NORTHWESTERN
UNIVERSITY

DESIGN GUIDELINES
AND
TECHNICAL STANDARDS

Date of Issuance: January 1, 2014

DIVISION 23 – HVAC

SECTION 23 0000 – HVAC DESIGN CRITERIA

General Criteria

1. General: The Heating, Ventilation, and Air Conditioning (HVAC) systems within Northwestern's facilities need to be designed and maintained to provide occupant comfort and to meet the goals of safety, reliability, serviceability, and efficient operation as described below:

    a. Safety for building occupants during equipment operation and for maintenance personnel equipment service.

    b. Reliability of the systems in regard to the quality of components and materials and in the required equipment redundancy.

    c. Well-maintained HVAC systems result in lower operating costs and extended service life. Therefore, the serviceability of the systems should promote easy access to equipment and valves.

    d. Systems efficiency should consider all operating costs, including energy and maintenance.

2. Redundancy: The design must identify and address points of failure for systems serving critical spaces, which are to be identified with the owner. Redundancy and/or back-up systems should be identified. (For example, for an area with critical temperature stability requirements, a secondary source of cooling may be required as back-up to the central plant systems).

3. Sustainability: HVAC system design should employ sustainable design concepts to meet the goals of NU and the community it serves.

Sustainability Overview

1. General: Refer to Design Guidelines for Energy Usage Intensity (EUI) requirements.

2. Energy Analysis and Modeling:

    a. Energy analysis shall be completed in the Schematic Design Phase and updated during the Design Development Phase utilizing a DOE-2 energy analysis computer program.

    b. The energy analysis shall be used to evaluate energy efficiency measures and inform design decisions. A final model shall be prepared upon completion of the construction documents.

3. Refrigerants:

    a. Use of zero CFC-based refrigerants shall be the minimum requirement.

    b. Refrigerants that have low impact on both ozone depletion and global warming shall be chosen.

4. HVAC Systems:

    a. Consideration should be given to provide increased ventilation beyond the code-required minimum when doing so would have minimal impact on energy consumption.

    b. Consideration for natural ventilation systems during appropriate seasonal conditions to maximize energy savings.

    c. Consideration should be given to providing individual thermal comfort control to the maximum number of occupants. Where possible, greater than 50% of all permanent occupants shall be provided with localized means to control their thermal comfort. Thermal comfort control shall be provided for all multi-occupant spaces, such as classrooms and conference rooms.

    d. Review project specific requirements and current standards with NU Project Manager during the design phase of the project.

5. Controls:

    a. Building Automation System (BAS) – For projects with energy-using systems, a BAS shall be included or the systems shall be controlled by an existing BAS.

    b. Lighting – Lighting systems shall have local controls and shall include switches, occupancy sensors, photocells, pre-set controllers and/or other controls as appropriate. Where daylight dimming is used, the lighting controls may be integrated into the BAS to maximize energy conservation.

    c. Measurement, metering, monitoring system shall be fully integrated into campus-wide system. Refer to the NU Metering Standards.

    d. Minimum items to be metered:

        i. System level outside air.

        ii. Building level cooling.

        iii. Building level heating.

        iv. Building level electrical subdivided by lighting and power.

        v. System level heat recovery.

        vi. Building level water.

e. Integration with campus-wide system:

i. New construction projects and renovation projects will include the installation of Direct Digital Control (DDC) systems integrated into the central BAS platform.

ii. Refer to DDC standards for additional information.

6. Commissioning:

a. HVAC systems and controls shall be commissioned by an independent commissioning authority.

b. Specific systems to be commissioned and responsibilities for commissioning shall be discussed with the NU Project Manager.

c. A/E shall include commissioning specifications in their construction documents.

HVAC Criteria

1. General:

a. Investigate the application of condensate reclamation off AHU cooling coils, for irrigation, cooling tower make-up, etc.

b. Chemical shot feeders only apply to building closed loops. Chemical treatment on Central Utility Plant (CUP) systems are accomplished at the CUP with no additional chemical treatment or makeup in the buildings.

2. Steam Distribution: Refer to Design Guidelines.

3. Hydronic Distribution:

a. Hot water heating systems shall utilize the campus central steam system when available. If central system steam is not nearby, a life cycle cost analysis will need to be completed comparing extending campus steam into the building versus other types of heating systems. Refer to NU Steam Framework Plan.

b. Hot water heating systems shall have standby pumps and heat exchangers sized for 100% of the load.

4. Comfort Cooling: Refer to Design Guidelines.

5. Process Cooling:

a. Process chilled water (CHW) shall be through plate and frame heat exchanger to CUP CHW. In no case shall CUP CHW be used directly for process cooling. Design the heat exchanger for a maximum CUP CHW supply temperature of 52 degrees F.

b. Process cooling loads are to be presented to the NU Project Manager for review during the design phases of the project.

c. Where process cooling loads are identified in the design, provide hard pipe connections to the loop. Braided tubing, barbed fittings, etc. are not permitted.

6. Air Distribution:

   a. Ductwork and diffuser velocities must achieve the sound criteria developed for each project. Review project specific requirements with the NU Project Manager.

   b. Return air is to be ducted. Ceiling plenum returns are not permitted.

7. HVAC Controls: Refer to NU DDC Standards.

8. Health and Safety Criteria:

   a. HVAC System designs shall comply with:

      i. The local codes having jurisdiction.

      ii. Occupational Safety and Health Administration (OSHA).

      iii. Northwestern University Insurance requirements.

9. Vibration Monitoring:

   a. NU has an existing vibration monitoring system installed on critical equipment bearings, motors, fans, and pumps.

   b. Determine with NU Project Manager prior to completion of Design Development Phase whether vibration monitoring will be required for the project.

10. Operation and Maintenance Criteria:

    a. Design documents shall require operation and maintenance manuals to be delivered to the owner.

    b. The design and layout of HVAC equipment shall show flow arrows for each hydronic system.

    c. Floor plans with the design and layout of HVAC equipment shall show the required service clearance space for each piece of equipment, including, but not limited to, tube pull space, coil removal, and unit-mounted starter electrical panel code required clearances.

    d. Floor plans with the design and layout of HVAC equipment shall show the required path for equipment removal and replacement to the exterior of the building. This equipment is defined as equipment too large to fit through a standard 30” x 84” door such as AHU sections, pumps, chillers, boilers, large fans, heat exchangers and electric switch gear, etc.

11. Comfort Criteria:

    a. General: Room comfort to be designed to provide space temperature of 72 degrees F year round, with seasonal set points of 68 degrees F and 74 degrees F.

    b. Labs shall be provided with humidification. Specific requirements to be reviewed with NU Project Manager during the design phases of the project.

    c. See Comfort Criteria Matrix at the end of this section for additional information.

12. Project Requirements:

    a. Submittal /Shop Drawing requirements: Review project specific requirements with NU Project Manager.

    b. Coordination Drawing requirements: Review project specific requirements with NU Project Manager.

    c. Coordination with other trades: Review project specific requirements with NU Project Manager.

    d. Operation and Maintenance Manual requirements: Review project specific requirements with NU Project Manager.

    e. Record Drawings requirements: Review project specific requirements with NU Project Manager. Coordinate Steam, Chilled water, Domestic water and Sprinkler outages with Campus Facilities Management Operations.

Comfort Criteria Matrix	General Classroom	Teaching and Research Labs	Library	Residence Halls	Dining Halls	Student Centers	Administrative Offices	Mechanical Rooms	Electrical Rooms	Telecomm Rooms
HVAC SYSTEM TYPES										
All air variable air volume with code minimums with reheat	X		X	X	X	X	X			
Displacement air from floor, column or low side wall discharge	X		X	X	X	X	X			
Chilled beam with code minimum outside air	X	X	X		X	X	X			
100% Outside air Constant or Variable air volume with makeup air and code minimums with reheat		X								
Heat Recovery unit for laboratory exhaust system		X								
Heat Recovery unit for kitchen/dishwasher exhaust to exchange with 100% minimum outside air AHU					X					
Heat Recovery unit for bathroom/toilet exhaust to exchange with 100% minimum outside air AHU				X						
Gang hood and general lab exhaust where acceptable		X								
4 pipe fan coil units with code minimum outside air				X						
Provide mechanical ventilation supply and exhaust as required by code or for cooling or combustion air								X		
HEATING										
Design Temperature 70°F ± 2°F	X	X	X	X	X	X	X			
Temperature Set Point 68°F	X	X	X	X	X	X	X	X	X	X
Reheat for interior rooms & exterior room perimeter walls with no glass	X	X	X	X	X	X	X			
Perimeter fin tube or radiant ceiling Panel for perimeter with glass heights less than 12ft	X	X	X	X	X	X	X			

Comfort Criteria Matrix	General Classroom	Teaching and Research Labs	Library	Residence Halls	Dining Halls	Student Centers	Administrative Offices	Mechanical Rooms	Electrical Rooms	Telecomm Rooms
HEATING Cont'd										
Perimeter fin tube at multiple levels or forced hot air from top & bottom or a combination of the two for perimeter with glass height 12 feet or more	X	X	X	X	X	X	X			
For rooms over 25 feet deep from window, consider a separate perimeter zone.	X		X		X	X	X			
Provide Unit Heaters								X		
Provide electric only Unit Heaters									X	
COMFORT COOLING										
Provide mechanical/electrical cooling for mechanical rooms that have electronic controls with maximum temperature requirements								X	X	
Provide computer room air conditioning units for mechanical cooling, heating, dehumidifying and humidifying the space										X
AIR DISTRIBUTION										
Provide even distribution of air with multiple supply and returns	X	X	X	X	X	X	X			
Avoid supply air directed at or near face of laminar flow of fume hood		X								
HUMIDITY CONTROL EQUIPMENT										
No winter humidification is required	X			X	X	X	X			
Summer maintain 50% maximum ± 5%	X	X	X	X	X	X	X			X
Winter maintain 30% minimum ± 5%		X	X							X
Clean steam humidification with RO water make up and all stainless steel piping is required		X								

ABBREVIATIONS, GENERAL

AI	Analog Input
AO	Analog Output
BAS	Building Automation System
BI (DI)	Binary (Digital) Input
BO (DO)	Binary (Digital) Output
CUP	Central Utility Plant
EMS	Energy Management System
FACP	Fire Alarm Control Panel
PRS	Pressure Reducing Station
SD	Smoke Detector

ABBREVIATIONS, DRAWINGS

AFMS	Airflow Measuring Station
CHWP	Chilled Water Pump
CHWR	Chilled Water Return
CHWS	Chilled Water Supply
CU	Copper
D	Diameter
DP	Differential Pressure
DPT	Differential Pressure Transmitter
EMS	Energy Management System
FCV	Flow Control Valve
FOT	Flat On Top
FT	Flow Transmitter
F&T	Float and Thermostatic (Trap)
HPS	High Pressure Steam
HWR	Hot Water Return
HWS	Hot Water Supply
IB	Inverted Bucket (Trap)
LCHWR	Laboratory Chilled Water Return
LCHWS	Laboratory Chilled Water Supply
LPC	Low Pressure Condensate
LPS	Low Pressure Steam
NC (FC)	Normally Closed (Failed Closed)
NO (FO)	Normally Open (Fail Open)
PRV	Pressure Reducing Valve
P	Pump
PI	Pressure Indicator (Gauge)
PP	Primary Pump (Chilled Water)
PS	Proof (Status) Switch
RPZ	Reduced Pressure Zone
SS	Stainless Steel
TI	Temperature Indicator (Thermometer)
TT (RTD)	Temperature Transmitter (Resistance Temperature Device)

END OF SECTION

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SECTION 23 0513 – MOTORS

1. General: This section outlines general requirements for motors.

2. Design Considerations:

    a. Motors driven by a VFD shall not operate into their service factor.

    b. Motors within an air handling unit (air stream) shall be Totally Enclosed Fan Cooled (TEFC).

    c. HVAC motors outdoors not in an air stream shall be Totally Enclosed Fan Cooled (TEFC).

    d. HVAC motors indoors not in an air stream shall be open drip proof (ODP).

    e. The service factor of HVAC motors shall be 1.15.

    f. Motors, except those controlled driven by a variable frequency drive, shall have class B insulation.

    g. Motors controlled by a variable frequency drive shall have class F or H insulation and a winding thermostat to detect motor overheat conditions.

    h. Motors driven by a VFD shall be provided with shaft grounding brush similar to AEGIS SGR to prevent bearing from shaft current.

END OF SECTION

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SECTION 23 0514 – VARIABLE FREQUENCY DRIVES (VFD's)

1. General: This section outlines general requirements for variable frequency drives.

2. Design Considerations:

    a. VFD's to be purchased by local contractor through a local representative authorized for startup and service.

    b. The VFD manufacturer shall perform a harmonic analysis at no cost to the University. The minimum Allowable shall be 5% distortion for current and voltage per IEEE-519

    c. The VFD shall include the following features:

        i. Main input circuit breaker.

        ii. Input: 4 - 20 mA (AO).

        iii. Output for a 4-20 mA feedback to Energy Management System (EMS) (AI) via communications link.

        iv. System enable terminals from EMS (BO).

        v. System status contact for EMS (BI).

        vi. Malfunction alarm contact for EMS.

        vii. Digital current meter mounted on the door.

        viii. 3 Contactor bypass.

            1. NOTE: Bypass on VFD's is not permitted. However if desired by Engineer of Record, they will be reviewed on a case by case basis.

            2. Consider dual-inverter option where redundancy is critical.

        ix. Overload relay.

        x. RFI protection.

        xi. DC link reactor.

        xii. IGBT (Insulated Gate Bipolar Transistors) technology.

        xiii. Carrier frequency: 8 kHz.

        xiv. Isolation transformer, if required.

d. The VFD shall have 110% continuous current capability, 120% overload capacity for 60 seconds.

e. The VFD shall have minimum NEMA 1 enclosure. Enclosure shall be determined by the environment where VFD is being installed.

f. High motor winding temperatures shall shut down the driven device and alarm.

3. Application

a. No bypass is to be provided when:

i. Fan Array: 3 or more fans are used.

ii. Redundant Fans: 2 fans are used, each at 100% capacity.

iii. Redundant Pumps: 2 pumps are used, each at 100% or 3 pumps are used, each at 50%.

4. Acceptable Manufacturers:

a. Danfoss Graham Company.

b. Emerson (Saftronics Inc.).

c. ABB.

END OF SECTION

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SECTION 23 0529 – MECHANICAL SUPPORTING DEVICES

1. General: This section outlines general requirements for mechanical supporting devices.

2. Design Considerations:

    a. Hangers and supports for both interior and exterior use to be steel hot dipped galvanized coated.

    b. Hangers are required to be specific to pipe and ductwork independently and not shared.

    c. Where insulation in not required use similar metal hangers such as copper hanger for copper pipe and stainless steel hanger for stainless steel pipe.

    d. Rods shall have electroplated zinc or hot dip galvanized finish.

    e. Rigid inserts are required for insulated pipe and ductwork.

    f. Ductwork: Metal and flexible duct hangers and supports shall be in accordance with SMACNA “HVAC Duct Construction Standards – Metal and Flexible,” latest edition.

END OF SECTION

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SECTION 23 0550 – VIBRATION ISOLATION

1. General: This section outlines general requirements for vibration isolation.
2. Design Considerations:
    a. All rotating equipment shall have vibration isolation from building structure.
    b. Free standing spring isolators are not permitted.
    c. Floor-mounted spring vibration isolators shall be housed type springs.
3. Fans and Ductwork:
    a. Fan vibration isolation shall be completed by the Architect / Engineer in compliance with Table 23 0550-1.

Table 23 0550-1							
Fan Schedule				Vibration Isolation			
Fan No.	Location	Wheel Diameter in.	Arrange ment	Fan RPM	Motor HP	Type Isolator	Static Deflection in.

    a. Ducts within 50 feet of the fan discharge shall be isolated by spring hangers with neoprene cups.
4. Pumps and Piping:
    a. Pump vibration isolation shall be in compliance with Table 23 0550-2.

Table 23 0550-2					
Pump Schedule			Vibration Isolation		
Pump No.	Location	Type	Motor HP	Type Isolator	Static Deflection, in.

    a. The first three hangers and floor supports from equipment (, pumps) shall be isolated by spring hangers with neoprene cup for pipe and spring isolated concrete inertia base mounts respectively.

b. Piping passing through equipment room walls, floors, or ceilings shall be all directional acoustical pipe seals.

c. Risers shall be suspended from or supported by all directional acoustical pipe anchors and telescoping type guides

d. Concrete bases after the system is in operation shall have a minimum 2 in. clearance between the floating base and the floor.

5. Acceptable Manufacturers:

a. Amber/Booth Company.

b. Mason Industries.

c. Vibration Mountings & Controls, Inc.

d. Vibro-Acoustics.

END OF SECTION

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SECTION 23 0553 – MECHANICAL SYSTEMS IDENTIFICATION

1. General: This section outlines general requirements for mechanical systems identification.

2. Design Considerations:

    a. Provide labels on pipe and ductwork every 20 feet and at every change in direction.

    b. Stenciling of labels is not permitted.

    c. Piping shall be marked in accordance with ANSI Standard A13.1, most current version.

    d. Provide a flow arrow at each pipe label for direction of flow.

    e. Provide labels for each type of air duct including a flow arrow for direction of flow.

    f. Fire damper access panels shall be permanently identified on the exterior by labels not less than 2 inches in height reading: FIRE DAMPER.

    g. Smoke damper access panels shall be permanently identified on the exterior by labels not less than 2 inches in height reading: SMOKE DAMPER.

    h. Combination fire/smoke dampers can be reset manually. Mark the access panel from which the damper can be reset by a label not less than 2 inch in height reading: RESETTABLE FIRE/SMOKE DAMPER. Mark the other access panel by a label not less than 2 inches in height reading: FIRE/SMOKE DAMPER.

    i. Static pressure sensors in ductwork shall be permanently identified on the exterior by labels not less than 2 inches in height reading: STATIC PRESSURE SENSOR.

    j. Humidity sensors in ductwork shall be permanently identified on the exterior by labels not less than 2 inches in height reading: HUMIDITY SENSOR.

    k. Provide equipment labels for air-handling units, fan pumps, chillers, boilers, etc. Labels shall spell out the system or equipment. Do not use abbreviations.

3. Acceptable Manufacturers:

    a. Brady USA Inc., Signmark Div.

    b. Kolbi Industries Inc.

    c. Panduit Corp.

END OF SECTION

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SECTION 23 0594 – TESTING, ADJUSTING, AND BALANCING (TAB)

1. General: This section outlines the general requirements for testing and balancing during the design and/or construction phases of the project.

2. Design Considerations:

    a. The TAB contractor shall be typically procured directly by Northwestern University. Review specific requirements with the NU Project Manager prior to the start of the project and/or during the design phases.

3. Certification:

    a. Each TAB technician shall be certified by AABC (Associated Air Balance Council) or NEBB (National Environmental Balancing Bureau).

    b. Certification is required for air systems, hydronic systems, sound, and vibration. Test procedures shall be in accordance with the latest edition of AABC or NEBB Standards, ASHRAE - 2011 HVAC Applications Chapter 38.

4. Acceptance Criteria:

    a. For most spaces, the total supply air quantity to each space of a system shall be within -5% to +10% of design. Review project specific requirements with NU Project Manager.

    b. The percent tolerance of each outlet within a space shall be per Table 23 0594-1.

Table 23 0594-1			
System	Number of Outlets in Space		
	1	2	3 or More
Single Zone, Multizone, VAV	-5% +10%	±10%	±15%
Heating and Ventilating	-5% +10%	±15%	±15%

    c. Air quantity of each return air grille and diffuser shall be within ±10% of design. The design room pressurization must be maintained regardless of the tolerance at each individual diffuser.

    d. Vivariums: In general, these laboratories shall be under negative pressure. The design should meet the current NIH Design Requirements Manual for Biomedical

Laboratories and Animal Research Facilities. Any reduction in airflow shall be presented by the project Engineer of Record and reviewed by the NU Project Manager and Project Engineer.

e. Culture Rooms: These rooms shall be under positive pressure.

f. Hydronic Systems: Heating and cooling hydronic systems shall be balanced so that the flow is from 0 to +5% of design at each coil.

g. Combination fire/smoke dampers in dynamic smoke control systems shall be tested for closure under airflow conditions (International Mechanical Code-2009, Section 607), and to assure positive pressure of certain zones, and negative pressure for other zones. Smoke dampers in dynamic smoke control systems must close under airflow conditions.

5. Reports:

a. The contractor prior to TAB work shall submit the following data for review.

b. TAB personnel qualification and certification reports.

c. Test procedures.

d. TAB report forms.

e. As tests are completed the contractor shall submit test reports with includes an executive summary. The executive summary shall state extent of system compliance, system deficiencies, and recommended changes.

6. Approved Contractors:

a. Independent Test and Balance.

b. CEPRO.

c. Project Architect / Engineer to confirm with NU Project Manager that testing and balancing contractors are currently in good standing with NU.

END OF SECTION

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SECTION 23 0700 – MECHANICAL SYSTEM INSULATION

1. General: This section outlines the general requirements for mechanical system insulation.

2. Design Considerations:

    a. Piping insulation thickness shall be in compliance with ASHRAE/IES Standard 90.1-2010, "Energy Efficient Design of New Buildings Except New Low-Rise Residential Building," Table 6.8.3A and 6.8.3B.

    b. Insulation shall butt to preformed insulation covers furnished with circuit setters.

    c. Insulated pipe and fittings outdoors shall be covered by Zeston 300 series fitting covers and pipe jacketing. Seams and joints shall be waterproof.

    d. Insulated pipe fittings indoors shall be covered by Zeston 2000 PVC covers.

    e. Pipe insulation subject to maintenance personnel traffic or within 18 inches of the floor shall be rigid and water resistant.

        i. Density of the insulation shall not be less than 12 lb/ft3; the thermal conductivity of the material shall not exceed 0.45 BTU·in./(hr·ft2·ºF) at 100ºF.

        ii. Insulation thickness shall be determined from ASHRAE/IES Standard 90.1-2010 and increased to the values in Table 23 0700-1.

Table 23 0700-1	
Thickness from ASHRAE/IES Standard 90.1-2010	Rigid Insulation Thickness, in.
0.5	1.0
1.0	2.0
1.5	2.5
2.0	3.5
2.5	4.5
3.5	6.0

        iii. Insulation shall have a jacket; either metal or Zeston series 300 PVC.

f. Glass vent piping shall be insulated and metal jacketed.

   i. Acceptable Manufacturers:

      1. Certain Teed Corp.

      2. Knauf Fiber Glass GmbH.

      3. Owens-Corning Fiberglas Corp.

      4. Schuller International, Inc.

g. Removable Insulation Covers:

   i. Steam valves, steam expansion joints, and awkward surfaces not covered by insulation shall be covered by a removable ceramic fiber blanket.

   ii. Acceptable Manufacturers:

      1. Advance Thermal Corp.

      2. Thermal Energy Products, Inc.

      3. Temptec.

      4. Remco Technology, Inc.

h. Chilled and Low temperature Condenser Water Pumps: Each water pumps shall be covered by 1 inch thick AP Armaflex applied with a waterproof adhesive. Removable components shall use Velcro applied to both the Armaflex and the pump surface with a waterproof adhesive such that the pieces can be removed for servicing without damage.

i. Chillers: Each chiller shall be covered by 1 in. thick AP Armaflex applied with a waterproof adhesive. All removable components shall use Velcro applied to both the Armaflex and the shell surface with a waterproof adhesive such that the pieces can be removed for servicing without damage.

j. Converters:

   i. Shell and tube heating shall be covered by 2-1/2 in thick rigid glass fiber insulation in accordance with ASTM C612, Type IA and IB, suitable for temperatures to 450°F,

   ii. Plate and frame shall be covered by 1 in. thick AP Armaflex applied with a waterproof adhesive:

k. Condensate Pump / Receivers: Provide a cover of 2 inch thick rigid glass fiber insulation in accordance with ASTM C612, Type IA and IB, suitable for temperatures to 450°F,

i. Supply, return, and exhaust ducts and plenums shall be insulated in accordance with ASHRAE/IES Standard 90.1-2010, “Energy Efficient Design of New Buildings Except New Low-Rise Residential Building,” Table 6.8.2A and 6.8.2B.

1. Exception: Exhaust ducts not used for heat recovery in unconditioned spaces need not be insulated.

l. Ductwork in mechanical equipment rooms and exposed in other areas shall be covered with rigid insulation with a flame retardant vapor barrier.

m. Flexible fibrous blanket insulation with a factory-applied vapor-barrier shall be applied to all concealed ductwork requiring insulation.

n. Exhaust ductwork in unconditioned spaces which exits through an exterior wall shall be insulated 20 ft minimum from the exterior wall.

o. Insulation shall be installed in compliance with the “Commercial & Industrial Insulation Standards” by MICA (Midwest Insulation Contractors Association).

END OF SECTION

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SECTION 23 2113 – HYDRONIC PIPING

1. General:

    a. This section outlines the general requirements for hydronic pipe and pipe fittings, including valves, unions, and flanges.

    b. Specific requirements shall be reviewed with the NU Project Manager during the design phases of the project.

    c. Materials: Piping shall conform to ASTM standards.

2. Design Considerations:

    a. General: Piping shall be routed orthogonally (no diagonal shortcuts).

        i. Exception: Common pipe of the chilled water bridge.

    b. Provide vents at the high point of piping systems, in accessible locations, to allow for system venting. Vents shall have isolation valves, pressure gauge, and boiler drain.

    c. Expansion tanks shall be diaphragm type; the pre-charge pressure shall be specified to suit the system.

    d. Air separators shall be installed in each heating system distribution loop at the point of lowest air solubility and vented to atmosphere.

    e. Hot and Chilled Water Piping:

        i. Each new closed hydronic system shall have full bore strainers and a particulate side-stream filter rated at 100 microns, unless specified otherwise.

            1. Show on the drawings for each new hydronic system full bore strainers and a 15% side stream filter. Specify the micron filtration size for the side-stream filter.

        ii. No piping with a fluid shall be routed over electrical busway housings. For electrical busway housings provide a minimum 24 inches on both sides and the bottom.

    f. Tracer Wire:

        i. Non-electrical pipe installed below grade shall have a 12 AWG copperhead Reinforced Tracer Wire, or equal. Tracer wire to be accessible at each end in manholes.

ii. Tracer Wire shall be installed on the pipe as shown on the contract drawings.

iii. Tracer wires shall terminate in each tunnel and manhole where new utilities penetrate. Tracer wires shall be provided with labels noting what pipe the wire is affixed to (ie. Chilled Water Supply, Pumped Condensate Return, etc).

3. Pipe Support Guides:

   a. Piping shall be spaced and supported at a maximum of 10 foot intervals in conduit by insulating support-guides and to permit pipe to expand and contract freely without stress or wear on pipe or insulation as well as provide for drainage and free air circulation.

4. Expansion Loops, Moment Guided, Ells and Tees:

   a. Prefabricated ells, loops and tees to be provided where shown on plan drawings and to consist of pipe, insulation, and conduit conforming to the same pipe and welding specifications as specified before herein for straight runs. Tees, anchors, elbows and other fittings shall be factory connected and prefabricated to straight sections whenever shipping requirements permit.

   b. Expansion loops to be of proper design in accordance with stress limits indicated by ASME Code for pressure piping, District Heating Section. Install loop piping in conduit suitably oversized to handle the calculated pipe expansion without damaging the insulation.

   c. The piping system is designed with both expansion loops and expansion joints. The piping system shall be designed to accommodate this requirement by including moment guides as required for the piping system to function properly in conjunction with expansion joints.

   d. Cold springing or pre-stressing piping as a means for control of expansion in any portion of the steam system is not allowed.

5. Anchors:

   a. Prefabricated plate anchors to be provided where shown and to consist of a steel plate welded to pipe and conduit. Steel plate shall be 1/2” thick for 1” to 22” conduit and 3/4” thick for conduit over 22” for anchors with expansion loops.

   b. Concrete block to be cast over plate and conduit and to be large enough for firm anchorage into undisturbed trench sidewalls and/or bottom. Concrete block to be at least 36” in length and extend minimum of 12” beyond entire anchor plate. The piping vendor shall provide detailed instructions to Contractor for oversized anchors due to expansion joints. The Contractor shall provide oversized anchors as detailed by the piping vendor.

6. End Seals and Gland Seals:

    a. Terminal ends of conduits inside manholes, to be equipped with end seals consisting of steel bulk head plate welded to pipe and conduit. Where there is no anchor within 5'-0" of terminal end, conduits to be equipped with gland seals consisting of packed stuffing box and gland follower mounted on steel plate welded to end of conduit. End seals or gland seals to be equipped with drain and vent openings located diametrically opposite on vertical centerline of mounting plate and to be shipped to job site with plugs in place. Terminate conduits 4" beyond inside face of manhole or building walls to protect any exposed piping insulation from damp wall condensation. Refer to drawing details for further construction and dimensional requirements

    b. All end and gland seals shall be reinforced with 12" long galvanized steel sleeve at the sealing surface to prevent compression of the outer jacket and insulation from modular wall sealing devices. The protection sleeve shall be minimum 6 gauge thickness and shall be outside of the HDPE jacket. Where the galvanized steel sleeve stops on the outside of the manhole, the sleeve shall be shrink wrapped to the HDPE jacket and sealed water tight.

7. Field Joints:

    a. Field joints shall conform to the pipe manufacturer's specifications.

    b. Field joints shall consist of field installed mineral wool insulation banded with stainless steel bans on the carrier pipe, field applied 10 gauge connector sleeve on the inner conduit, field applied foam insulation, polyethylene heat shrink wrap and split HDPE jacket at a minimum. Field joint materials and methods shall be provided by and approved by the piping manufacturer.

8. Chilled Water in Central Utility Plant (CUP):

    a. 2-1/2 inches and Smaller:

        i. Pipe: ASTM A53, Type F, standard weight, carbon steel.

        ii. Fittings: ASME B16.4, Class 125, cast iron, threaded or ASME B16.3, Class 150, malleable iron, threaded.

        iii. Unions: ASME B16.29, malleable iron, Class 250. Refer to Unions and Flanges in this Section.

    b. 3 inches through 24 inches:

        i. Pipe: ASTM A53, Grade B, Type E or S, standard weight, carbon steel.

        ii. Fittings: ASTM A234 Grade WPB/ASME B16.9, standard weight, seamless, carbon steel weld.

        iii. Flanges: Class 150. Refer to Unions and Flanges in this Section.

c. 30 inches through 42 inches:

i. Pipe: API-5L, Grade B, Type DSAW, 0.375" wall thickness, carbon steel.

ii. Fittings: ASTM A234, Grade WPB/ASME B16.9, 0.375" wall thickness, seamless, carbon steel weld.

iii. Flanges: Class 150. Refer to Unions and Flanges in this Section.

9. Chilled Water (Underground):

a. Piping and Fittings 8 inches through 36 inches:

i. Ductile iron pipe, 300 psi minimum working pressure, ANSI/AWWA C151/A21.51, with external asphaltic coating. Nominal piping wall thicknesses shall be as follows:

4”	0.25”
6”	0.25”
8”	0.25”
10”	0.26”
12”	0.28”
14"	0.30"
16"	0.32"
18"	0.34"
20"	0.36"
24"	0.40"
30”	0.45”

ii. Fittings shall be ductile iron mechanical joint type manufactured in accordance with ANSI/AWWA C110/A21-10, rated for 250 psi working pressure.

iii. Straight pipe joints and fittings to be restrained joint-type. Joints and fittings shall be flexible and shall be designed to provide positive restraint against end-wise separation due to thrust.

iv. All pipe taps shall be drilled and tapped using corporation stop. Saddle taps will not be allowed.

b. Restrained Type Joint - All Sizes:

i. Pipe Joints:

1. US Pipe “TRFlex” or American Cast Iron Pipe “Flex Ring” or approved equal. American Cast Iron Pipe “Fastite” or US Pipe “Tyton” joint with EBBA Iron Series 1100 or Series 1700 harness type restraints may also be used. All joints shall be restrained type. Pressure rating of 250 psi minimum.

2. All bolts shall be low alloy, high strength steel bolts having minimum yield strength of 45,000 PSI and which are cathodic to the pipe, meeting the requirements of AWWA C111.

3. Gasket material shall be SBR.

4. Pipe Fittings, Valves and Connections to Existing Systems: Equal to EBBA Iron Series 1100 or Series 1700 Megalug restraint systems for push-type or mechanical joint piping, fittings and valves.

5. Series 1100 solid ring restraints shall have a rated working pressure of 350 psi up to 16” pipe and 250 psi for 18” to 36” pipe.

6. Series 1700 restraints shall have a rated working pressure of 350 psi up to 16” pipe and 250 psi for 18” to 36” pipe.

7. Gasket material shall be SBR.

10. Waste Water:

a. Pressurized Waste Water:

i. Type K copper water tube, (drawn) temper, ASTM B88; with copper drainage fittings (DWV), ANSI B16.23; wrought copper drainage fittings (DWV), ANSI B16.29; lead free (<.2%) solder ASTM B32; flux, ASTM B813.

11. Unions and Flanges:

a. Unions:

i. 2 1/2 inches and Smaller:

1. Forged steel, ASTM A105 Grade 2, ASME B16.11, socket weld, 3000lb. WOG with steel to steel seats.

b. Flanges:

   i. 3 inches and Larger:

      1. ASTM A105, ANSI B16.5, hot forged steel flanges, welding neck pattern. Slipon pattern flanges are not allowed. Bore dimension of welding neck flange shall match inside diameter of connected pipe. Use raised face flanges for mating with other raised face flanges with self-centering flat ring gaskets. Use flat face flanges for mating with other flat face flanges with full face gaskets.

   ii. Flange pressure class indicated in respective piping service is minimum required. Mating flange pressure class shall match pressure class of device connected to such as valves and piping specialties. Flanged connection will on be permitted at specialty connections such as at a vessel or specialty valve.

c. Flange Gaskets:

   i. Gasket material to be asbestos free and suitable for pressure temperatures and fluid of piping system. Non-metallic gaskets shall be in accordance with ANSI/ASME B16.21 and ASTM F104.

   ii. Gaskets shall be equal to Flexitallic Style CG, graphite filler, 304 SS winding, carbon steel centering ring, 0.175" thickness.

d. Bolting:

   i. For all connections to valves, use bolts studs.

   ii. Bolts, bolt studs, nuts and washers used on piping systems in Central Utility Plant (CUP), tunnel and manholes shall have zinc plated finish.

   iii. Thread shall be in accordance with ANSI/ASME B1.1, Class 2A tolerance for external threads and Class 2B tolerance for internal threads. Threads shall be coarse-thread series except that alloy steel bolting 1-1/8" and larger in diameter shall be 8 pitch thread series.

   iv. Threaded rods are not allowed as fastening elements on steam systems.

   v. For Class 150 and Class 300 flanges at 400°F or lower temperature, use carbon steel bolts or stud bolts conforming to ASTM A307, Grade B with nuts conforming to ASTM A307.

   vi. For Class 300 flanges at 500°F or lower temperature, use alloy steel bolts or stud bolts conforming to ASTM A193, Grade B7 or B16, with nuts conforming to ASTM A194, Grade 2H.

12. Valves – General:

    a. General: Install valves as shown on plans, details and according to the valve manufacturer's installation recommendations.

    b. Provide chain operators for manually operated valves 4" and larger, located more than 6'-0" above normal working surface.

13. Chilled Water (In Tunnel):

    a. Butterfly Valves:

        i. Valves to conform to latest revision of AWWA C-504. Valves to be tight closing, rubber seated. Valves to be zero-leakage at 200 psig, and shall be suitable for throttling service and operation after long periods of inactivity. Valves shall be rated for 250-psi non-shock working pressure minimum. Valves to be designed for direct buried application.

        ii. Cast iron body ASTM A-126B, Class B, restrained flanged (ANSI B16.1) ends. Valve shall be furnished complete with joint accessories (bolts, nuts, and gaskets). Flanging shall be lugged type permitting removal of downstream piping while using valve for system shutoff.

        iii. Resilient seat shall be ethylene propylene diene Monomer (M-class) rubber (EPDM). EPDM seats shall be peroxide cured.

        iv. Valves 20" and smaller shall have the seat bonded directly to the body. Valve 24" and larger shall have seats that are mechanically retained in the valve body. Either seat shall be capable of mechanical adjustment in the field and field replacement.

        v. Valve discs shall be constructed of cast iron ASTM A-126, Class B or ductile iron ASTM-A-536. Disc shall have stainless steel seating edge to mate with valve seat.

        vi. Valve shaft to be 18-8, Type 304 stainless steel with "V" / "cup" PTF style self-adjusting packing.

        vii. Valve assembly shall be furnished with a non-adjustable factory set thrust bearing designed to center the valve disc at all times.

        viii. Shaft bearings shall be contained in the integral hubs of the valve body and shall be self-lubricated sleeve type and shall be sealed in place with "V" / "cup" PTF style self-adjusting packing.

        ix. Prior to shipment, valves to be hydrostatically and leak tested at the factory in accordance with AWWA C-504. Factory hydrostatic test shall be performed at 200 psig for all valves.

            1. NU and Architect / Engineer shall have option to be present to witness factory testing for the first valves that are 20" and smaller

and the first valves that are 24" and larger. Valve manufacturer shall be responsible for providing transportation and accommodations for two (2) NU representatives and one (1) representative of the Architect / Engineer.

x. Provide worm gear operators. Provide rotary hand wheels with adjustable position stop and position indicators. Size hand wheel operators with no higher than 40 lb rim pull at full valve pressure rating.

14. Chilled Water (Underground):

a. Butterfly Valves:

i. Valves to conform to latest revision of AWWA C-504. Valves to be tight closing, rubber seated. Valves to be zero-leakage at 200 psig, and shall be suitable for throttling service and operation after long periods of inactivity. Valves shall be rated for 250-psi non-shock working pressure minimum. Valves to be designed for direct buried application.

ii. Cast iron body ASTM A-126B, Class B, restrained mechanical joint (AWWA C-151/ANSI 21.11) or flanged (ANSI B16.1) ends. Valve shall be furnished complete with joint accessories (bolts, nuts, gaskets and glands).

iii. Resilient seat shall be ethylene propylene diene Monomer (M-class) rubber (EPDM). EPDM seats shall be peroxide cured.

iv. Valves 20" and smaller shall have the seat bonded directly to the body. Valve 24" and larger shall have seats that are mechanically retained in the valve body. Either seat shall be capable of mechanical adjustment in the field and field replacement.

v. Valve discs shall be constructed of cast iron ASTM A-126, Class B or ductile iron ASTM-A-536. Disc shall have stainless steel seating edge to mate with valve seat.

vi. Valve shaft to be 18-8, Type 304 stainless steel with "V" / "cup" PTF style self-adjusting packing.

vii. Valve assembly shall be furnished with a non-adjustable factory set thrust bearing designed to center the valve disc at all times.

viii. Shaft bearings shall be contained in the integral hubs of the valve body and shall be self-lubricated sleeve type and shall be sealed in place with "V" / "cup" PTF style self-adjusting packing.

ix. Prior to shipment, valves to be hydrostatically and leak tested at the factory in accordance with AWWA C-504. Factory hydrostatic test shall be performed at 200 psig for all valves.

1. NU and Architect / Engineer shall have option to be present to witness factory testing for the first valves that are 20" and smaller and the first valves that are 24" and larger. Valve manufacturer shall be responsible for providing transportation and accommodations for two (2) NU representatives and one (1) representative of the Architect / Engineer.

x. Valves to be complete with grease packed buried service gear operator, shaft extensions with centering disk located on shaft, to within one foot of finished grade and soil pipe.

xi. Refer to drawings for length of shaft extensions and soil pipes.

xii. Valves shall be Pratt Groundhog or approved equal.

15. Underground Valve Specialties:

a. Valve Boxes:

i. Valve boxes shall be 2 - piece cast iron, screw type, 5 1/4" shaft with stay-put heavy duty traffic weight lid marked “CHILLED WATER” to match piping system. Boxes shall be equal to Figure UTL 273, as manufactured by Dewey Brothers, Tyler or Charlotte Pipe and Foundry Co.

ii. Valve boxes to be coated with coal tar for buried service application.

b. Valve Wrenches:

i. Provide T-handle extension wrench with flexible socket for each different shaft size. Socket shall be sized for gate valve operating nut.

16. Ball Valves:

a. 2" and Smaller: bronze body, threaded, stainless steel ball and stem, full port, teflon seat rings, blowout-proof stem, three piece construction, 600 psi WOG, 150 psi SWP.

17. Drain and Vent Valves:

a. In Tunnel: Ball valves as specified above with hose thread adapter and cap. Provide 2" minimum drain valves provided with short threaded nipple and cap. All vent valves shall be minimum 3/4" in size.

18. Swing Check Valves:

a. Provide check valves at condensate lines at outlet of traps. Install check valve between trap and gate valve.

19. Drain Valves:

    a. Provide drain valves at all low points of piping systems for complete drainage of systems.

20. Chilled Water - Drain and Vent Valves:

    a. Provide drain valves at all low points of piping systems for complete drainage of systems. Provide vent valves at high points for venting of air. Locate drains and vents as indicated on the contract drawings and as required due to actual installed conditions.

21. Pressure Equalizing Valves:

    a. Provide pressure equalizing valves on valves in the following locations:

        i. High pressure steam (230 psig) shut-off valves 3" and larger for supervised warm-up.

END OF SECTION

DIVISION 23 – HVAC

SECTION 23 2116 – HYDRONIC PIPING SPECIALTIES

1. General: This section outlines the general requirements for hydronic piping specialties.

2. Design Considerations:

    a. Provide chain-wheel operators for valves 6 inches and larger mounted over 8 feet above floor.

    b. Furnish gear operators for valves 8 inches and larger.

        i. Acceptable Manufacturers:

            1. Flowseal.

            2. Bray.

            3. Neles-Jamesbury.

            4. DeZurik.

            5. Posi-Seal.

            6. Zwick (Tri-Con series).

            7. Milwaukee.

3. Primary/Secondary Bridge Valves, Hot and Chilled Water: Typically not permitted. Project specific requirements to be reviewed on a case-by-case basis.

    a. For each project the A/E shall submit bridge piping details to NU Project Manager and NU Project Campus Energy Management System (EMS) Department for review.

    b. A minimum 60 psig instrument-quality air shall be piped to the bridge valve.

    c. For piping details see the NU Direct Digital Control Standards.

4. Hot and Chilled Water Coil Control Valves:

    a. For piping details see the NU Direct Digital Control Standards.

    b. Valves shall be standard as manufactured by controls vendor, electric actuated unless special case calls for pneumatic, to be flagged by engineer for NU review.

    c. Engineer to calculate valve CV and select appropriate valve as part of design.

5. Butterfly Valves (Regular Isolation Valve):

    a. Resilient Seat:

        i. Isolation valves 2-1/2 inch and 3 inch may be ball or butterfly. Pipe sizes 4 inch and larger shall be butterfly.

        ii. Butterfly valves shall ANSI Class 150, lugged design.

        iii. Butterfly valves shall be with a handle or actuator as follows:

            1. 6 inch: handle.

            2. 8 inches and greater: Manual-gear actuator.

        iv. Acceptable Manufacturer:

            1. Neles-Jamesbury, Inc.; Model No. 815L-11-2236TT.

    b. Butterfly for Control Valve Duty: High Performance with Rubber Seat.

        i. Carbon steel or stainless steel body

        ii. ANSI Class 150 design rated for 275 psi at 100°F

            1. Bubble-tight shut off with pressures in either direction to 275 psi.

            2. Threaded lug type, upper and lower body bearings with thrust bearings,

            3. One piece single or double offset shaft of 316 stainless steel and center less ground and polished to minimize bearing and packing wear, PTFE seats.

    c. Butterfly for Critical Shutoff Duty:

        i. High Performance with Metal seat for steam and condensate only. No triple offset high performance butterfly valves permitted elsewhere in system.

    d. Butterfly for Direct Buried Service:

        i. Pratt Groundhog/AWWA Valves.

6. Ball Valves:

    a. Isolation valves 2-1/2 inch and 3 inch may be a ball or butterfly. Pipe sizes 2 inches and smaller shall be ball.

    b. Ball valves shall be bronze, 600 psig WOG, full port, with a 316 stainless steel ball and stem.

c. Insulated valves shall have a 2-1/4 in. stem extension.

d. Acceptable Manufacturers:

i. Conbraco Industries, Inc. (APOLLO®)

ii. Neles-Jamesbury, Inc.

iii. Watts Regulator Co.

7. Gate Valves: Gate valves are not permitted.

8. Circuit Setters:

a. Circuit setters shall be furnished with preformed insulation covers by the circuit setter manufacturer.

b. Acceptable Manufacturers:

i. Bell & Gossett, ITT Fluid Handling Division.

ii. Nexus.

9. Triple Duty Valves:

a. Acceptable Manufacturers:

i. Bell & Gossett, ITT Fluid Handling Division.

ii. TACO, Inc.

10. Check Valves:

a. Check valves shall be ANSI class 150, minimum depending on the service. Valve shall be carbon steel body and plate, metal seal, serrated raised face end connections, and a solid body lug design with threaded holes bolted from each end.

b. Horizontal:

i. Acceptable Manufacturers:

1. Nibco.

2. Mueller.

c. Vertical:

i. Acceptable Manufacturers:

1. Crane.

2. Nibco.

3. Mueller.

d. Non Slam Type:

i. Acceptable Manufacturers:

1. Stockham, Style G.

2. Crane Duo Chek.

11. Thermometers:

a. Thermometers shall be red appearing mercury, 9-inch scale, aluminum case, adjustable angle, and aluminum stem.

b. Wells shall be brass with a 2.5 inch extension neck. The insertion length shall be in compliance with Table 23 2116-1.

Table 23 2116-1 Immersion Length for Thermometer Wells		
Pipe Diameter, in.	Well Immersion Length, in.	
	Perpendicular Mount	Elbow Mount
3	N/A*	8½
4	N/A*	8½
6	4½-5½	8½
8	4½-5½	8½
10	4½-5½	8½
12 and larger	8½	8½

* Perpendicular mount shall not be used on 3 and 4-in. pipe. Stem cooling effects may occur.

c. Scale Range:

i. Chilled Water: 0 to 100°F or 0 to 120°F.

ii. Hot Water: 30 to 240°F or 30 to 300°F.

d. Thermometers shall be packed in a thermal conductive compound by the Piping Contractor. Preferred products are:

i. Honeywell: Part No. 107408.

ii. Johnson Controls: F-1000-182.

iii. York: 013-00898-000.

e. Acceptable Manufacturers:

i. H. O. Trerice Co.

ii. Weksler Instruments Corporation.

12. Pressure Gauges:

a. Pressure gauges shall have a minimum 4-1/2" diameter die cast aluminum case, glass or acrylic plastic window, phosphor bronze bourdon tube with bronze bushed movement, recalibration from front of gauge dial and 1/4" NPT forged brass socket

b. Gauge accuracy shall meet ANSI B40.100 Grade 1A (±1% full scale).

c. Select gauge range so that normal operating pressure is at midpoint of gauge.

d. Acceptable Manufacturers:

i. Trerice 600 Series.

ii. Weksler.

iii. Weiss.

13. Flexible Metal Hose:

a. Flexible hose shall be stainless steel, double braided.

b. Length shall be adequate to control vibration and noise. The live (flexible portion of the assembly) and assembly lengths shall be determined by the Piping Contractor.

c. Acceptable Manufacturers:

i. Flexicraft Industries, Chicago.

ii. Metraflex.

iii. Hyspan.

iv. Expansion Joint Systems.

v. Flexonics

14. Chilled Water Flow Meters:

    a. Flow meters in conjunction with RTDs to measure temperature difference are used on the both campuses to totalize ton-hours of chilled water usage of each building on the central chilled water system.

    b. For Chilled water flow meter detail and specifications see the NU Direct Digital Control Standards.

    c. See NU Meter Requirements for both steam/condensate systems and chilled water systems.

15. Solenoid Valves:

    a. Solenoid valves are to be slow acting.

    b. Acceptable Manufacturer:

        i. Automatic Switch Company (ASCO).

16. Chemical Feed Pumps:

    a. Acceptable Manufacturer:

        i. LMI (Liquid Metronics Division) Milton Roy, Acton, MA 01720.

17. Expansion Tanks:

    a. Expansion tanks shall be compression or pressurized as shown on the drawings.

    b. Expansion compression tanks shall be constructed in accordance with Section VIII, Division 1 of the ASME Boiler and Pressure code and stamped 125 psig working pressure or greater.

    c. Expansion pressurized tanks shall be pre-charged, steel with a replaceable butyl rubber bladder. The tank shall be constructed in accordance with Section VIII of the ASME Boiler and Pressure Code and stamped 125 psig working pressure or greater. The tank shall include a charging valve (standard tire valve) to facilitate on-site charging of the tank to meet system requirements.

    d. Expansion tanks shall be located and piped in compliance with the drawing details.

    e. Acceptable Manufacturers:

        i. AMTROL.

        ii. Bell and Gossett.

        iii. Armstrong.

18. Acoustical Penetration Seals:

    a. Provide acoustical pipe penetrations at all mechanical room penetrations in compliance with the drawing details.

    b. Option 1. The vibration isolation manufacturer may provide a molded synthetic rubber seals between the penetration sleeve and the pipe on both sides of the penetration. The seals shall be attached by stainless steel clamps. The clearance between the pipe and the sleeve shall be filled with fiberglass.

    c. Option 2. The vibration isolation manufacturer may provide a split seal consisting of two bolted halves with 3/4 in. or thicker neoprene sponge bolted to the inner faces. The seal shall be tightened around the pipe to eliminate clearance between the inner sponge face and the piping. Concrete may be packed around the seal to make it integral with the wall or ceiling if the seal is not in place prior to the construction of the building member. Seals shall project a minimum 1 in. past either face of the penetration.

    d. Acceptable Manufacturers:

        i. Amber/Booth Company.

        ii. Mason Industries.

        iii. Vibration Mountings & Controls, Inc.

19. Backflow Preventers:

    a. Acceptable Manufacturers:

        i. Watts Regulator Company, Series 909.

20. Baseboard Radiation Heaters:

    a. Baseboard heaters shall be hot water, minimum 1-1/4 inch copper tubing.

    b. A/E shall consider the design for baseboard radiation heaters with a supply water temperature of 120 degrees F.

21. Air Separators:

    a. Install on building closed loops only, not on Central Utility Plant (CUP) distributed utilities.

    b. Air separators shall be constructed in accordance with Section VIII, Division 1 of the ASME Boiler and Pressure code and stamped 125 psig working pressure or greater.

    c. Expansion tanks shall be located and piped in compliance with the drawing details.

d. Acceptable Manufacturers:

i. AMTROL.

ii. Bell and Gossett.

iii. Armstrong.

END OF SECTION

DIVISION 23 – HVAC

SECTION 23 2123 – PUMPS

1. General: This section outlines the general requirements for mechanical pumps.

2. Design Considerations:

    a. It is preferred that pump speeds not exceed 1800 rpm.

    b. Standby pumps should be 100% capacity.

    c. For pump piping details see drawings. Strainers shall be full bore.

    d. Nameplates shall include impeller diameter, rated capacity (gpm), rated head (ft) rpm, motor horsepower, and rpm.

    e. Pump suction diffusers shall be provided when the pump suction pipe is 90 degrees.

    f. Status Switch: The piping contractor shall install the differential pressure switch status (proof) switches provided by the BAS (Building Automation System) contractor.

    g. Gauges:

        i. Provide differential pressure gages at all pumps:

        ii. Gauges shall be glycerine-filled.

        iii. Gauges on a common hydronic system shall have consistent scale ranges.

        iv. Provide isolation “pete” plug valves on all gage connections.

        v. Provide temperature indicators on the supply and return side of all heat exchangers, chillers and boilers. All gauges shall have consistent temperature ranges.

        vi. Provide pressure gauges on the supply and discharge sides of all pumps and heat exchangers.

3. Acceptable Manufacturers:

    a. Motors up to 25 hp:

        i. Bell & Gossett, ITT Fluid Handling Division.

        ii. Fairbanks-Morse®, Aurora Pump Co.

        iii. Armstrong.

iv. Peerless.

v. Gould.

b. Motors 30 hp and greater:

i. Fairbanks-Morse, Aurora Pump Co.

ii. ITT A-C Pump.

iii. Armstrong.

iv. Peerless.

v. Gould.

END OF SECTION

DIVISION 23 – HVAC

SECTION 23 2113 – STEAM PIPING

1. General:

    a. This section outlines the general requirements for steam pipe and pipe fittings, including valves, unions, and flanges.

    b. Specific requirements shall be reviewed with the NU Project Manager during the design phases of the project.

    c. Materials: Piping shall be meet ASTM requirements.

2. Design Considerations:

    a. General: Piping shall be routed orthogonally (no diagonal shortcuts).

    b. Tracer Wire:

        i. All non-electrical pipe installed below grade shall have a 12 AWG copperhead Reinforced Tracer Wire, or equal. Tracer wire to be accessible at each end in manholes.

        ii. Tracer Wire shall be installed on the pipe as shown on the contract drawings.

        iii. Tracer wires shall terminate in each tunnel and manhole where new utilities penetrate. Tracer wires shall be provided with labels noting what pipe the wire is affixed to (ie. Chilled Water Supply, Pumped Condensate Return, etc).

3. High Pressure Steam in CUP and Manholes (100 and 230 PSIG):

    a. 2-1/2 inches and Smaller:

        i. Pipe: ASTM A106, Grade B, extra strong, carbon steel.

        ii. Fittings: ASTM A105 Grade II/ASME B16.11, 3000 lb. forged steel, socket weld.

        iii. Unions: Forged steel, 3000 lb., socket weld. Refer to Unions and Flanges in this Section.

    b. 3 inches and Larger:

        i. Pipe: ASTM A106, Grade B, extra strong, carbon steel.

        ii. Fittings: ASTM A234 Grade WPB/ASME B16.9, extra strong, seamless, carbon steel weld.

iii. Flanges: Class 300. Refer to Unions and Flanges in this Section.

4. Pumped Condensate and Steam Trap Condensate in CUP (100 And 230 PSIG):

   a. 2-1/2 inches and Smaller:

      i. Pipe: ASTM A106, Grade B, extra strong, carbon steel.

      ii. Fittings: ASTM A105 Grade II/ASME B16.11, 3000 lb. forged steel, socket weld.

      iii. Unions: Forged steel, 3000 lb., socket weld. Refer to Unions and Flanges in this Section.

   b. 3 inches and Larger:

      i. Pipe: ASTM A106, Grade B, extra strong, carbon steel.

      ii. Fittings: ASTM A234 Grade WPB/ASME B16.9, extra strong, seamless, carbon steel weld.

      iii. Flanges: Class 300. Refer to Unions and Flanges in this Section.

5. Pumped Condensate and Steam Trap Condensate in Manholes:

   a. 2-1/2 inches and Smaller:

      i. Pipe: ASTM A312, 304L, Schedule 40S, seamless stainless steel.

      ii. Fittings: ASTM 182, Gr. F304, ASME B16.11, 3000 lb socket-weld.

      iii. Unions: 3000 lb socket-weld, stainless steel ground joint.

   b. 3 inches and Larger:

      i. Pipe: ASTM A312, 304L, Schedule 40S, seamless stainless steel.

      ii. Fittings: ASTM A403, Gr. WP, Class S or Class W, ASME 16.9.

      iii. Flanges: ASTM A182, Gr. F304, ASME B16.5, 150 lb std. with 1/16" raised face, serrated face finish and welding neck.

      iv. Bolts: Stud bolts, ASTM A193, Gr. B7.

      v. Nuts: ASTM A194, Gr. 2H.

6. High Pressure Steam and Condensate (Underground) – General:

   a. All underground steam and condensate shall be engineered drainable, dryable type. Contractor fabricated piping and fittings are not allowed. No metal components shall be exposed to earth.

b. The high pressure piping design shall be based on 230 psig steam at 410 degrees F. The condensate piping design shall be based on 230psig at 410 degrees F.

c. All straight sections, fittings, anchors and other accessories shall be factory prefabricated to job dimensions, and designed to minimize the number of field welds. The design shall be computer analyzed by the piping system manufacturer to determine stresses and movements of the service pipe and to ensure that the system design is in strict conformance with ANSI B31.1 latest edition, and stamped by a registered professional engineer licensed in the state of Illinois. The analysis shall include piping and structures inside the manholes.

d. The piping manufacturer shall provide minimum of 25 days of on-site technical assistance during installation of the piping. The factory representative shall be a factory trained technician to witness requirements outlined in the installation portion of this specification.

e. Contractor shall perform a computerized pipe stress analysis for the piping systems in the underground steam system. Submit stress analysis report including input data, system graphics, output data including: system forces and moments, system deflections, system stresses, hanger, support and anchor loading summary and other pertinent data. Analysis shall consider actual materials of construction and a system pressure and temperature of 250 PSIG and 450°F, base temperature is 50°F. Analysis output data shall be utilized to select proper supports, guides and anchors to resist actual loads calculated. Pipe stress analysis calculations to be submitted to the Engineer for review along with the re-engineered piping system shop drawings.

7. Pipe Support Guides: Piping shall be spaced and supported at a maximum of 10 foot intervals in conduit by insulating support-guides and to permit pipe to expand and contract freely without stress or wear on pipe or insulation as well as provide for drainage and free air circulation.

8. Expansion Loops, Moment Guided, Ells and Tees:

a. Prefabricated ells, loops and tees to be provided where shown on plan drawings and to consist of pipe, insulation, and conduit conforming to the same pipe and welding specifications as specified before herein for straight runs. Tees, anchors, elbows and other fittings shall be factory connected and prefabricated to straight sections whenever shipping requirements permit.

b. Expansion loops to be of proper design in accordance with stress limits indicated by ASME Code for pressure piping, District Heating Section. Install loop piping in conduit suitably oversized to handle the calculated pipe expansion without damaging the insulation.

c. The piping system is designed with both expansion loops and expansion joints. The piping system shall be designed to accommodate this requirement by including moment guides as required for the piping system to function properly in conjunction with expansion joints.

d. Cold springing or pre-stressing piping as a means for control of expansion in any portion of the steam system is not allowed.

9. Anchors:

a. Prefabricated plate anchors to be provided where shown and to consist of a steel plate welded to pipe and conduit. Steel plate shall be 1/2” thick for 1” to 22” conduit and 3/4” thick for conduit over 22” for anchors with expansion loops.

b. Concrete block to be cast over plate and conduit and to be large enough for firm anchorage into undisturbed trench sidewalls and/or bottom. Concrete block to be at least 36” in length and extend minimum of 12” beyond entire anchor plate. The piping vendor shall provide detailed instructions to Contractor for oversized anchors due to expansion joints. The Contractor shall provide oversized anchors as detailed by the piping vendor.

10. End Seals and Gland Seals:

a. Terminal ends of conduits inside manholes, to be equipped with end seals consisting of steel bulk head plate welded to pipe and conduit. Where there is no anchor within 5’-0” of terminal end, conduits to be equipped with gland seals consisting of packed stuffing box and gland follower mounted on steel plate welded to end of conduit. End seals or gland seals to be equipped with drain and vent openings located diametrically opposite on vertical centerline of mounting plate and to be shipped to job site with plugs in place. Terminate conduits 4” beyond inside face of manhole or building walls to protect any exposed piping insulation from dampwall condensation. Refer to drawing details for further construction and dimensional requirements

b. All end and gland seals shall be reinforced with 12” long galvanized steel sleeve at the sealing surface to prevent compression of the outer jacket and insulation from modular wall sealing devices. The protection sleeve shall be minimum 6 gauge thickness and shall be outside of the HDPE jacket. Where the galvanized steel sleeve stops on the outside of the manhole, the sleeve shall be shrink wrapped to the HDPE jacket and sealed water tight.

11. Field Joints

a. Field joints shall conform to the pipe manufacturer’s specifications.

b. Field joints shall consist of field installed mineral wool insulation banded with stainless steel bans on the carrier pipe, field applied 10 gauge connector sleeve on the inner conduit, field applied foam insulation, polyethylene heat shrink wrap and split HDPE jacket at a minimum. Field joint materials and methods shall be provided by and approved by the piping manufacturer.

12. Service Pipe (Steam and Condensate Carrier Pipe):

a. Steam:

i. 2-1/2 inches and Smaller:

1. Pipe: ASTM A106, Grade B, extra strong, carbon steel.
2. Fittings: ASTM A105 Grade II/ASME B16.11, 3000 lb. forged steel, socket weld.
3. Unions: Forged steel, 3000 lb., socket weld. Refer to Unions and Flanges in this Section.

ii. 3 inches and Larger:

1. Pipe: ASTM A106, Grade B, extra strong, carbon steel.
2. Fittings: ASTM A234 Grade WPB/ASME B16.9, extra strong, seamless, carbon steel weld.
3. Flanges: Class 300. Refer to Unions and Flanges in this Section.

b. Pumped Condensate

i. 2 inches and Smaller:

1. Pipe: ASTM A312, 304L, Schedule 40S, seamless stainless steel
2. Fittings: ASTM 182, Gr. F304, ASME B16.11, 3000 lb socket-weld
3. Unions: 3000 lb socket-weld, stainless steel ground joint

ii. 2-1/2 inches and Larger:

1. Pipe: ASTM A312, 304L, Schedule 40S, seamless stainless steel
2. Fittings: ASTM A403, Gr. WP, Class S or Class W, ASME 16.9
3. Flanges: ASTM A182, Gr. F304, ASME B16.5, 150 lb std. with 1/16" raised face, serrated face finish and welding neck
4. Bolts: Stud bolts, ASTM A193, Gr. B7.
5. Nuts: ASTM A194, Gr. 2H.

iii. Straight sections shall be supplied in 40-foot or random length with 6” of piping exposed at each end for field joint fabrication where possible. Fittings shall be ASTM A234 Grade WPC/ANSI B16.9, Schedule 40, seamless, carbon steel butt weld fittings.

c. Service Pipe Insulation:

i. Insulation shall be mineral wool insulation fabricated in half or V-Groove insulation sections.

ii. The insulation shall be secured to the pipe by stainless steel bands. Insulation thickness shall be as specified herein with a thermal conductivity of not more than 0.33 at 200°F mean temperature. The insulation shall be installed such that joints are staggered preventing a continuous joint between the carrier pipe and the inner conduit.

d. Inner Conduit:

i. 10 gauge for conduits 26” and smaller. 6 gauge for conduits above 26”. All conduit shall be either electric resistance welded pipe conforming to ASTM A-135 or electric fusion welded pipe conforming to ASTM A-139. Conduit shall be finished in prime coat finish. Where field welds and connections are made, Contractor shall field install prime coat finish.

e. Inner Conduit Insulation and Outer Jacket:

i. Conduit insulation shall be factory-applied polyurethane foam, having density of 2.0 to 3.0 pounds per cubic foot for all straight lengths and fittings. The insulation thickness shall be 1” minimum. The urethane foam shall meet ASTM C591 with the following minimum characteristic K factor equal to 0.14, density of 2 pcf and a closed cell content of 90 to 95%.

ii. The outer jacket shall be High Density Polyethylene (HPDE) with a minimum wall thickness of 150 mils.

f. System Description:

i. The underground conduit system shall consist of the following minimum:

Carrier Pipe	Insulation (Mineral Wool)	Nominal Outer Conduit
16" HPS	4.0"	28"
14” HPS	4.0”	26”
12” HPS	4.0”	24”
8” HPS	4.0”	22”
6” HPS	4.0”	19”
8” CPD	2.0”	18”
6” CPD	2.0”	15”
4” CPD	1.0”	13”
3” CPD	1.0”	11”

ii. All piping inner conduit shall be insulated with 1.0” polyurethane foam insulation with HDPE outer jacket as specified above.

iii. Manufacturers:

1. Ravanco model Insul-800, Thermacor model Duo-Therm 505 or Perma Pipe model Multi-Therm 500.

13. Unions and Flanges:

a. Unions:

i. 2 1/2 inches and Smaller:

1. Forged steel, ASTM A105 Grade 2, ASME B16.11, socket weld, 3000lb. WOG with steel to steel seats.

b. Flanges:

i. 3 inches and Larger:

1. ASTM A105, ANSI B16.5, hot forged steel flanges, welding neck pattern. Slipon pattern flanges are not allowed. Bore dimension of welding neck flange shall match inside diameter of connected pipe. Use raised face flanges for mating with other raised face flanges with self-centering flat ring gaskets. Use flat face flanges for mating with other flat face flanges with full face gaskets.

ii. Flange pressure class indicated in respective piping service is minimum required. Mating flange pressure class shall match pressure class of device connected to such as valves and piping specialties. Flanged connection will on be permitted at specialty connections such as at a vessel or specialty valve.

c. Flange Gaskets:

i. Gasket material to be asbestos free and suitable for pressure temperatures and fluid of piping system. Non-metallic gaskets shall be in accordance with ANSI/ASME B16.21 and ASTM F104.

ii. Gaskets shall be equal to Flexitallic Style CG, graphite filler, 304 SS winding, carbon steel centering ring, 0.175" thickness.

d. Bolting:

i. For all connections to valves, use bolts studs.

ii. Bolts, bolt studs, nuts and washers used on piping systems in CUP, tunnel and manholes shall have zinc plated finish.

iii. Thread shall be in accordance with ANSI/ASME B1.1, Class 2A tolerance for external threads and Class 2B tolerance for internal threads. Threads shall be coarse-thread series except that alloy steel bolting 1-1/8" and larger in diameter shall be 8 pitch thread series.

iv. Threaded rods are not allowed as fastening elements on steam systems.

v. For Class 150 and Class 300 flanges at 400°F or lower temperature, use carbon steel bolts or stud bolts conforming to ASTM A307, Grade B with nuts conforming to ASTM A307.

vi. For Class 300 flanges at 500°F or lower temperature, use alloy steel bolts or stud bolts conforming to ASTM A193, Grade B7 or B16, with nuts conforming to ASTM A194, Grade 2H.

14. Valves – General:

    a. General: Install valves as shown on plans, details and according to the valve manufacturer's installation recommendations.

    b. Provide chain operators for manually operated valves 4" and larger, located more than 6'-0" above normal working surface.

15. High Pressure Steam Pumped Condensate and Steam Trap Condensate System Valves (100 TO 230 PSIG/450°F):

    a. Isolation Valves:

        i. High pressure steam and condensate isolation valves shall be ANSI Class 300.

            1. Up thru 2-1/2 inches:

                a. Description: Ball, full port, carbon steel body, 316 SS ball & stem, “Xtreme” seats & PTFE seals or reinforced PTFE seats & seals, rated for 300 psi at 600°F, threaded end connections, 4” stem extension Jamesbury: ASTM A193 Grade B7bolts with ASTM A194 Grade 2H nuts.

                b. Manufacturer and Model No.:

                i. Apollo 83-540-64-04.

                ii. Jamesbury 4BX-22236XT-1.

            2. 3 inches and Larger:

                a. Description: Butterfly ANSI Class 300, rated for 300 psi at 600°F, lugged, carbon steel body as follows:

                i. Disc: nickel plated carbon steel or carbon steel.

                ii. Seat: laminated Type 321 SS & graphic disc seat, or carbon steel body with a SS welded overlay for the body seat.

iii. Shaft: A276 Type 431 stainless steel shaft.

iv. Bi-directional dead end.

v. Valve shall be triple offset.

vi. Valve shutoff shall be ANSI Class IV.

vii. All valves shall have a manual-gear actuator.

viii. All valves located more than 8 ft above the equipment floor shall have a chain wheel.

b. Manufacturer and Model No.:

i. Jamesbury/Metso/Neles LI/SD.

ii. Zwick A1-YZA11AG.

iii. Adams MAK.

ii. Prior to shipment, valves to be hydrostatically and leak tested at the factory. Factory hydrostatic test shall be performed at 300 psig for all valves.

1. NU and Architect / Engineer shall have option to be present to witness factory testing for the first valves that are 2-1/2" and smaller and the first valves that are 3" and larger. Valve manufacturer shall be responsible for providing transportation and accommodations for two (2) NU representatives and one (1) representative of the Architect / Engineer.

b. Swing Check Valves:

i. 2” and Smaller: ASTM B62, cast steel body, threaded ends, regrinding, Y-pattern swing type, renewable TFE seat disc, Class 300 (300 psi WOG), conforming to MSS SP-80.

c. Globe Valves:

i. 2" and Smaller: ANSI Class 600, steel body, stainless steel disc & seat ring, threaded ends.

ii. 2-1/2" and Larger: ANSI Class 300, steel body, stainless steel disc & seat ring, butt weld ends, constructed in accordance with ASME B16.34

d. Pressure Equalizing Valves

i. Use 1-1/2" globe valve for use on valves 6" to 10".

ii. Use 2" globe valve for use on valves larger than 12".

e. Drain Valves:

i. Gate valves as specified above with hose thread adapter and cap. Provide 1" minimum drain valve except strainer blowdown valves to be blowdown connection size. Drain valves shall be provided with short threaded nipple and cap.

16. Pressure Equalizing Valves:

a. Provide pressure equalizing valves on valves in the following locations:

i. High pressure steam (230 psig) shut-off valves 3" and larger for supervised warm-up.

END OF SECTION

DIVISION 23 – HVAC

SECTION 23 2116 – STEAM PIPING SPECIALTIES

1. General: This section outlines the general requirements for steam piping specialties.

2. Design Considerations:

    a. Provide chain-wheel operators for valves 6 inches and larger mounted over 8 feet above floor.

    b. Furnish gear operators for valves 8 inches and larger.

    c. Isolation valves 2-1/2 inch and 3 inch may be a ball or butterfly. Pipe sizes 2 inches and smaller shall be ball valves.

3. Butterfly Valves:

    a. Butterfly for Critical Shutoff Duty: High Performance with metal seat for steam and condensate only. No triple offset high performance butterfly valves permitted elsewhere in system.

4. Gate Valves: Gate valves are not permitted.

5. Pressure Gauges:

    a. Pressure gauges shall have a minimum 4-1/2" diameter die cast aluminum case, glass or acrylic plastic window, phosphor bronze bourdon tube with bronze bushed movement, recalibration from front of gauge dial and 1/4" NPT forged brass socket

    b. Gauge accuracy shall meet ANSI B40.100 Grade 1A (±1% full scale).

    c. Select gauge range so that normal operating pressure is at midpoint of gauge.

    d. Acceptable Manufacturers:

        i. Trerice, others equal to Trerice 600 Series.

        ii. Weksler.

        iii. Weiss.

6. Steam Pressure Reducing Valves:

    a. The maximum sound pressure level of a valve shall not exceed 92 dBA.

    b. The Federal (OSHA) standard for permissible noise exposure is as follows:

Duration, Hours per Day	Sound Level, dBA
8	90
6	92
4	95

7. Pressure Reducing Stations (PRS):

    a. General: The justification for a single stage PRS is space and cost.

    b. Preferred. Each PRS shall be two stage with the main and bypass valves in each stage as follows, and piped in compliance with the drawing details.

        i. Main Valve: Fisher type 667-E-4160K globe valve with cast iron body, SST trim, PTFE packing, fail closed diaphragm actuator, and a pneumatic controller with proportional plus reset control. Low bleed assembly (MIZER) shall be included with the controller.

        ii. Bypass Valve: Fisher type 92B pilot-operated regulator with a cast iron body, and SST trim.

    c. Alternate. Each PRS shall have one main valve in parallel with one bypass valve piped in accordance to the drawing details.

        i. Two inch and smaller valves shall be screwed; 3-inch and larger valves shall be class 250 flanged.

    d. Approved Manufacturers:

        i. Fisher Controls International, Inc.

        ii. Spence Engineering Co.

8. Ball Valves:

    a. Ball valves shall be bronze, 600 psig WOG, full port, with a 316 stainless steel ball and stem and 250 psi steam trim.

    b. Insulated valves shall have a 2-1/4 inch stem extension.

    c. Acceptable Manufacturers

        i. Conbraco Industries, Inc. (APOLLO®)

        ii. Neles-Jamesbury, Inc.

        iii. Watts Regulator Co.

9. Condensate Receiver Sets:
    a. Condensate receiver sets shall have two 100% capacity pumps.
    b. Pump motors shall be TEFC, 1800 rpm maximum (3600 rpm not acceptable).
    c. Condensate pumps shall have 2 NPSH pumps.
    d. Acceptable Manufacturers:
        i. Peerless.
        ii. Domestic.
        iii. Skidmore.
        iv. Weinman.
        v. Sterling.
        vi. Hoffman.
        vii. Mepco.
        viii. Shipco.
10. Steam Traps:
    a. A/E shall size each steam trap required for projects.
    b. Traps shall be inverted bucket or float and thermostatic (F&T).
    c. Orifice traps are not permitted.
    d. Acceptable Manufacturers:
        i. Armstrong International, Inc.
        ii. Spirax Sarco, Inc.
11. Steam / Condensate Flow Meters:
    a. For condensate meter detail and specifications see the NU Direct Digital Control (DDC) Standards.
    b. See NU Meter Requirements for steam/condensate systems.

END OF SECTION

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DIVISION 23 – HVAC

SECTION 23 3114 – DUCTWORK

1. General: This section outlines the general requirements for ductwork. Specific requirements shall be coordinated with the NU Project Manager during the design phases of the project.

2. Design Considerations:

    a. Fibrous glass ductwork is not permitted.

    b. Lined ductwork is not permitted.

    c. When space permits, round spiral ductwork is preferred over rectangular ductwork.

    d. Laboratory exhaust ductwork shall be 316 stainless steel and not 304 stainless steel. Engineer of Record shall evaluate other ductwork material options based on use and dilution of system.

    e. Duct systems must be designed, not just sized by use of the Trane Ductulator or the friction chart. Procedures to follow are the 2013 ASHRAE Handbook of Fundamentals, Chapter 21 (Duct Design), page 21.21 (HVAC Duct Design Procedures).

3. Ductwork Construction:

    a. Round, flat oval and rectangular ductwork shall be fabricated in accordance with SMACNA “HVAC Duct Construction Standards - Metal and Flexible,” Third Edition, 2005, except as follows:

        i. General:

            1. Galvanized outdoor ductwork shall have a G90 galvanized coating per ASTM Standard A525. G60 coating is not permitted.

            2. Laboratory exhaust ductwork shall be 316 stainless steel.

            3. Laboratory exhaust ductwork must be welded construction.

            4. Show all Volume dampers on the contract drawings.

        ii. Round:

            1. Round ducts shall be spiral or longitudinal with fully welded seams. Longitudinal seams are not permitted where ductwork is exposed. Snap-lock seams are not permitted.

2. Acoustical lined round ductwork shall have an inner perforated liner.

    a. Acceptable Product: Acoustic-K27, United McGill Corp.

3. Crimp joints are not permitted.

4. Pleated elbows are not permitted.

5. Adjustable elbows are not permitted.

6. Use radius elbows with minimum centerline radius to width or diameter ratio of 1.5.

    a. Where 1.5 radius elbows do not fit use 1.0 radius elbows.

    b. Where 1.0 radius elbows do not fit use square throat elbows with full splitter vanes.

iii. Rectangular:

1. Acoustical lined rectangular ductwork is not permitted.

2. Ductwork thickness shall be 22 gauge minimum, except where any welding other than longitudinal seams is performed, the thickness shall be 18 gauge minimum.

3. Button punch snaplock seams are not permitted.

4. Transverse (girth) joints T-4, 9, 17, 18, 19, 20, and 23 not permitted.

5. Mitered elbows with turning vanes are not permitted. Use radius elbows.

iv. Flat Oval:

1. SMACNA Type 1 reinforcement (Figure 3-6 of SMACNA's duct construction standards) is not permitted.

2. Flat oval ductwork is not permitted for exhaust systems.

4. Ductwork Installation:

a. Hangers and supports shall be in accordance with SMACNA "HVAC Duct Construction Standards - Metal and Flexible," third edition, 2005, except as follows:

i. Wire hangers are not permitted.

ii. Flexible duct shall be installed and supported in accordance to the SMACNA "HVAC Duct Construction Standards - Metal and Flexible," second edition, 1995.

b. SMACNA HVAC Duct Construction Standards, 1995, Figure 2-15: Flexible duct elbows at the diffuser as shown is not permitted. Elbows must be sheet metal (see drawing details).

c. Provide acoustical duct silencers at fan room duct penetrations.

d. Branch connections shall be in compliance with the drawing details. Extractors and splitter dampers are not permitted.

5. Sealing:

a. Ductwork shall be sealed at the factory and remain sealed at all times until installed. Ductwork must be sealed at all times even if being worked on. Seals can be removed only during immediate installation and must be restored immediately upon non-work activity. Ductwork being worked on shall be sealed at the end of each work day.

b. Ductwork shall be sealed in compliance with Table 23-3114-1. Pressure-sensitive tape shall not be used as the primary sealant on metal ducts.

Table 23-3114-1 – Minimum Duct Seal Levels[a]

Duct Location	Supply		Exhaust	Return
	< 2 in. wg	≥ 2 in. wg		
Outdoors	A	A	A	A
Unconditioned Spaces	B	A	B	B
Conditioned Spaces (concealed ductwork)	C	B	B	B
Conditioned Spaces (exposed ductwork)	A	A	B	B

6. [a]See Table 23-3114-2 for definition of seal level.

Table 23-3114-2 – Duct Seal Levels[a]	
Seal Level	Sealing Requirements
A	All transverse joints, longitudinal seams, and ductwork penetrations.
B	All transverse joints and longitudinal seams.
C	Transverse joints only

[a]Transverse joints are two ducts orientated perpendicular to flow. Longitudinal seams are joints orientated in the direction of airflow. Duct wall penetrations are openings made by screws, fasteners, Round and flat oval spiral lock seams need not be sealed prior assembly, but may be coated after assembly to reduce leakage. All other connections are considered transverse joints, including but not limited to spin-ins, taps, and other branch connections, access door frames, and duct connections to equipment.

a. Gasketed flanges (SMACNA Joints T-24, T-25, and proprietary slip-on flanges) shall be sealed with a mastic.

b. Acceptable Products: United Duct Sealer (United McGill Corp.) Hardcast, McGill AirSeal, Ductmate, Mon-Eco Industries or H.B. Fuller/Foster

7. Leakage Tests:

a. Leakage tests shall be conducted in accordance with the SMACNA HVAC Air Duct Leakage Test Manual, 1st edition, 1985. Section 3 (General Procedures), Section 5 (Test Apparatus, and Section 6 (Test Reports). Positive and negative pressure ductwork shall be tested in the positive mode.

b. Tests shall be completed before insulation is applied and ducts are concealed by building enclosures. Tests may be conducted in sections.

c. Leakage tests shall be witnessed by the University.

d. Leakage shall not exceed the values in Table 23-3114-3

Table 23-3114-3 – Allowable Leakage Rates, cfm/100 ft^2 Surface Area				
Location	Test Pressure, in. wg	Rectangular Ductwork	Round Ductwork	Flat Oval Ductwork
Low Pressure Ductwork[a]	2	9.4	4.7	4.7
All Other Ductwork[b]	4	14.8	7.4	7.4

[a] Supply Ductwork: Ductwork downstream of VAV/CAV Terminals
Return Ductwork: Ductwork upstream of VAV/CAV Terminals.
[b]Supply, Return, and Exhaust Ductwork.

END OF SECTION

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DIVISION 23 – HVAC

SECTION 23 3314 – DUCTWORK SPECIALTIES

1. General: This section outlines the general requirements for ductwork specialties and accessories.

2. Flexible Duct:

    a. Flexible duct shall be Class 1 “Air Duct” manufactured in compliance with UL 181. Each piece of “Air Duct” shall be UL labeled.

    b. Acceptable Manufacturers:

        i. Thermaflex, Model M-KE.

        ii. Casco.

        iii. Flexmaster, Type 6.

    c. “Air Connectors” manufactured in accordance to US 181 are not permitted because “Air Connectors” are less durable than “Air Ducts.”

3. Combination Fire/Smoke Dampers:

    a. Combination fire/smoke dampers shall be installed at combination fire and smoke zone boundaries.

    b. Fire/smoke dampers shall be multi-blade, UL555 and UL 555S labeled. Curtain-type dampers are not permitted.

    c. Combination fire/smoke dampers shall have a 3-hour rating.

    d. Dampers shall have a Leakage Class III label. Seals shall be metal-to-metal.

    e. Dampers shall be rated for 4000 fpm minimum.

    f. Fire dampers shall incorporate a reusable electric McCabe™ link with an external manual reset lever (see drawing details). The releasing device shall be 24 Vdc in compliance with UL 873. The resettable link shall be 280ºF, UL 33 listed.

    g. Combination fire/smoke dampers shall be installed in accordance with the manufacturer’s installation instructions.

    h. Combination smoke/fire dampers shall have access panels on each side of the damper in compliance with the drawing details. Access panels shall have a single pane Plexiglas viewport.

    i. Acceptable Fire/Smoke Damper Manufacturers

i. Prefco Products, Inc., Model 5010 with a manual actuator.

ii. Air Balance.

iii. Greenheck.

iv. Nailor.

v. Cesco.

vi. Ruskin.

j. The maximum sizes for UL listed 1 1/2 hour rated fire/smoke dampers is tabulated below. For 3 hour rated dampers the maximum vertical damper is 30" x 30". No multiple sizes or horizontal dampers are UL listed as of the date of this standard.

UL Listed Prefco Model 5010 Fire/Smoke Dampers			
Orientation	Single Section	Multiple Section	
		Single Section	Multiple Section
Vertical	36" W x 45" H	36" W x 45" H 30" W x 30" H 36" W x 42" H	72" W x 45' H (2 sections) 120" W x 30" H (4 sections) 72" W x 84" H (4 sections)
Horizontal	31" W x 33" H	26" W x 42" H	52" W x 42" H (2 sections)

4. Fire Dampers:

a. Fire dampers shall be installed at all duct penetrations through fire rated walls and floors.

b. Fire dampers shall be multi-blade, UL 555 labeled. Curtain dampers are not permitted.

c. Fire dampers shall have a either a 1-1/2 or 3-hour rating depending on the rating of the wall.

d. Fusible links shall be 212ºF, UL listed.

e. Fire dampers shall be installed in accordance with the manufacturer's installation instructions.

f. Fire dampers shall have access panels on each side of the damper in compliance with the drawing details. Access panels shall have a single pane Plexiglas viewport.

5. Smoke Dampers:

   a. Smoke dampers shall be installed at all duct penetrations through smoke zone boundaries not having a fire resistance rating.

   b. Smoke dampers shall be multi-blade, UL555 and UL555S labeled. Curtain-type dampers are not permitted.

   c. Dampers shall have a Leakage Class III label. All seals shall be metal-to-metal.

   d. Dampers shall be rated for 4,000 fpm minimum.

   e. Damper actuators shall be electric.

   f. Smoke dampers shall be installed in accordance with the manufacturer's installation instructions.

   g. Combination smoke/fire dampers shall have access panels on each side of the damper in compliance with the drawing details. Access panels shall have a single pane Plexiglas viewport.

6. Flexible Connections:

   a. Flexible connections shall be 0.024 in. thick, 30 oz/yd2 glass fabric double-coated with polychloroprene.

   b. Acceptable Product:

      i. Ventfabrics, Inc., Ventglas.

7. Access Panels:

   a. Access panels shall be as shown on the project drawings and as follows:

      i. upstream of modulating dampers;

      ii. upstream and downstream of airflow measuring stations;

      iii. upstream and downstream of duct mounted coils;

      iv. upstream of humidifiers; and

      v. between the VAV terminal units and the reheat coil, and downstream of the VAV terminal unit reheat coils.

b. Access panels shall be located upstream and downstream of fire dampers, smoke dampers, and combination fire/smoke dampers to permit inspection and maintenance of the damper and its operating parts.

c. Access panels shall be 16 in. by 16 in minimum, or 16 in. by the duct height/width.

8. Louvers:

a. Minimum Louver depth: 6 inches.

b. The minimum free area of a 48 in. square louver shall be 45%.

c. The water penetration of outdoor air intake louvers shall be less than 0.2 oz/SF/0.25 hour based on laboratory tests in compliance with AMCA Standard 500.

d. The face velocity of individual louvers or each louver in a bank of louvers should not exceed the following values (Source: ASHRAE Handbook of Fundamentals, 2013, Table 6, Page 21.17. Review project specific requirements with NU Project Manager and take into consideration snow infiltration.

i. Outdoor Air Intake:

1. 7000 cfm and greater: 400 fpm maximum (Peak velocity not average velocity).

2. Less than 700 fpm: see Table 23-3314-1.

ii. Exhaust:

1. 5000 cfm and greater: 500 fpm maximum.

2. Less than 500 fpm: See Table 23-3314-1.

Table 23-3314-1

CFM per Louver	Outdoor Air Intake Louver		Exhaust Louver	
	Maximum Face Velocity, fpm	Minimum Face Area, SF	Maximum Face Velocity, fpm	Minimum Face Area, SF
1000	170	6	190	5.5
2000	250	8	310	6.5
3000	300	10	400	8
4000	330	12	450	9

Table 23-3314-1				
CFM per Louver	Outdoor Air Intake Louver		Exhaust Louver	
	Maximum Face Velocity, fpm	Minimum Face Area, SF	Maximum Face Velocity, fpm	Minimum Face Area, SF
5000	380	13.5	500	10
6000	390	15.5	500	12
7000	400	17.5	500	14

9. Sound Attenuators:

   a. A noise calculation is required for both the supply and return ductwork of all air handling units, and the supply and return ductwork of all return/exhaust fans.

   b. For each system the minimum attenuator DIL (Dynamic Insertion Loss) in each octave band shall be in compliance with Table 23 3314-2. The self-noise of the attenuator must be at least 5 dB less than the silenced sound power level in each octave band. A schedule should be issued with the drawings specifying the noise attenuation required in each of the following octave band frequencies (Hz): 125, 250, 500, 1000, 2000, 4000, and 8000, similar to the following:

Table 23 3314-2 – Minimum Required Attenuator DIL (dB, re 10^{-12} watts)							
System	Octave Band Center Frequency						
	125	250	500	1000	2000	4000	8000

   c. Provide acoustical duct silencers at conference rooms and classrooms, 3 foot length minimum. Consider acoustical duct silencers at offices. Review and verify specific requirements with NU Project Manager.

   d. Acoustical lined round ductwork is permitted, but the duct must have an inner perforated liner.

   e. Acoustical lined rectangular ductwork is typically not permitted. Review and verify specific requirements with NU Project Manager.

   f. Acceptable Flexible Duct Manufacturers:

      i. Industrial Acoustics Company.

      ii. Semco, Aerosonics.

iii. United McGill.

iv. Aeroacoustic.

v. Commercial Acoustics.

vi. Vibro-Acoustics, VAW Systems.

vii. Ruskin Sound.

viii. Dynasonics.

g. Sound Attenuators shall be tested in accordance with ASTM E-477-99 silencer test standard in aero-acoustic test facility which is NVLAP accredited for ASTM E-477-99 Standard.

END OF SECTION

DIVISION 23 – HVAC

SECTION 23 3400 – FANS

1. General:

    a. This section outlines the general requirements for mechanical fans.

    b. Specific requirements shall be coordinated with the NU Manager during the design phases of the project.

2. Design Considerations:

    a. Stainless steel and fiberglass reinforced plastic (FRP) are available.

    b. For fan coatings, consult with fan manufacturers.

3. Packaged Air Handling Units:

    a. Review fan assembly on a case-by-case basis with NU Project Manager.

4. Centrifugal Fans:

    a. Fans with wheel diameters 36 inches and smaller shall be Class II minimum. Fans greater than 36 inches shall be Class III minimum.

    b. Bearings shall be mounted in split-pillow blocks with grease fittings. Bearings shall be designed for a minimum L10 (rating) life of 100,000 hours as defined by ANSI/AFBMA Standard 9.

    c. Vibration isolation base shall have seismic restraints.

    d. Fan ratings shall be tested and certified in accordance with AMCA Standards 211 and 311 and fans shall bear AMCA Seal

    e. Provide OSHA Compliant belt and shaft guards for belt driven fans.

    f. Acceptable Manufacturers:

        i. Barry Blower.

        ii. Buffalo Forge Div., The Howden Fan Co.

        iii. Chicago Blower Corp.

        iv. Greenheck.

        v. Industrial Air.

        vi. Twin City.

5. Plenum Fans:

    a. Plenum Fans may be used for static pressure 6 inches SP and below.

    b. Fans shall be airfoil centrifugal type designed for industrial duty and suitable for continuous operation. Fans shall be single width, single inlet, arrangement 3.

    c. Air handling quality, heavy-duty, grease lubricated, pillow block, self-aligning ball or roller type. Bearings shall be selected for minimum life (ABMA L10) of not less than 100,000 h operation at maximum cataloged operating speed.

    d. Acceptable Manufacturers:

        i. Barry Blower.

        ii. Chicago Blower Corp.

        iii. Greenheck.

        iv. Twin City.

6. Fan Array:

    a. Fan array system shall consist of multiple, direct driven, arrangement 4 plenum fans constructed per AMCA requirements for duty specified. Fans shall be selected to deliver scheduled airflow quantity at scheduled operating total static pressure and scheduled fan/motor speed. Fan array shall be selected to operate at system total static pressure that does not exceed 90% of scheduled fan's peak static pressure producing capability at scheduled fan/motor speed.

    b. Fan intake wall, inlet funnel, and motor support structure shall be powder coated for superior corrosion resistance. Motors shall be standard pedestal mounted type, T-frame motors selected at specified operating voltage, rpm, and efficiency as needed to meet performance requirements. Motors shall include isolated bearings or shaft grounding. Each fan/motor cartridge shall be dynamically balanced to meet AMCA standard 204-96, category BV-5, to meet or exceed Grade 2.5 residual unbalance.

        i. Fan array shall provide uniform air flow and velocity profile across entire air way tunnel cross section. Airflow and velocity shall not exceed scheduled cooling coil and/or filter bank face velocity when measured at a point 12 inches from intake side of fan wall array intake plenum wall, and distance of 48 inches from discharge side of fan wall intake plenum wall.

        ii. Provide partition between fans to minimize system effect.

        iii. Provide structural frame to support upper fans with solid floor panel partition between fans as shown on drawings to minimize system effect.

iv. Each fan in array shall be provided with back flow prevention means that produces less than 0.10 inches wc of static pressure drop and/or system effect when that fan is enabled. Any such system effects and/or pressure drops shall be submitted and included as component in determining fan system total static pressure as submitted. Manufacturer's pressure drop ratings of any such equipment, developed from straight run test conditions will not be accepted.

v. Provide 2 separate variable frequency drives for fan array. Each VFD shall control half of fans in array. Provide one backup VFD for air handling unit.

vi. Fan array shall be sized such that upon single fan failure, remaining fans could ramp up and provide same 100% design capacity.

vii. Technology with multiple fans having individual VFDs may be considered.

viii. Provide local electrical disconnect for each fan.

ix. Contractor shall provide all wiring to air handling unit components that require power.

c. Acceptable Manufacturers:

i. AcoustiFLO.

ii. Greenheck.

iii. Hunt Air.

iv. Twin City.

7. Laboratory Exhaust Fans – Centrifugal:

a. Lab Fume hood fans shall be with coating recommended for application, drive arrangement 10 or 1, AMCA Class C spark resistant construction

b. Air handling quality, heavy-duty, grease lubricated, pillow block, self-aligning ball or roller type. Bearings shall be selected for minimum life (ABMA L10) of not less than 100,000 h operation at maximum cataloged operating speed.

c. Acceptable Manufacturers:

i. Barry Blower.

ii. Chicago Blower Corp.

iii. Greenheck.

iv. Twin City.

END OF SECTION

DIVISION 23 – HVAC

SECTION 23 3600 – AIR TERMINAL DEVICES

1. General: This section outlines the general requirements for air terminal devices.

2. Design Considerations:

    a. Fan powered terminals are not generally permitted. Fan powered terminal for final diffuser filtering applications may be considered with NU Project Manager approval.

    b. VAV terminals shall have a reheat coil with access panels upstream and downstream.

3. VAV Terminals:

    a. Terminal units shall be variable volume, single duct, pressure independent, direct digital control (DDC).

    b. Terminal unit shall be furnished with a hot water reheat coil. The reheat coil control valve shall be DDC controlled by the terminal box controller. For reheat coil piping details see drawings.

    c. The box casing shall be 22 gauge minimum; the damper assembly shall be 16 gauge minimum.

    d. Box manufacturer shall provide an access door between the terminal unit and the reheat coil.

    e. The box manufacturer shall furnish the multi-point, center averaging sensor.

    f. The control contractor shall furnish the control components to the terminal box manufacturer for factory mounting. The box manufacturer shall include the cost to mount the control components.

    g. Acceptable Manufacturers

        i. Price.

        ii. Nailor.

        iii. Titus Products.

        iv. Tuttle & Bailey.

        v. Phoenix electric actuated in laboratory buildings.

4. Exhaust Air Terminals:

    a. Basis-of-Design: Titus Products, Model ECV.

    b. Acceptable Manufacturers:

        i. Price.

        ii. Nailor.

        iii. Tuttle & Bailey.

        iv. Phoenix electric actuated in laboratory buildings.

5. Diffusers:

    a. The diffuser style and color shall be reviewed by the NU Project Manager.

    b. Grilles, not diffusers, shall be specified, and duct dampers used for balancing. Show all balancing dampers on the drawings.

    c. VAV ceiling diffusers shall be in accordance with Table 23 3600 – 1.

Table 23 3600-1 VAV Ceiling Diffusers		
Metalaire	Titus	Tuttle & Bailey
5000-IV	--	RC
5800A	--	DA
--	TMRA	P3
5800	--	DM

    Note: Model numbers on the same line are comparable diffusers.

    d. Diffusers shall be tested in accordance with ANSI/ASHRAE Standard 70, current edition.

    e. Acceptable Manufacturers:

        i. Metalaire Industries, Inc.

        ii. Titus Products.

        iii. Tuttle & Bailey.

        iv. Price.

v. Krueger.

vi. Enviro-Tec (ETI).

vii. Nailor.

END OF SECTION

DIVISION 23 – HVAC

SECTION 23 4114 – FILTERS

1. General:

    a. This section outlines the general requirements for filters.

    b. Specific requirements shall be coordinated with the NU Project Manager during the design phases of the project.

2. Design Considerations:

    a. General:

        i. It is preferred that air handling units have the following filter sections, where efficiency is the ASHRAE atmospheric dust-spot efficiency determined by ASHRAE Standard 52.2-2007.

            1. Prefilter: 25-30% efficiency minimum MERV 7

            2. Final: 80-90% efficiency minimum MERV 13

        ii. Heat recovery coils must have prefilters.

3. Prefilters: Prefilters shall be extended surface pleated panel 4 inches in depth. Efficiency shall be 25-30% minimum, MERV 7 where efficiency is the atmospheric dust spot efficiency determined by ASHRAE Standard 52.2-2007.

4. Final Filters: Final filters shall be extended surface, non-supportive pocket type. Efficiency shall be 80-90% minimum, MERV 13 where efficiency is the atmospheric dust spot efficiency determined by ASHRAE Standard 52.2-2007.

5. Filters shall have UL, Class I or Class II Listing

6. Filters on 100% OA units for before and after the preheat coil depending on winter and summer (Snow loading)

7. Use Slide out filter racks when total CFM is 5000 CFM or under, Use Lift out filter frames for units above 5000 CFM.

8. For slide out filter racks, each housing shall have door on both sides to facilitate changing filters. Doors shall have perimeter gaskets to minimize air leakage, shall be hinged, and shall have cam-lock or lever handle latches to secure the door

9. For lift out filter frames, the frames shall be minimum 16 gauge galvanized construction with provisions for assembly in a bank. Frames shall be suitable for filters scheduled and incorporate gaskets and spring clips to prevent air bypass.

10. Three (3) sets of pre-filters shall be provided, one (1) set for use during construction, one (1) set for building turnover to owner, and one (1) spare set. Two (2) sets of after and final filters shall be provided: one (1) set for building turnover to owner and one (1) spare set.

11. Bag-In / Bag-Out filter housings shall be provided with isolation dampers/valves on each side.

12. Filter pressure drop gauges shall be across each bank of filters.

END OF SECTION

DIVISION 23 – HVAC

SECTION 23 5214 – PRIMARY HEATING EQUIPMENT

1. General: This section outlines the general requirements for primary heating equipment.

2. Design Considerations:

    a. Fired boilers are used in the Central Utility Plant (CUP) for both the Chicago and Evanston campuses. The primary heating equipment is for convertors from steam to heating hot water.

    b. Convertor (shell and tube heat exchanger)

        i. Shell and tube type with removable copper U-tube bundle, steel shell, tube sheets, and heads.

        ii. Heat exchangers shall be constructed and stamped in accordance with the latest ASME Code for Unfired Pressure Vessels. Each unit shall be registered with National Board of Boiler and Pressure Vessel Inspector.

        iii. Heat exchangers shall have tube side working pressure of125 psi and test pressure of 250 psi with shell side working pressure of 150 psi and test pressure of 195 psi.

    c. Acceptable Manufacturers:

        i. Bell and Gossett.

        ii. Armstrong.

        iii. Adamson.

        iv. Taco.

END OF SECTION

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DIVISION 23 – HVAC

SECTION 23 7313 – PACKAGED AIR HANDLING UNITS

1. General: This section outlines the general requirements for packaged air-handling units (AHU).

2. Design Considerations – Systems 3500 CFM and Smaller:

    a. Units shall be factory packaged.

    b. Systems shall be constant air volume (CAV). Engineer of Record shall evaluate the use of Variable Air Volume (VAV) with Life cycle analysis.

    c. Air handling units are to be designed with 20 percent additional capacity for future expansion.

    d. Unit shall be 16 gauge, galvanized steel, bolted standing seam construction. Galvanized steel shall have a G-90 coating. A G-60 coating is not permitted.

    e. The base shall be welded 2-1/2 in. minimum structural channel construction with full walk-on G-90 galvanized steel floors in all sections. No paint is permitted.

    f. Unit shall have a double wall casing with 2 in. insulation minimum and in compliance with ASHRAE/IES Standard 90.1-2010, “Energy Efficient Design of New Buildings Except New Low-Rise Residential Building,” Table 9-2. The fan section shall have a perforated liner. All other sections shall have a solid inner liner.

    g. The condensate drain pan shall be 16 gauge, 304 stainless steel. Drain pans are to be insulated double bottom construction.

    h. Fans: Refer to Section 23 3400.

    i. Filters: Filters shall be in compliance with Section 23 4114 and removable through access doors without removing the doors.

    j. Economizer Dampers: An economizer damper section shall not be furnished with the air handling unit. Economizer dampers shall be furnished by the temperature control contractor and installed in the ductwork by the sheet metal contractor.

    k. Coils: Refer to Section 23 8216.

    l. Humidifier: Refer to Humidification Equipment Section 23 8413.

        i. The humidifier control valves , strainers and valves shall be outside of the AHU (outside of the airstream)

m. Access Sections:

   i. Access sections shall be 24 in. minimum and shall have access doors on both sides.

   ii. Access doors shall have a single pane Plexiglas viewport. Access panels are not permitted.

   iii. Actual height of view port window to consider concrete pad height and be 5’-0” above finished floor to bottom of view port window. View port window to be 12 inch x 10 inch minimum size.

n. The housekeeping pad shall be adequate to install the cooling coil drain pan trap in compliance with the drawing details.

o. Acceptable Manufacturers:

   i. AAON.

   ii. Buffalo Air Handling Co.

   iii. ETL.

   iv. Hunt Air.

   v. Ventrol.

END OF SECTION

DIVISION 23 – HVAC

SECTION 23 7323 – FACTORY-FABRICATED CUSTOM AIR HANDLING UNITS

1. General:

    a. This section outlines the general requirements for factory-fabricated custom air handling units (AHU's).

    b. Specific requirements shall be coordinated with the NU Project Manager during the design phases of the project.

2. Design Considerations:

    a. Air handling units greater than 3500 cfm shall be factory built-up air handling units.

    b. Air handling units shall be double wall, 4-in. thick, acoustically lined, with a 22-gage minimum galvanized steel inner liner. The fan section shall be perforated; the other sections shall be solid. Perforated fan section with stand-offs for insulation liner with Tedlar film thickness of 1.0.

    c. Cooling coils shall have a 16 gauge, 304 stainless steel drain pan. Drain pans are to be insulated double bottom construction.

    d. The cooling coil drain pan shall have a trap in compliance with the drawing details. When the housekeeping pad is not adequate for the trap, the cooling coil(s) shall be mounted on a 304 stainless steel stand to permit installation of the trap.

    e. Coils shall have slide out racks and not face bolted.

    f. Seal coat mechanical room concrete floors and equipment pad underneath AHU.

3. Fans: Fan shall be in compliance with Section 23 3400.

4. Filters: Filters shall be in compliance with Section 23 4114.

5. Humidifier. Refer to Humidification Equipment Section 23 8413.

    a. The humidifier control valves , strainers and valves shall be outside of the AHU (outside of the airstream)

    b. Do not locate the humidifier upstream of the fan section. The preferred location for the humidifier section is downstream from the fan section.

    c. When the humidifier is located in the air handling unit it should be located 18 inches downstream of the heating coil and a minimum 3 ft upstream of the cooling coil.

6. Plenums:

    a. Each plenum between components shall have an access door with a view port on both sides of the unit. Doors shall open against pressure and the view port shall be 12 inch x 12 inch minimum size, double wire thermal pane. Actual height of view port window to consider concrete pad height and be 5'-0" above finished floor to bottom of view port window.

        i. Acceptable access door manufacturers are:

            1. Cesco Products.

            2. Semco Inc.

    b. Plenums shall have a fluorescent fixture with a moisture-proof cover. All penetrating conduit shall be sealed internally. Low temperature electronic ballast required for fluorescent lights. Provide a light switch for each plenum.

    c. Plenums shall have outside each door a 120 VAC outlet with waterproof cover.

7. Dampers:

    a. Leakage. Damper leakage shall not exceed 4 cfm/ft2 at 1 in. wg pressure differential (Leakage Class I). Leakage shall be determined by tests conducted in compliance with AMCA 500.

    b. Basis of Design – Outside Air Dampers: Outside air dampers shall be equal to Tamco Series 9000 thermally insulated dampers

    c. Acceptable Manufacturers:

        i. Tamco.

        ii. Ruskin.

    d. Frame:

        i. Type. The frame shall be channel shape.

        ii. Material. The frame shall be 13 gage (0.0934 in.) galvanized sheet steel or 0.125 (actual web thickness) 6063-T5 extruded aluminum.

    e. Blade:

        i. The blade shape shall be airfoil symmetrical to the axle pivot point.

        ii. Material. The blade shall be a 0.063 in. aluminum extrusion.

    f. Blade Seals: Blade seals shall be Santoprene (Advanced Elastomer Systems, L.P.) thermoplastic rubber.

g. Jamb Seals: Stainless steel.

h. Axle: Axles shall be plated steel and both ends 3/8 in. square minimum for positive linkage attachment.

i. Linkage:

   i. Plated steel.

   ii. Linkage shall be dual and concealed in the jamb (out of the air stream).

   iii. Jack shafting is not permitted.

j. Bearings: Axle bearings shall be bronze oilite. Blade seals shall be accessible for removal and replacement at the blade edges.

k. Acceptable Manufacturers – Factory Built-up Air Handling Units:

   i. Air Enterprise.

   ii. Buffalo.

   iii. Trane Custom.

   iv. TMI.

   v. Ventrol.

8. Leakage Testing:

   a. Built-up units must be leak tested at 12 in. wg. Tests shall be conducted in compliance with SMACNA's HVAC Air Duct Leakage Test Manual, 1st edition, 1985.

   b. Draw-thru units shall be tested under negative pressure. Blow-thru units shall be tested under positive pressure.

   c. Inlets and outlets shall be sealed. The leakage rate of the unit shall not exceed 0.5% of the total Scheduled AHU CFM.

END OF SECTION

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DIVISION 23 – HVAC

SECTION 23 8216 – COILS

1. General: This section outlines the general requirements for coils.

2. Design Considerations:

    a. For both the Evanston and Chicago campuses the supply chilled water temperature is 42 degrees F. The coil should be selected for a minimum 16 degrees F temperature differential.

    b. For the Evanston campus central chilled water system primary and secondary (distribution) piping, consult the NU Facilities Management Office (FMO).

    c. For the Chicago campus central chilled water system piping, consult the NU Facilities Management Office (FMO).

    d. Drawings of the buildings on the system are on file at the NU Facilities Management Office (FMO).

    e. Packaged Air Handling Units:

        i. Coils shall be slide out style and not face bolted so that they can be removed without affecting the structural integrity of the unit.

        ii. Coil connections to be schedule 40 red brass.

        iii. Vent and drain connections shall be stainless steel pipe and extend to the exterior of the unit.

        iv. Piping details to be provided on the drawings.

    f. Coil Types for the following:

        i. Heat Recovery:

            1. Coils shall be constructed of 0.024” tube wall, 5/8” OD seamless copper tubes with aluminum fins

            2. Casings shall be minimum 16 gauge, 304 stainless steel having stainless steel end supports and top and bottom .

            3. Maximum allowable fin spacing shall be 10 fins per inch. Coil depth shall not exceed 8 rows

            4. Acceptable manufacturers:

                a. Buffalo.

b. Marlo.

c. Heatcraft.

d. Aerofin.

e. Temtrol.

ii. Hot Water Preheat and Reheat:

1. Coils shall be constructed of 0.024 inch tube wall, 5/8-inch OD seamless copper tubes with aluminum fins

2. Casings shall be minimum 16 gauge, galvanized steel having galvanized end supports and top and bottom.

3. Maximum allowable fin spacing shall be 10 fins per inch. Coil depth shall not exceed 8 rows

4. Acceptable manufacturers:

a. Buffalo.

b. Marlo.

c. Heatcraft.

d. Aerofin.

e. Temtrol.

iii. Chilled Water:

1. Coils shall be constructed of 0.035” tube wall, 5/8” OD seamless copper tubes with continuous plate type aluminum fins

2. Casings shall be minimum 16 gauge, 304 stainless steel having stainless steel end supports and top and bottom .

3. Maximum allowable fin spacing shall be 10 fins per inch. Coil depth shall not exceed 8 rows

4. Acceptable manufacturers:

a. Buffalo.

b. Marlo.

c. Heatcraft.

d. Aerofin.

e. Temtrol.

END OF SECTION

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DIVISION 23 – HVAC

SECTION 23 8413 – HUMIDIFICATION EQUIPMENT

1. General: This section outlines the general requirements for humidification equipment.

2. Design Considerations:

    a. Central Utility Plant (CUP) steam must not be used for humidification.

    b. Steam for building humidification may be generated by an evaporative heat exchanger that uses CUP steam on the primary side of the heat exchanger.

3. Do not locate steam humidifiers immediately upstream of a fan. The preferred location is downstream of the supply fan. Observe manufacturer's free distance downstream of steam injectors.

4. Maintain minimum recommended manufacturer's air velocity for vapor absorption.

5. Provide Humidifiers for:

    a. In AHU:

        i. .Factory-assembled steam dispersion unit shall include the following components:

            1. Steam supply header/separator

            2. Condensate collection header

        ii. Each dispersion tube shall be fitted with steam discharge tubelets inserted into tube wall. Each tubelet shall be made of thermal-resin material designed for high steam temperatures. Two rows of tubelets in each dispersion tube shall discharge steam in diametrically opposite directions, perpendicular to airflow

        iii. Acceptable manufacturers:

            1. Armstrong.

            2. Dri-Steem.

            3. Carel.

            4. Pure Humidifier Co.

    b. In Ductwork (Booster).

        i. Factory-assembled steam dispersion unit shall include the following components:

1. Steam supply header/separator.
2. Condensate collection header.
3. Steam dispersion tubes spanning distance between 2 headers.

ii. Each dispersion tube shall be fitted with steam discharge tubelets inserted into tube wall. Each tubelet shall be made of thermal-resin material designed for high steam temperatures. Two rows of tubelets in each dispersion tube shall discharge steam in diametrically opposite directions, perpendicular to airflow

iii. Acceptable manufacturers:

1. Armstrong.
2. Dri-Steem.
3. Carel.
4. Pure Humidifier Co.

6. For CUP steam to Clean steam generators the acceptable manufacturers:
   a. For small units use Dri-Steem model STS (all Stainless steel).
   b. For larger units use Cemline unfired boilers (all Stainless steel).
7. Clean steam piping and makeup water to be 304 stainless steel.
8. Make up water to the clean steam generators to use RO water and DI water.
9. Provide after coolers for condensate to drain applications.
   a. After coolers shall be constructed of 304 stainless steel and furnished with inlet, vent and drain connections and stainless steel striking plate
   b. Acceptable Manufacturers: (Units shall be similar to DriSteem Drane Kooler)
      i. DriSteem.
      ii. Penn Separator.
   c. Consider air cooled condensate coolers for humidifiers in custom air handling units to save water versus domestic water cooled condensate coolers.

END OF SECTION