SECTION 23 82 16 - AIR COILS

PART I - GENERAL

1.1 SECTION INCLUDES

A. Chilled water coils

B. Hot water coils

C. Steam coils

D. Heat pipe coils

1.2 RELATED SECTIONS

A. *23 73 23 – Custom Air Handling Units*

B. *23 34 00 – HVAC Fans*

C. *23 31 00 – HVAC Ducts*

D. *23 09 13 – Control Dampers*

1.3 COORDINATION

A. Section shall be coordinated with *Section 23 73 23 – Custom Air Handling Units*, *23 31 00 – HVAC Ducts, 23 31 00 – HVAC Fans* and other related sections.

[Note to PSC: Coils located within custom air handling equipment and associated heat recovery systems are to fully comply with the standards herein. Coils located within smaller "packaged" air handling and unitary equipment are to comply with these standards to the greatest degree practical. When specifications are prepared for such "lower grade" equipment, standards herein are to be used as basis and are to be edited as appropriate for equipment. Exception: Standards provided herein for zone reheat "booster coils" are to apply in their entirety regardless of system type/application.]

[Note to PSC: Standards for AHUs within section 23 73 23 – Custom Air Handling Units within these Facility Standards do not include standards for coils. Rather, this section 23 82 16 – Coils is referenced by the AHU standards and is to be treated as a subsection of those.]

1.4 REFERENCES

A. *AHRI Standard 410 – Forced-Circulation Air-Cooling and Air-Heating Coils*

B. *AHRI Standard 1060 – Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment*

C. N*ADCA Standard ACR 2013 - Assessment, Cleaning and Restoration of HVAC Systems*

D. *CDA – Copper Development Association – Copper Tube Handbook*

E. *ASHRPSC Standard 84 – Method of Testing Air-to-Air Heat Exchangers*

F. Applicable SMACNA Standards

G. Applicable ASTM Standards

H. Interna*tional Mechanical Code*

1.5 QUALITY ASSURANCE

A. Air coils shall be *AHRI certified*, assuring validity of published performance ratings.

B. Products and execution shall be in compliance with applicable codes and standards including those referenced above in paragraph entitled *REFERENCES*.

C. Installation, start-up and operation shall be in compliance with Manufacturer's recommendations and IOM.

1.6 SUBMITTALS

A. Shop drawings including but not limited to following:
   1. General description
      a. Coil type, configuration, number of rows
   2. Scale drawings including plan and elevation views
      a. Pipe connections, shown in each view
      b. Pertinent dimensions
      c. Dry and operating weights
   3. Component data
      a. Tubes, including size, materials, wall thickness
      b. Fins, including type, materials, thickness, fin density (FPI), fin profile
      c. Headers, including materials, thickness, connection size
      d. Casing, including materials, metal gauge
   4. Performance parameters
      a. Water side
         (a) Fluid type (water, % glycol), fluid capacity
         (b) Fluid flow rate, tube velocity, pressure drop
         (c) EWT, LWT
      b. Air side
         (a) Airflow rate, face velocity, pressure drop
         (b) Entering air DB/WB, leaving air DB/WB
         (c) Total, sensible capacities
   5. AHRI certification seal or equivalent

1.7 DELIVERY, STORAGE AND HANDLING

A. Coils, especially finned areas, shall be protected from physical damage during delivery, storage and handling.

B. Coils shall be protected from exposure to dust, debris and fluids.

C. Header connections, including vents and drains, shall be capped to protect pipe threads.

1.8 WARRANTY

A. Air coils shall be warranted by Manufacturer to be free from defects in material and workmanship and perform as specified for period of one year from date of startup or 18 months from date of delivery whichever occurs first. Manufacturer shall repair or replace unit or defective component(s) at no cost to Owner. Repaired unit shall be like new with no cutting, patching or notable modification as determined by PSC or Owner.

PART 2 - PRODUCTS

2.1 GENERAL

A. All coils shall be rated in accordance with *AHRI Standard 410* and shall bear the AHRI stamp or symbol.

B. All coils including those associated with central station equipment (e.g. air handling units, dedicated outdoor air units, associated heat recovery equipment) of any make shall fully satisfy specifications herein.

C. Project-specific performance and construction requirements shall be as scheduled on drawings or as otherwise indicated in project documents.

D. Large coils located outside air handling units (e.g. duct-mounted, plenum mounted) shall comply with all requirements for AHU mounted coils.

E. Bypass dampers, if provided with coil, shall comply with *Section 23 09 13 – Control Dampers.* Not applicable to integral face and bypass dampers.

2.2 WATER COILS

A. General

1. Coil shall be of staggered tube, continuous parallel plate fin design.
2. Tubes shall be expanded into fins to form permanent bond.
3. Circuiting and connections shall be arranged to provide counter-flow of water and air.
4. "Turbulators" not allowed.
5. Coil shall be supplied with vent at high point and drain at low point of tube bundle.
6. Coil shall be fully drainable by gravity.
7. Coil shall have same end connections unless indicated otherwise in project documents.
8. To ensure maximum heat transfer over wide range of flow rates, coils shall be selected for fluid velocity through tubes as high as possible without exceeding 6 FPS. In no case shall fluid velocity exceed 8 FPS. Design fluid velocity shall be no less than 3 FPS. *[Note to PSC: The goal here is to maintain turbulent flow at reduced flow rates while avoiding heat transfer reduction at high velocities. For typical HVAC coil applications flow "goes laminar" at approximately 1-2 FPS (depending on fluid temperature) and heat transfer begins to fall off above approximately 6 FPS.]*
9. Water pressure drop shall be as scheduled but shall not exceed 20 ft. w.c.
10. Coil thermal performance shall be determined based upon fluid media indicated on schedule (e.g. water, 30% ethylene glycol solution).
11. If not otherwise scheduled, coil performance shall be based upon following parameters:
    a. 100% water for standard temperature air applications.
    b. 30% ethylene glycol solution for applications with freeze potential (typically finned tube elements, convectors and AHU preheat coils).
12. Coil shall be AHRI rated with 0.0005 fouling factor.
13. Headers outside airflow shall be insulated in same manner as piping.
14. Individual coil sections (i.e. sections with continuous plate fins) shall not exceed 48" in height.

B. Tubes

1. Tubes shall be seamless copper, 5/8" nominal OD with 0.035" wall thickness minimum.
2. Return bends shall be attached to tubes as independent fittings. "Hairpin" tube return design without separate return bend fittings is not allowed. Return bends shall be one nominal wall thickness heavier than circuit tubing.

C. Fins

1. Fins shall be aluminum for standard applications, 0.0095" minimum thickness.
2. To facilitate cleaning, fins shall be flat or have low continuous corrugation.

3. Maximum fin density shall not exceed 12 FPI for flat fins, 10 FPI for low corrugation fins.

[Note to PSC: Maximum FPI and fin profile are specified to facilitate coil cleaning.]

D. Headers

1. Coil headers shall be seamless copper, type K minimum. Cast iron headers not allowed.
2. Each header shall have vent and drain.
3. Connection stubs shall be seamless copper or red brass with MPT connections. Stubs shall be capped for shipping purposes.

E. Casing and Supports

1. Casing shall have flanged connections unless indicated otherwise in project documents or dictated by specific application.
2. Casing, end supports and intermediate tube supports shall be G90 galvanized steel for heating applications and type 304 stainless steel for cooling applications.
3. All formed sheet metal components shall be 16 gauge minimum. For large and/or heavy coils casing shall be thicker gauge as required to provide adequately rigidity.
4. Intermediate tube supports shall be provided for coils having finned tube length 48" or longer. Support shall be provided for each 48" tube length.
5. End supports and tube sheets shall have die formed belled tube holes or ferrules to minimize tube abrasion.

F. Pressure Test

1. Completed coil assembly shall be pneumatically leak tested at 300 PSIG minimum under water and shall be guaranteed for 200 PSIG working pressure.

G. Non-Standard Applications

1. For non-standard applications, all component materials and thicknesses shall be selected for specific application. For corrosive vapor applications type 304 or type 316 stainless steel or factory-applied phenolic coatings are viable options. *[Note to PSC: Address this more specifically for application. For example, type 304 stainless steel may be inadequate for application.]*

H. Approved Manufacturers

1. Heatcraft
2. Marlo
3. PSCrofin
4. Coil Master
5. Armstrong Hunt
6. Nortek

2.3 CHILLED WATER COILS

A. Coil shall satisfy requirements of *WATER COIL* section above with additional requirements:

1. Casing, end supports and intermediate tube supports shall be fabricated from type 304 stainless steel.
2. Fasteners shall be stainless steel.
3. Individual coil section (i.e. sections with continuous plate fins) shall not exceed 48-inch face height. Height shall be further limited as required to prevent moisture carryover at

design operating conditions. Manufacturer shall be engaged to make such determination.

4. Air velocity through "net free area" of coil face shall be no greater than 450 FPM.

   [Note to PSC: Reduction of coil air velocity and associated air pressure drop is encouraged to reduce fan energy consumption.]

5. Air pressure drop shall not exceed 1.0 in. w.c. at design CFM airflow.

6. Performance of cooling coils served by campus central chilled water system shall be based upon following parameters:

   a. Entering chilled water temperature shall be 43 degrees F.

   b. Leaving chilled water temperature shall be 59 degrees F minimum.

   [Note to PSC: For chilled water coils served by central system, LWT greater than 59F is encouraged. Design CHW "delta T" in excess of 16F results in "capacity charge" reduction. Delta T less than 16F will result in capacity charge penalty.]

2.4 HOT WATER COILS

A. Coil shall satisfy requirements of WATER COIL section above with additional requirements:

1. Air velocity through net free area of coil shall be no greater than 600 FPM.

2. Air pressure drop shall not exceed 0.5 in. w.c. at design CFM airflow.

3. If not otherwise scheduled, coil performance shall be based upon following parameters:

   a. Entering fluid temperature shall be 180 degrees F.

   b. Leaving fluid media temperature shall be 160 degrees F.

[Note to PSC: For applications where water is heated by means other than central steam, design HW supply and return temperatures may be reduced as appropriate.]

2.5 ZONE HOT WATER REHEAT COILS (a.k.a. BOOSTER COILS)

A. Coil shall satisfy requirements of HOT WATER COIL section above with following modifications:

1. Tubes shall be 5/8" nominal OD with 0.025" wall thickness minimum.

   a. Alternate: Tubes may be ½" nominal OD with 0.020" wall thickness minimum.

2. Fin thickness shall be nominal 0.008" minimum.

3. Headers and connection stubs shall be type L copper minimum with MPT connections. Stubs shall be capped for shipping purposes.

4. Fluid pressure drop shall not exceed 20 ft. w.c.

5. Air velocity through full face area of coil shall be no greater than 600 FPM.

6. Air pressure drop shall not exceed 0.25 in. w.c. unless indicated otherwise in project documents.

2.6 STEAM COILS

[Notes to PSC: Steam coils are typically disallowed on new projects. They are reserved for direct coil replacement. However, limitations of existing infrastructure may make installation of steam coils(s) the only viable option. If so, approval from Owner is to be obtained prior to document preparation.

Steam coil heat output is very difficult to control. Thus, care must be taken to avoid oversizing steam coils and associated control valves. Control valve(s) are to be selected for design heating load, not coil capacity. Multiple parallel control valves ("1/3-2/3") are often required to *provide adequate turn-down, especial if coil sizing includes backup capacity for heat recovery device and/or future system expansion.*

Standards for steam coils below are in the context of 100% OA preheat coils. Preheat coils in mixed air systems with higher EAT may have less stringent design limitations. But we should be mindful that failure modes with controls or dampers can turn a mixed air unit into a 100% OA unit. Some configurations such as IFB can be difficult to protect with a dedicated freeze-stat.]

A. General

1. Steam coils shall be horizontal distributing type, vertical distributing type, horizontal integral face and bypass (IFB) type or vertical IHB type as indicated in project documents. Standard non-distributing (serpentine) coils not allowed.
2. Given nuances of steam coil design and application, manufacturer shall be contacted regarding coil selection, sizing and configuration and recommendations shall be followed very closely.
3. "Tube-in-tube" distributing design, referred to as "non-freeze coil", shall be used for horizontal tube coils regardless of steam pressure and inlet air temperature. 5/8" inner tube within 1" outer tube shall be default design. Design shall minimize temperate gradient of leaving air from side to side.
4. Steam coils exposed to freezing conditions shall typically be down-fed vertical single-tube or up-fed tube-in-tube design. Regardless, design shall minimize temperate gradient of leaving air from top to bottom.
5. Where space above vertical tube coil is limited, up-fed IFB coil shall be used within length limitations of tubes.
6. Horizontal tube-in-tube design is acceptable for freezing conditions although maximum tube length may be more limited. Allowable horizontal tube length can be increased by feeding tubes from supply headers at both ends. Thus, larger horizontal tube steam coils shall be fed from both ends per Manufacturer's recommendations.
7. Larger steam coils exposed to freezing conditions shall be face and bypass design. Tubes may be oriented vertically or horizontally.
8. Face and bypass design may be integral face and bypass (IFB) or external face and bypass (historical design). External face and bypass configuration typically uses horizontal tube-in-tube design.

[Notes to PSC:

- *Vertical tube-in-tube design not recommended for down-fed vertical tube coils. Since first steam jet is located substantially below top header, non-condensables can collect and become trapped in annular space between tubes above, yielding cold area at top of coil. At least one manufacturer (Marlo) allows tube-in-tube design for vertical up-fed coils. Openings are provided at top of inner tube allowing non-condensables to be swept from top of tubes and down through annular space.*
- *Up-fed steam coils are advantageous in that a top steam supply header is not required. Combined supply/return header is located at bottom.*
- *Steam velocity is a significant factor in steam coil design. Required steam velocity increases as steam pressure decreases based upon specific volume/enthalpy of steam. Velocity limit is typically 6,000 FPM. Such limitation can constrain maximum length of tubes. Maximum tube length can also be impacted by condensate flow rate through annular space between inner and outer tubes. Condensate can "back up" at outlet of tubes, thus becoming cold and vulnerable to freezing. This limitation is greater for horizontal tube coils than for vertical tube coils.*
- *One should keep in mind that without the use of face and bypass dampers temperature control must be accomplished modulation of the steam flow rather than modulation of*

airflow. This results in variable steam pressure within the coil. One must remain mindful of the freeze potential associated with operation at very low steam pressure.

- *As all are aware, it is extremely difficult to control leaving air temperature from any steam coil, especially an IFB coil. The key is in optimizing the transition from air-side control to steam control and back again. This is difficult even with the best sequence and programming. The solution? Don't use an IFB steam coil. But if you must, buy the best there is with tight sealing dampers.*

- *Another option: Go back to the tried and true external face and bypass configuration.]*

B. Sizing/selection

1. If not otherwise scheduled, coil sizing shall be based upon 2 PSIG saturated steam at coil inlet.
2. Air pressure drop shall be as scheduled, maximum.
3. Steam coils shall be carefully sized. Oversizing shall be avoided.

C. Tubes

1. Steam distributing coils shall utilize copper inner distributing steam tube centered in outer condensing tube and have properly spaced orifices angled in direction of condensate flow.
2. Tubes shall be seamless copper. Inner tube shall be 5/8" nominal OD. Outer tube shall be 1" OD nominal, minimum, sized to handle condensate load. Tube wall thickness shall be 0.049" minimum.

D. Fins

1. Fins shall be aluminum for standard applications, 0.010" thick minimum.
2. Fins shall be flat or low continuous corrugation.
3. Fin density shall be 10 FPI maximum unless indicated otherwise in project documents. Maximum fin density of 8 FPI recommended.

E. Headers

1. Coil headers shall be seamless copper, type K minimum.
2. Headers shall incorporate inner steam baffle to evenly distribute steam to all coil tubes. Condensate headers shall be sized to handle full design condensate load.
3. Condensate connection shall be located such that bottom of connection is no higher than bottom of lowest tube to ensure proper drainage.
4. Connection stubs shall be schedule carbon steel with MPT connections.
5. Headers for larger coils shall incorporate multiple supply connections as required for evenly distributed steam pressure throughout entire length of header.

F. Casing and Supports

1. Casing, end supports and intermediate tube supports shall be G90 galvanized steel. All formed sheet metal components shall be 16 gauge minimum.
2. Casing shall have flanged supports/connections unless otherwise indicated within project documents or determined by application.
3. Intermediate tube supports shall be provided for coils having finned tube length 48" or longer. Support shall be provided for each 48" tube length.
4. End supports and tube sheets shall have die formed belled tube holes or ferrules to minimize tube abrasion.
5. For horizontal tube coils, tubes shall be pre-pitched in casing to facilitate condensate drainage.

G. Pressure Test

1. Completed coil assembly shall be pneumatically leak tested at 190 PSIG under water and guaranteed for operating pressures to 150 PSIG.

H. Basis of Design

1. Heatcraft
2. Marlo
3. PSCrofin

2.7 EXTERNAL FACE AND BYPASS COILS

A. Coil shall be horizontal tube-in-tube steam distributing type unless indicated otherwise in project documents. Horizontal tube coil shall be fed from headers at both ends as required for size/capacity.

B. Face and bypass dampers shall be provided, properly positioned and mounted upstream of coil face.

1. Face dampers shall have high temperature rated blade and jamb seals.
2. Dampers shall comply with all requirements of *Section 23 09 13.43 – Control Dampers*.

2.8 IFB STEAM COILS (INTEGRAL FACE AND BYPASS) - HORIZONTAL OR VERTICAL TUBE

[Note to PSC: Use of an IFB steam preheat coil is not necessarily the best choice for all freeze protection applications. Cost and damper/linkage maintenance are among factors to be considered. IFB coils should only be used where truly necessary.]

A. General

1. IFB coils shall consist of vertically or horizontally oriented alternating dampered finned tube cores and air bypass sections. *[Note to PSC: Edit as appropriate.]*
2. IFB coils shall maintain constant discharge air temperature regardless of variations of entering air temperature while operating at full steam pressure.

B. Performance

1. Leaving air temperature measured three feet downstream of coil shall be maintained at temperature not varying more than 5 degrees F from average discharge temperature of coil.
2. Damper assembly shall be designed to maintain constant air flow volume not varying more than +/- 5% regardless of bypass damper position.
3. Coil/damper assembly shall include discharge shut-off dampers and damper blade and edge seals such that air bypassing finned tube cores shall not result in air temperature rise greater than 2 degrees F with steam pressure delivered to supply header at 5 PSIG.

C. Dampers

1. Dampers shall be connected by readily accessible stainless steel linkage, isolated from air stream and driven by actuator controlled by BAS.
2. Damper blades shall be fabricated from minimum 0.90” thick thermally reflective extruded anodized aluminum, pivoting on aluminum alloy damper rods housed in stainless steel or oil impregnated bronze bearings. Use of painted steel damper blades not permitted.
3. Blade edge seals shall be utilized where damper blades close to form seal. Blade edge seals shall be conservatively rated for worst case steam temperature. Blade edge seals shall be silicone or superior material rated for higher temperature.

D. Frame

1. Flanged frame assembly shall be 14 gauge minimum G90 galvanized steel. Duct mounting holes and removable lifting lugs shall be provided.

E. Finned Cores

1. Fins shall be continuous plate type. Outer tubes shall be expanded into fins to form permanent bond.

2. Each individual finned tube core shall be supported at tube ends by 16 gauge minimum tube sheet with copper ferrules to minimize tube abrasion.

3. Finned tube cores shall be isolated from bypass airstream by 16 gauge minimum sheet metal baffles. Use of moving sheet metal dampers as baffles not allowed.

F. Tubes

1. Horizontal tubes shall be steam distributing type with inner distributing steam tube centered in outer condensing tube. Inner tube shall have properly spaced orifices angled in direction of condensate flow and shall be designed to prevent collection of non-condensables in top portion of tubes.

   a. Tubes shall be seamless copper. Inner tube shall be 5/8” nominal OD. Outer tube shall be 1” OD nominal minimum, sized to handle condensate load. Tube wall thickness shall be 0.049” minimum.

2. Vertical tubes shall be single 5/8” nominal OD.

   a. Tubes shall be seamless copper. Tubes shall be 5/8” nominal OD. Tube wall thickness shall be 0.049” minimum.

3. Stainless steel tubes may be substituted for copper.

G. Fins

1. Fins shall be aluminum, 0.010” thickness minimum.

2. Stainless steel fins may be substituted for aluminum.

H. Headers

1. Coil headers shall be seamless copper, type K minimum, or red brass.

2. Connection stubs shall be schedule carbon steel with MPT connections.

I. Pressure Test

1. Completed coil assembly shall be pneumatically leak tested at 190 PSIG under water and guaranteed for operating pressures to 150 PSIG.

J. Non-Standard Applications

1. For non-standard applications, all component materials and thicknesses shall be selected for specific application.

K. Basis of Design

1. Armstrong Hunt Duramix

2. Marlo Stratomizer

2.9 HEAT PIPE COILS

A. General

1. Linear-Tube Heat Pipe Coils

   a. Shall provide passive heat energy exchange between two counter-flow air streams.

b. Shall be configured with tubes horizontal or vertical as shown on drawings or otherwise indicated in project documents.

c. Shall be affixed and shall have no requirement for tilting to ensure specified performance in all operating conditions.

d. Shall be single unit for heat exchange between adjacent airstreams

e. Shall be matched coil set with interconnecting piping for heat exchange between remote airstreams.

2. U-framed “wrap-around” heat pipe coils

a. Shall provide dehumidification of air at cooling coil location.

b. Shall incorporate adequate access between heat pipe and cooling coil on each side of cooling coil.

1) Face–to-face clear dimension on each side of coil shall typically be 30” minimum but in no case shall be less than 24”. *[Note to PSC: Discuss maximum available dimension with Manufacture. Edit access requirement if required.]*

B. Configuration

1. Series Flow

a. Heat pipe tubes shall be configured in series circuits such that liquid and vapor travel in same direction around circuit making wicking and capillary action unnecessary.

b. Basis of Design: Heat Pipe Technologies

2. Bidirectional Flow (Conventional)

a. Individual heat pipe tubes shall incorporate interior tube wall enhancements for wicking of heat transfer fluid via capillary action for transfer of liquid and gas in opposite directions.

b. Basis of Design: Innergy tech, Inc.

c. Other approved: Thermofin

[Note to PSC: Both configurations (series and bidirectional) are to be evaluated for specific application. If both designs are deemed acceptable, specification may remain as written. If only one of the two is deemed acceptable, specification is to be edited accordingly.]

C. Finned Tubes

1. Tubes shall be individually processed, charged, hermetically sealed and factory tested for leakage.

2. Series Flow

a. Tubes shall be rigid copper tubing expanded into aluminum plate-type fins to form permanent bond.

b. Tube diameter shall be 1/2” or 5/8” nominal OD as selected for optimal performance.

c. Tube wall thickness shall be 0.035” minimum.

d. Fin thickness shall be 0.095“ minimum.

e. Fin density shall not exceed 12 FPI.

3. Bidirectional Flow

a. Tubes shall be aluminum with integral fins.

b. Tube diameter shall be 1” ID nominal.

c. Tube wall thickness shall be 0.166” minimum.

d. Fin density shall not exceed 12 FPI.

D. Working Fluid

1. Heat transfer fluid shall be selected on basis of heat pipe operating temperatures and compatibility with tube and wick materials.

E. Casing

1. Material and Gauge

a. Casing end supports and intermediate tube supports shall be G90 galvanized steel for heating only applications and type 304 stainless steel for applications that include cooling.

b. All formed sheet metal components shall be 16 gauge minimum unless indicated otherwise in project documents. Thicker gauge shall be provided as required to maintain rigidity of larger and/or heavier coils.

2. Supports

a. Intermediate tube supports shall be provided for coils having finned length 48” or longer. Support shall be provided for each 48” tube length.

b. End supports and tube sheets shall have die formed belled tube holes or ferrules to minimize tube abrasion.

3. Covers

a. End covers shall be provided to protect tube ends. Covers shall be same material and thickness as casing.

F. Partition

1. Partition shall be provided to isolate adjacent airstreams to ensure no cross contamination.

2. Partition shall be same material and thickness as casing. Partition shall be double wall foam filled construction.

3. Partition shall be located in center of heat pipe coil unless indicated otherwise in project documents.

G. Drain Pan

1. Drain pans shall be provided for coils that generate condensate in cooling mode. Drain pans shall be pitched drainable and shall include intermediate drain pans as required to prevent moisture carryover.

2. Drain pans shall be stainless steel, double wall construction and shall be completely insulated with rigid two-part expanded urethane foam.

3. Drain pans shall comply with all applicable requirements of *Section 23 73 23 – Custom Air Handling Units.*

H. Coil Dimensions

1. Coil sections shall not exceed 48” in height for coils that generate condensate in cooling mode. Height shall be further limited as required to prevent moisture carryover at design operating conditions. Manufacturer shall be engaged to make such determination.

I. Bypass Dampers

1. Heat pipe coil bypass dampers shall be provided as shown on drawings.

2. For linear side-by-side heat pipe coil automated dampers shall be provided in both air streams (i.e. outdoor/supply, return/exhaust) to allow bypass of air to reduce air pressure drop, facilitate economizer operation and provide frost control.

   a. Dampers shall be sized such that combined airflow through bypass damper and coil is sufficient to provide 100% outdoor air economizer.

3. For wrap around heat pipe coil bypass dampers shall be provided to reduce air pressure drop.

4. Bypass dampers and actuators shall comply with requirements of *Section 23 09 13 – Control Dampers.*

5. Damper actuation/automation shall be provided by Temperature Control Manufacturer.

J. Non-Standard Applications

For non-standard applications, all component materials and thicknesses shall be selected for specific application. For corrosive vapor applications components exposed to airflow shall be type 304 or type 316 stainless steel or shall be phenolic coated at factory .*[Note to PSC: Further identify material and/or coating.]*

K. Controls

[Note to PSC: Owner is to be contacted to confirm control requirements for specific project. Sections below shall be edited as appropriate.]

1. All control devices and programming shall be provided by Temperature Control Contractor in accordance with requirements of *Section 23 09 23 – Building Automation System (BAS) for HVAC* and *Section 23 09 13 – Instrumentation and Control Devices for HVAC*.

2. Manufacturer / Installing Contractor shall coordinate installation of controls and startup of AHU with Temperature Control Contractor.

PART 3 – EXECUTION

3.1 COIL PROTECTION

A. Coils shall be protected from physical damage during delivery, storage and handling.

   1. Coils shall be protected from exposure to dust, debris and fluids.

   2. Header connections shall be capped to protect pipe threads.

3.2 PIPING

A. Unions/flanges shall be installed at each coil pipe connection as applicable.

B. For coils located in air handling units, piping and other exterior system components shall be configured to facilitate coil removal via slide out through wall of unit. *[Note to PSC: "Slide out" configuration can substantially facilitate coil removal and replacement. It is not an uncommon requirement for University campuses. If this configuration is deemed inappropriate or unnecessary a standard "through-the-door" design may be pursued. Owner approval is required prior to proceeding with design other than slide-out.]*

C. Air vents and drains, complete with valves, shall be provided for each water coil.

D. Headers outside airflow shall be insulated in same manner as piping.

E. Cooling coil condensate drain lines shall be trapped and piped to drain independently.

F. Steam and hot water coils shall be piped with adequate offsets to minimize stress at header connections due to thermal expansion. If not practical to provide adequate flexibility in this manner, flexible pipe connectors may be used although their use is generally discouraged.

G. "Double fed" steam coils shall be piped such that pressure of steam supplied to each header is approximately equal.

H. Multiple steam coils shall be trapped individually.

I. Steam condensate piping at coil outlet shall be full connection size.

J. Full size condensate drip leg shall be provided. Vertical drop shall be 14” minimum from bottom of coil to trap inlet unless indicated otherwise on drawings.

K. Steam trap shall be provided at outlet of each individual coil to provide full condensate drainage under all operating conditions. Trap shall be float and thermostatic type.

L. Steam trap shall be located for ease of access to facilitate service and removal/replacement.

M. Vacuum breaker shall be provided at coil outlet. Elevation shall be at or above coil outlet. Steam trap shall not be located at steam trap elevation.

N. For steam coils, carefully sized control valves shall be provided. Valves shall not be oversized. Multiple parallel valves shall typically be provided (e.g. 1/3-2/3).

3.3 LOCATION / ACCESS

A. Adequate access shall be provided for convenient inspection and cleaning of coils.

B. Installed distance between upstream and downstream of coil faces shall typically be 30” minimum. In no case shall space between coils be less than 24”. Such requirement applies to space between U-framed “wrap-around” heat pipe coils, both sides of associated cooling coil.

C. Adequate clearance shall be maintained relative to adjacent structures and/or building systems to allow coil replacement without alteration of any system or component. Adequate access shall be provided at coil valves and piping.

D. Coils, especially cooling coils, shall not be installed above valuable furnishings, electrical equipment, electronic devices, etc. where leakage could result in costly damage. If impractical to do so, provision of protective drain pan is required.

E. IFB Coil Access

1. Adequate access shall be provided for maintenance of damper linkage. 12” minimum clearance shall be provided between coil frame and interior wall of air handling unit. Access shall be from entering air side of coil. Blank off panel shall be provided on leaving air side.

3.4 BYPASS DAMPERS

A. Face and bypass dampers shall be provided for external face and bypass steam coil configuration.

B. Face dampers shall be properly positioned and mounted upstream of coil face.

C. Face dampers shall have high temperature rated seals.

D. Dampers shall comply with all requirements of *Section 23 09 13.43 – Control Dampers*.

3.5 INSTALLATION

A. Unless otherwise indicated within project documents, coil casings shall have flanged connections and shall be secured with threaded fasteners. Sheet metal screws shall not be used.

B. Fasteners and hardware shall be same material as connected components. Where connected components are dissimilar material, stainless steel fasteners shall be used.

C. Structural supports shall be provided for stacked coils within air handling unit or plenum. Supports shall be configured to facilitate removal of coil sections by sliding out through wall of unit.

D. When two or more cooling coils are stacked in an assembly, intermediate drain pans shall be provided.

E. Water and steam coils shall be installed dead level to facilitate full drainage by gravity.

F. Substantial separation shall be provided between steam preheat coil and coil that follows, especially in case of an IFB coil, A separation of 4-6 ft. (or more) is required to avoid nuisance freezstat trips.

G. Heat pipe coils shall be positioned as recommended by Manufacturer to ensure optimal circulation of heat transfer fluid.

H. Sheet Metal blank off panels shall be provided to prevent bypass airflow.

I. Properly configured duct transitions shall be provided at duct mounted coils. Transitions shall be in compliance with applicable *SMACNA Standards*.

J. Coil fins shall be combed and straightened after installation is complete.

3.6 ENTERING AIR REQUIREMENT

A. Air streams of differing temperature shall be thoroughly mixed prior to entering coils.

B. During operation, coils shall be exposed to filtered air only. Filters shall be provided.

C. Coil fins shall be combed and straightened after installation is complete.

3.7 CLEANING

A. Coils shall be cleaned to satisfaction of PSC and Owner.

B. *NADCA Standard ACR 2013 - Assessment, Cleaning and Restoration of HVAC Systems* shall be utilized by PSC as basis for determining need for cleaning, extent thereof and methodology to be employed.

C. Only non-hazardous non-toxic cleaning agents and materials shall be used. MSDS cut sheets shall be provided upon request.

END OF SECTION 23 82 16

This section of the *U of I Facilities Standards* establishes minimum requirements only.
It should not be used as a complete specification.