Air equal to Ruskin IBD2-Style 'B' or Style 'C'. Dampers in return and exhaust systems may have the blades in the air stream if permitted by the University's Representative, and shall be equal to Ruskin IBD2-Style 'A'. Fire-stop flaps shall be as shown in the Underwriters' Laboratories list for the specific ceiling assembly used.

.3 Combination balancing/fire damper: Price VCS4

.4 Combination Smoke and Fire Dampers: Multi-blade type complete with operating shaft, stainless steel side seals and fire resistant insulating blade seals. Dampers shall bear U.L.C. label for 1-1/2 hours and shall be of the same manufacturer as noted for fire dampers. Damper shall be open/closed from motor operator and fully closed on melting of fusible link. Limit switches shall be provided to show position of damper blades. Leakage through dampers shall not exceed 0.506 L/s (10 cfm/sq.ft.) of damper area at 1.0 kPa (4.0 in. wg.) of differential pressure when tested in accordance with AMCA Standard 500. Submit test data with Shop Drawings.

.5 Smoke Dampers: Similar to dampers described above but without fusible link.

.6 Positive Seal Shut-Off Dampers:

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-geared 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.

The damper shall be all weld design, all pressure retaining weld joints and seams shall be continuously welded. Weld joints and seams requiring only intermittent welds by design shall not be continuously welded interior weld joints, where possible, shall be continuously welded to provide a smooth interior design, as a minimum, all welds shall be wire brushed and/or buffed to remove heat discolouration, burrs and sharp edges. All welding procedures, welders, and welder operators shall be qualified in accordance 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.

.7 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.

.8 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.

.9 Gravity backdraft dampers shall be multi-blade louver type, constructed of light grade aluminum. Blades shall be joined with a tie bar and have rust-proof shafts rotating in bronze bushings.

.10 Motorized dampers for Control Operation: In accordance with applicable requirements control systems (pneumatic) or central energy management systems section.

2.1.7. Acoustic Insulation: 25 mm (1 in.) thick rigid coated glass fibre.

2.1.8. Interior Duct Protective Coating: Chlorinated rubber base paint or Eisenheiss Black.

2.1.9. 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.

2.1.10. Laboratory exhaust ductwork shall be Type 316L welded stainless steel. Exhaust ductwork used for general exhaust only can be galvanized up to the general exhaust air valve.

2.2. FABRICATION

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

3. Execution

3.1. INSTALLATION

3.1.1. 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.

3.1.2. 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.

3.1.3. 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.

Hang all ductwork securely and in a rigid manner. Provide hangers as follows:

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.

3.1.4. Support all vertical ducts at each floor, on all sides, with angle riveted to the ducts.

3.1.5. 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.

3.1.6. 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:

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.

.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.

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

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.

.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.

3.1.8. 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

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

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.

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

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

TABLE 5: HIGH PRESSURE RECTANGULAR DUCT CONSTRUCTION

MAX. DUCT DIMENSION	SHEET METAL US GAUGE	CONSTRUCTION
Up to 300 mm (12 in.)	22	Flanged angle gasketted 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 gasketted 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 gasketted 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 gasketted 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 gasketted 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 gasketted 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 x50 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 gasketted 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 x50 mm x 3 mm (2 in. x 2 in. x 3/16 in.) at maximum 600 mm (24 in.) centres.

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

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

3.1.13. 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.

3.1.14. 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.

3.1.15. 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.

3.1.16. 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 University's Representative.

3.1.17. Select the gauge of metal and method of construction for the new size. Notify the University's Representative of any change before such changes are incorporated into the work.

3.1.18. If changes of location of duct, are required because of building construction, review with the University's Representative before the locations indicated are changed in any way.

3.1.19. 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.

3.1.20. 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 University's Representative and the testing company before installation.

3.1.21. Provide flexible connections at each air handling unit and fan duct connection.

3.1.22. 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.

3.1.23. Provide splitter dampers as shown on Standard Details.

3.1.24. Incorporate gravity backdraft dampers where shown.

3.1.25. Install motorized dampers where directed.

3.1.26. 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.

3.1.27. Install combination smoke and fire dampers and smoke dampers where shown. Ensure operators are accessible for maintenance.

3.1.28. Receive automatic dampers from separate Section on site, and set in place under the supervision of the control manufacturer.

3.1.29. 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.

3.1.30. Paint visible internal surface behind each grille or register flat black.

3.1.31. Where duct is acoustically lined, duct dimensions shown are net, inside of lining.

3.1.32. 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.

3.1.33. Install PVC lined laboratory exhaust ductwork in accordance with the manufacturer's current installation. Special care shall be made at joints. Ductwork shall be coated with manufacturer'' recommended paint at joints prior to joining. Duct sealant shall be suitable for the chemical vapours to be conveyed in the exhaust air stream.

3.1.34. Apply acoustic insulation internally to ductwork where shown. In addition, internally line all low or medium pressure supply air ductwork in mechanical rooms, fan rooms, or equipment rooms. Install using both pins and adhesive. Pins shall be maximum 450 mm (18 in.) centres and shall be tack welded to the duct or plenum. Seal all edges of acoustic insulation to prevent air erosion with sheet metal nosing that overlaps the insulation by 19 mm (3/4 in.) minimum.

3.1.35. 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.).

3.1.36. Spin-in connections shall only be used downstream of variable volume boxes.

3.1.37. Ductwork shall be run parallel to the closest wall. Coordinate with piping and structural elements.

3.1.38. 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.

3.1.39. Supply air ductwork to variable volume boxes shall be rigid duct of size shown in schedules. If the length exceeds 3000 mm (10 ft.) or if there are 2-45 deg. elbows or 1-90 deg. elbow or more increase in supply air ductwork to the variable volume box one size. If the length exceeds 6000 mm (20 ft.) increase the duct by two sizes. Under no conditions shall be supply ductwork exceed 9000 mm (30 ft.) or have more than 3-90 deg. elbows or the equivalent.

END OF SECTION 23 31 13.00

1. General

1.1. WORK INCLUDED

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

1.2. RELATED WORK SPECIFIED ELSEWHERE

1.2.1. Continuous air slot in ceiling – under Division 9 – Finishes.

1.2.2. Door grilles – under Architectural Division – Grilles.

1.3. SUBMITTALS

1.3.1. 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.

1.3.2. Sample of exposed duct detail. See mechanical standard details on the drawings.

2. Products

2.1. MATERIALS

2.1.1. Diffusers, registers and grilles shall be Price, Metalaire, Nailor, Krueger, Titus or Carnes equal to the units specified.

2.1.2. 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).

2.1.3. 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.

2.1.4. All volume and air pattern devices shall be fully adjustable from the face of the diffuser, register or grille.

2.1.5. In gypsum board or plaster ceiling applications, provide matching mounting frame. Finish shall be prime painted, off-white in plaster and gypsum board ceilings.

2.1.6. 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.

2.1.7. 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

END OF SECTION 23 37 13.00

1. General

1.1. WORK INCLUDED

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

1.1.2. The locations of all sensors shall be discussed with and approved by the University's Representative, 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.

1.1.3. The control sequence descriptions are complementary. Provide detailed sequences of operation and all points required to implement the sequences.

1.1.4. 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.

1.1.5. All set points and reset schedules shall be visual on the associated dynamic graphic.

1.2. PROJECT SCOPE

1.2.1. All wiring shall be installed in conduit.

1.3. SYSTEM OUTLINE

1.3.1. 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 to operate on building LAN communication infrastructure.

1.4. APPROVED SUPPLIERS AND MANUFACTURERS

1.4.1. 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
Siemens Building Technologies Limited	Siemens Building Technologies Limited: Apogee	1577 North Service Rd. East Oakville, ON	David Barrett / 416-723-2736 david.barrett@siemens.com

1.5. EQUIPMENT SUPPLIED FOR INSTALLATION UNDER OTHER SECTIONS

1.5.1. Automatic control valves except otherwise noted.

1.5.2. Temperature sensor wells.

1.5.3. Terminal unit controllers including transformers. Ship to terminal unit manufacturer's facility for factory installation.

1.5.4. Motorized dampers except otherwise noted. Verify damper sizes and connection type with sheet metal contractor prior to ordering.

1.6. SUBMITTALS

1.6.1. 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 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.

.4 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.

.5 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.

.6 Products Schedule: Indicate: product designation, product name, product manufacturer, product model number, product data sheet reference number, quantities. Provide quantities required under the Work.

.7 Valve Schedule: Indicate: system designation, control device designation, valve body size, pipe sizes, valve design flow, selected valve Cv, selected valve design flow pressure drop, valve body configuration, valve body model number, actuator fail-safe position, actuator model number, actuator quantity, actuator close-off pressure rating.

.8 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.

.9 Room Schedule: Indicate: controller object name, controller address, controller model number, application designation, room designation, VAV air volume set points, sensor model numbers.

.10 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.

.11 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.

.12 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. Products

2.1. GENERAL APPLICATION PROGRAMS

2.1.1. Provide a specific set of programs to achieve automated, operator independent control of facility sub-systems.

2.1.2. SW-546 Exhaust Venturi Valve (VV-546) and Exhaust VAV Box (VAV-546)

.1 Venturi valve, VV-546 to modulate airflow between minimum and maximum according to sash position.

.2 VAV-546 to modulate such that the total air flow between VV-546 and VAV-546 is equal to 800 cfm.

2.2. 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 3rd party manufacturer controllers are based on different open system standard than BAS, it is the responsibility of BAS contractor to provide the appropriate interface for integration of that 3rd party manufacturer controller to BAS.

.3 If open system controllers are not available, include appropriate hardware equipment and software to allow bi-directional data communication between the BAS and 3rd party manufacturers' control panels.

2.3. POWER SUPPLIES AND LINE FILTERING

2.3.1. Provide a separate power supply for every Building Controller, Advanced Application Controller and Application Specific Controller for terminal units.

2.3.2. 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.

2.3.3. DC Power Supplies: Regulated output.
.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.

2.3.4. Power Line Filtering: Provide internal or external transient voltage and surge suppression for workstations and controllers.

2.4. CABINETS

2.4.1. Type: NEMA rated and suitable for installed environment.

2.4.2. 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.

2.4.3. Controllers, transducers and relays mounted on backing board or DIN rails within inner section behind hinged doors.

2.5. CONTROL DEVICES

2.5.1. Motorized Control Dampers:
.1 Sizing:
- 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.
- Two-position: Parallel blade.
- 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:
- 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.
- 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.

2.5.2. Actuators For Dampers, Electronic:
.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.

2.6. 1.8. WIRE AND CONDUIT

2.6.1. 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.

2.6.2. 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.

2.6.3. Junction boxes: Sized according to number, size and position of entering raceway; type: suitable for the environment.

2.6.4. 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.
.5 Failsafe: Non-spring return for VAV terminals; spring return for other applications.
.6 Spring return to normal position within 15 seconds.
.7 Manual Override: Crank type. External gear release for non-spring return actuators.
.8 Position Indicator: Reversible for clockwise or counter-clockwise rotation; set the 0 degrees mark to the failsafe position.
.9 Torque: To damper manufacturer’s requirements to provide complete compression of seals between frame and blades and for smooth control.

3. Execution

3.1. GENERAL WORKMANSHIP

3.1.1. 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.

3.1.2. Install products to manufacturer’s installation instructions.

3.1.3. Install parallel to building walls and floors unless indicated or specified or required by manufacturer's installation instructions.

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

3.2. COORDINATION

3.2.1. Submittals: To Part 1: General, Submittals.

3.2.2. Integrate and coordinate work under this section to controls and control devices provided or installed by others.

3.2.3. 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.

3.2.4. 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

3.3.1. 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.

3.3.2. 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.

3.3.3. 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.

3.3.4. Conceal conduit within finished shafts, ceilings, and walls as required. Install exposed conduit parallel with or at right angles to the building walls.

3.3.5. Plug or cap unused conduit openings and stubs with compatible fittings.

3.3.6. Route all conduit to clear beams, plates, footings and structural members except through column footings and grade beams.

3.3.7. Provide watertight seals at penetrations through outside foundation walls.

3.3.8. 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.

3.3.9. Maintain caps on conduit openings throughout construction.

3.3.10. 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.

3.3.11. Where exposed to weather or in damp or wet locations, provide waterproof flexible conduit.

3.3.12. 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.

3.3.13. Wire within cabinets shall be installed in a plastic tray with a cover. Terminate wires to field-removable, modular terminal strips.

3.3.14. 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. 1.12. POWER WIRING

3.4.1. Power for section 23 09 00.00 – Building Automation System (BAS) shall be provided under Electrical Division 16 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).

3.4.2. 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

3.5.1. Install communication wiring per controls manufacturer recommendations as to type of wire used and segment lengths.

3.5.2. Install communication wiring in conduit and raceways separated from other wiring.

3.5.3. Verify entire network’s integrity following cable installation using appropriate tests for each cable.

3.5.4. Each run of communication wiring to be continuous length without splices.

3.6. CABINETS

3.6.1. 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.

3.6.2. 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.

3.6.3. Coordinate cabinet locations with other trades and general contractor.

3.7. CONTROL DEVICES

3.7.1. 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.

3.7.2. 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.

3.7.3. Actuators for Dampers, Electronic:
.1 Mounting: Direct coupled to drive shaft or jackshaft using a V bolt design.

3.8. IDENTIFICATION

3.8.1. 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.

3.8.2. All wires passing through a junction box shall be tagged with the device identity or its termination point.

3.8.3. The junction boxes shall be tagged “BAS” with a sequential number suffix.

3.8.4. Label wires, control devices, controllers.

3.9. TESTING AND COMMISSIONING

3.9.1. Test and commission the BAS prior to the Demonstration and Acceptance Test.

3.9.2. Prepare test forms which shall identify each test. The forms shall be sub-divided into points, controllers, programs, loops, networks and graphics.

3.9.3. 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.

3.9.4. 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.

3.9.5. 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.

3.9.6. 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.

3.9.7. 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.

3.9.8. Dynamic graphics tests shall identify and confirm successful completion of the following:
.1 .1 All graphics.
.2 .2 All point objects per graphic.
.3 .3 All set-points per graphic.

END OF SECTION 23 09 23.00

1. General

1.1. WORK INCLUDED

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

2. Products

2.1. MATERIALS

2.1.1. Piping shall be standard weight black steel pipe with 1035 kPa (150 psi) malleable iron fittings or welded as accepted by authority having jurisdiction.

2.1.2. Valves shall be plug cocks and shall be acceptable to the authorities having jurisdiction.

2.1.3. Electrically operated solenoid valves shall be normally closed, 2-position valve in accordance with CSA Z21.21 and SCA C22.2 suitable for 120 Volt operation with general purpose actuator.

3. Execution

3.1. INSTALLATION

3.1.1. Connect to the metering station and provide all downstream pipe and appurtenances.

3.1.2. All piping up to and including the meter and incoming service pressure reducing station is by =Gas Company.

3.1.3. Supply and install pressure reducing valve, with relief pipes to atmosphere, in Boiler Room.

3.1.4. Weld all distribution piping within the building, and utilize screwed and/or flanged fittings at equipment only.

3.1.5. Paint all gas piping in its entirety in an approved colour in accordance with the Code.

3.1.6. Provide thermal expansion control for gas piping on the roof as required by CSAB149.1.

3.1.7. Provide normally closed electronically operated solenoid valve (s) in the incoming natural gas distribution pipe upstream of all natural gas fired boilers. Valve assembly shall include one or more valves as required to suit service size with no appreciable pressure drop and isolation and lockable bypass valve for emergency operation.

.1 Installation shall be complete with push/pull emergency stop switch with red mushroom operator with normally closed contact wired in series with solenoid valve. Solenoid valve shall be powered by emergency power where available. Depression of mushroom operator shall interrupt power to the solenoid valve until manually reset.

Mushroom operator shall be located at the boiler room entrance. Where entrance is not enclosed to the elements, the mushroom operator may be located on the inside at the door where it may be depressed without complete entry into the room. Provide all interconnected wiring as required for a complete and operational system.

END OF SECTION 23 11 23.00