MECHANICAL SPECIFICATION

UNIVERSITY OF TORONTO SCARBOROUGH CAMPUS

SY Level 2 Bio-Science Lab Interior Renovation

DATE:

March 19th, 2026

Issued For Tender

END OF SECTION 21 00 00.00

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.

1.1.2. 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. 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.

1.2. 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.)

	Insulation Conductivity		Nominal Pipe Diameter – mm (in.)					
Fluid Design Operating	Conductivity [W(m-K)] [h-cu.ft. – deg. F. (Btu-in.)]	Mean Rating Temp deg. C. (deg. F.)	Runouts Up to 50 (2)	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

2.1.1. 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.

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