3.0 DFCM REQUIREMENTS

3.8 HVAC

DFCM DESIGN MANUAL
UNIVERSITY OF UTAH SUPPLEMENT

January 15, 2016
GENERAL INTRODUCTION TO THE UNIVERSITY OF UTAH SUPPLEMENT:

The DFCM Design Manual “Design Requirements” (State of Utah, Department of Administrative Services, Division of Facilities Construction and Management, referred to herein as “DFCM Manual” or “Manual”) dated June 11, 2009 including highlighted updates is the basis for A/E design services provided for all University of Utah projects.

This document accepts the DFCM Manual as the University of Utah standard, and supplements the Manual with requirements which are needed to satisfy University organization and mission objectives.

The reader is directed first to the DFCM Manual, then to this supplement where added requirements are preceded by “ADDED” and paragraph alterations required to accommodate University processes are preceded by “REVISED.”

To remain consistent with the DFCM Manual, this supplement is organized in a format matching that of the parent Manual. Only portions of the parent Manual are reproduced in this supplement, either as navigation guides or as altered paragraphs. DFCM text is presented in a gray font. University additions and insertions are presented in normal font.

ADDED:

1. The A/E shall coordinate with the University Project Manager throughout design development to ensure systems are compatible with the University Master Plan, and plans for the user department at the University are coordinated with all required campus agencies.

2. This supplement contains required design elements for mechanical systems at the University, and design professionals are required to adhere to the information provided herein. The designer is also expected to conform to accepted industry design practices in the application of the requirements found in this supplement. Items not specifically addressed are left to the designer's professional judgment, but are subject to review.

3. Each division of the supplement is intended to assist the mechanical designer with design information which is considered unique to the University's mechanical systems. Facilities Management, including the departments of Facility Operations, Campus Planning, and Construction Project Delivery prepared this document to serve as a vehicle to insure consistency, quality, and maintainability in mechanical system design on campus.
4. The A/E’s work is subject to review and comment by Facilities Management at any time during design or construction.

   a. Progress checks by the University will result in written review comments. The A/E is expected to respond to each comment with written action items.

   b. The design engineer (or A/E design team) shall meet with the University Project Manager during the design to coordinate the progress of the work.

   c. Design reviews will be conducted whenever deemed necessary, but are considered mandatory for the schematic or design development progress check and final drawing submittal.

   d. Each design review comment (regardless of the source) is to be addressed in writing by the design engineer prior to completing the next phase of the project design. This action report shall be submitted to Facilities Management through the A/E team leader.

**ADDED:**

REVISIONS SUMMARY
for the University of Utah Supplement:

<table>
<thead>
<tr>
<th>REVISION DATE</th>
<th>LOCATION</th>
<th>SUMMARY OF CHANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 May 2015</td>
<td>3.8 GG. / Lab ventilation systems</td>
<td>Laboratory Ventilation Systems Several Small wording changes made</td>
</tr>
<tr>
<td>1 May 2015</td>
<td>- - -</td>
<td>DFCM quoted text and numbering revised to correspond with DFCM changes. University standards unchanged.</td>
</tr>
<tr>
<td>1 November 2014</td>
<td>3.8 Part 1 EE. / 15860 / i.</td>
<td>Spring Return added requirement.</td>
</tr>
<tr>
<td>1 May 2014</td>
<td>3.8 / part 1 / EE. / 15829</td>
<td>Exhaust Fans Updated standard to add performance based requirements for exhaust fans</td>
</tr>
<tr>
<td>1 May 2014</td>
<td>3.8 / part 1 / EE. / 15770</td>
<td>Custom Air Handling Units Added standard for Custom Air Handling Units</td>
</tr>
<tr>
<td>1 May 2014</td>
<td>3.8 / Part 1 / CC.</td>
<td>System Commissioning Updated Standard to reflect the requirements for the relationship between the commissioning agent and the design team</td>
</tr>
<tr>
<td>1 May 2014</td>
<td>3.8 / part 1 / DD.</td>
<td>Metering Added performance based requirements for metering and more detailed requirements for CHW and HTW meters</td>
</tr>
<tr>
<td>1 May 2014</td>
<td>3.8 / Part 1 / EE. / 15700</td>
<td>Heat Transfer / Boilers Updated standard to clarify some of the performance based requirements</td>
</tr>
<tr>
<td>1 May 2014</td>
<td>3.8 / part 1 / EE. / 15100 /</td>
<td>Chilled Water and Heating Water Valves Updated Standard and removed specific manufactures from the standard.</td>
</tr>
<tr>
<td>Date</td>
<td>Standard Number</td>
<td>Description</td>
</tr>
<tr>
<td>-----------------</td>
<td>-----------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>1 May 2014</td>
<td>3.8 / part 1 /</td>
<td><strong>Chilled Water and Heating Water Piping</strong> Updated Standard to eliminate</td>
</tr>
<tr>
<td></td>
<td>EE. / 15061 /</td>
<td>specific manufacturers and to add HDPE and polypropylene piping to the</td>
</tr>
<tr>
<td></td>
<td>f. / i</td>
<td>acceptable materials for use.</td>
</tr>
<tr>
<td>1 May 2014</td>
<td>3.8 / Part 1 /</td>
<td><strong>Test and Balance</strong> Updated Standard to reflect current practices.</td>
</tr>
<tr>
<td></td>
<td>EE. / 15995</td>
<td>Including adding NEBB to the acceptable licensing of balance contractors.</td>
</tr>
<tr>
<td>1 May 2014</td>
<td>3.8 / Part 1 /</td>
<td><strong>Chilled Water System</strong> Updated Standard to reflect more performance</td>
</tr>
<tr>
<td></td>
<td>EE. / 15995</td>
<td>based requirements.</td>
</tr>
<tr>
<td>1 May 2014</td>
<td>3.8 / Part 1 /</td>
<td><strong>Auto Faucet Battery Pack</strong> Updated standard to eliminate auto faucets</td>
</tr>
<tr>
<td></td>
<td>15450 / J / 6</td>
<td>with the exception of Handicapped lavatories.</td>
</tr>
<tr>
<td>1 May 2014</td>
<td>3.8 / Part 1 /</td>
<td><strong>Piping Material below Grade</strong> Removed “Blue Brute”</td>
</tr>
<tr>
<td></td>
<td>EE. / 15062</td>
<td></td>
</tr>
<tr>
<td>1 November 2013</td>
<td>3.8 / EE. /</td>
<td><strong>Heat Transfer</strong> Added / Updated Requirements</td>
</tr>
<tr>
<td></td>
<td>15700</td>
<td></td>
</tr>
<tr>
<td>1 November 2013</td>
<td>3.8 / C. / (13)</td>
<td><strong>Plumbing General Requirements</strong> Added / Updated Requirements</td>
</tr>
<tr>
<td></td>
<td>/ (19) / (20)</td>
<td></td>
</tr>
<tr>
<td>1 November 2013</td>
<td>3.8 / EE. /</td>
<td><strong>Soil, Waste and Vent</strong> Updated Requirement</td>
</tr>
<tr>
<td></td>
<td>15061 / p. / 2</td>
<td></td>
</tr>
<tr>
<td>1 November 2013</td>
<td>3.8 / EE. /</td>
<td><strong>Piping Material (Underground or Below Grade - &quot;b.g.&quot;)</strong> Updated</td>
</tr>
<tr>
<td></td>
<td>15062 / b. / 2</td>
<td>Requirements</td>
</tr>
<tr>
<td></td>
<td>/ c.</td>
<td></td>
</tr>
<tr>
<td>1 November 2013</td>
<td>3.8 / EE. /</td>
<td><strong>Soil and Waste Piping System</strong> Updated Requirements</td>
</tr>
<tr>
<td></td>
<td>15405</td>
<td></td>
</tr>
<tr>
<td>1 November 2013</td>
<td>3.8 / EE. /</td>
<td><strong>Valves and Accessories</strong> Updated / Added Requirements</td>
</tr>
<tr>
<td></td>
<td>15100</td>
<td></td>
</tr>
<tr>
<td>1 November 2013</td>
<td>3.8 / EE. /</td>
<td><strong>Plumbing Systems</strong> Updated Requirements</td>
</tr>
<tr>
<td></td>
<td>15400 / b. / 5</td>
<td></td>
</tr>
<tr>
<td>1 November 2013</td>
<td>3.8 / EE. /</td>
<td><strong>ATC – Automatic Temperature Control Systems, General</strong> Added New</td>
</tr>
<tr>
<td></td>
<td>15900 / a. / 4</td>
<td>Requirements</td>
</tr>
<tr>
<td>1 November 2013</td>
<td>3.8 / EE. /</td>
<td><strong>ATC – Controllers</strong> Added New Requirements</td>
</tr>
<tr>
<td></td>
<td>15902 /</td>
<td></td>
</tr>
<tr>
<td>1 November 2013</td>
<td>3.8 / EE. /</td>
<td><strong>ATC – Sensors</strong> Added New Requirements</td>
</tr>
<tr>
<td></td>
<td>15907 /</td>
<td></td>
</tr>
<tr>
<td>1 November 2013</td>
<td>3.8 / EE. /</td>
<td><strong>Packaged Air Handling / Rooftop Units</strong> Added New Requirement</td>
</tr>
<tr>
<td></td>
<td>15770 / t.</td>
<td></td>
</tr>
<tr>
<td>1 November 2013</td>
<td>3.8 / EE. /</td>
<td><strong>Cooling Towers</strong> Added New Requirements to Cooling Towers</td>
</tr>
<tr>
<td></td>
<td>15680 / e /</td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td>Requirement</td>
<td>Details</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>1 November 2013</td>
<td>3.8 / EE. / 15670 / d / 21) / e / 11)</td>
<td>Chillers Added new Requirements to Chillers</td>
</tr>
<tr>
<td>1 November 2013</td>
<td>3.8 / EE. / 15435 / c</td>
<td>Water Conditioning Systems Added New Requirement</td>
</tr>
<tr>
<td>1 November 2013</td>
<td>3.8 / EE. / 15435 / c / 1)</td>
<td>Water Conditioning Systems Added additional Manufacturers</td>
</tr>
<tr>
<td>1 November 2013</td>
<td>3.8 / EE. / 15450 / j / 5)</td>
<td>Flush Valves Added requirements for Flush Valves</td>
</tr>
<tr>
<td>1 November 2013</td>
<td>3.8 / C. / (17) / a / 6)</td>
<td>Fixtures and Floor Drains Added requirement referral for Flush valves</td>
</tr>
<tr>
<td>1 November 2013</td>
<td>3.8 / part 1 / EE. / 15061 / p.</td>
<td>Piping Material Added Piping Material Requirements</td>
</tr>
<tr>
<td>21 September 2012</td>
<td>3.8 / G. / (6) / e. / 3)</td>
<td>Steam System Extensions or Revisions Added requirement to verify existing system capacity and demand; and, detail new connection locations</td>
</tr>
<tr>
<td>21 September 2012</td>
<td>3.8 / G. / (6) / e. / 4)</td>
<td>Steam Condensate to SLC Sewer Added requirement to pre-cool condensate; and, A/E to coordinate with SLC Sewer Standards</td>
</tr>
<tr>
<td>21 September 2012</td>
<td>3.8 / X.</td>
<td>Start-Up Strainers Added requirement to display the start-up strainers for inspection</td>
</tr>
<tr>
<td>21 September 2012</td>
<td>3.8 / EE. / 15060 / a. / 1)</td>
<td>Pipe and Pipe Fittings Added “unless approved” to domestic manufacturer requirement</td>
</tr>
<tr>
<td>21 September 2012</td>
<td>3.8 / EE. / 15060 / a. / 2)</td>
<td>Pipe and Pipe Fittings Added requirement for seamless fittings</td>
</tr>
<tr>
<td>21 September 2012</td>
<td>3.8 / EE. / 15060 / c. / 5)</td>
<td>Piping Tests Added option for third party testing company</td>
</tr>
<tr>
<td>REVISION DATE</td>
<td>LOCATION</td>
<td>SUMMARY OF CHANGE</td>
</tr>
<tr>
<td>----------------</td>
<td>-----------------------------------------------</td>
<td>--------------------------------------------------------------------</td>
</tr>
<tr>
<td>21 September 2012</td>
<td>3.8 / EE. / 15061 / i. / j. and k. and l. and p. / 3)</td>
<td>Type L Copper Above Grade. Removed “95-5” and replaced with “lead free” solder</td>
</tr>
<tr>
<td>21 September 2012</td>
<td>3.8 / EE. / 15061 / c. / 4)</td>
<td>Natural Gas Piping, Above Grade. Added protective paint</td>
</tr>
<tr>
<td>21 September 2012</td>
<td>3.8 / EE. / 15061 / t.</td>
<td>Cooling Coil Condensate Drain. Removed Type “M” and replaced with Type “L” copper</td>
</tr>
<tr>
<td>21 September 2012</td>
<td>3.8 / EE. / 15062 / a. and 3.8 / EE. / 15351 / a. / 2) / e)</td>
<td>Buried Pipe Trace Wire, Warning Tape, Sand Cover. Added requirements for all buried piping as described in 3.2 Civil</td>
</tr>
<tr>
<td>21 September 2012</td>
<td>3.8 / EE. / 15062 / e. / 6)</td>
<td>Natural Gas Piping, Below Grade. Added protective sleeve when routed through a wall</td>
</tr>
<tr>
<td>21 September 2012</td>
<td>3.8 / EE. / 15066</td>
<td>HVAC Piping Systems Cleaning, Filling, Treatment. Added requirements and restrictions</td>
</tr>
<tr>
<td>21 September 2012</td>
<td>3.8 / EE. / 15400 / a. / 4) / b)</td>
<td>Parallel Reduced Pressure Backflow Preventers. Changed application from certain water systems to “required on all make-up water lines”</td>
</tr>
<tr>
<td>21 September 2012</td>
<td>3.8 / EE. / 15400 / b.</td>
<td>Disinfection of Piping Systems. Much of this section was re-written</td>
</tr>
<tr>
<td>27 February 2012</td>
<td>3.8 / EE. / 15995 / q.</td>
<td>Testing &amp; Balancing: Removed paragraph “q” (approved T&amp;B firms)</td>
</tr>
<tr>
<td>06 January 2012</td>
<td>- - -</td>
<td>University Design Standards. The former University Design Standards Chapters 1 through 12 were reformatted and re-issued as the U of U Supplement to the DFCM Design Manual.</td>
</tr>
</tbody>
</table>
Revisions Summary (continued)

<table>
<thead>
<tr>
<th>REVISION DATE</th>
<th>LOCATION</th>
<th>SUMMARY OF CHANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>06 January 2012</td>
<td>- - -</td>
<td>CD&amp;C has changed to Construction Project Delivery and is shown as Construction Project Delivery or Facilities Management in this document.</td>
</tr>
<tr>
<td>06 January 2012</td>
<td>- - -</td>
<td>Facilities Planning has changed to Campus Planning</td>
</tr>
<tr>
<td>06 January 2012</td>
<td>- - -</td>
<td>Business Services has changed to Facilities Business Services</td>
</tr>
<tr>
<td>06 January 2012</td>
<td>- - -</td>
<td>Plant Operations has changed to Facility Operations</td>
</tr>
<tr>
<td>06 January 2012</td>
<td>- - -</td>
<td>O&amp;M / Warranties. Removed. Relocated to the Supplemental General Conditions for University of Utah Projects</td>
</tr>
<tr>
<td>06 January 2012</td>
<td>3.8 / G. / (6) / j.</td>
<td>Glycol systems are to be contained within mechanical rooms (except fire protection piping)</td>
</tr>
<tr>
<td>06 January 2012</td>
<td>3.8 / Q. / (11)</td>
<td>Added requirement for sequence of operations</td>
</tr>
<tr>
<td>06 January 2012</td>
<td>3.8 / EE. / 15405 / b. / 6</td>
<td>Added requirement for direct connection to drain</td>
</tr>
<tr>
<td>06 January 2012</td>
<td>3.8 / EE. / 15900</td>
<td>Added Trane US, Inc. and Honeywell only by Wasatch Controls; removed Staefa Systems</td>
</tr>
<tr>
<td>06 January 2012</td>
<td>3.8 / EE. / 15061 / f. / 3</td>
<td>Added temperature ratings for EPDM gaskets</td>
</tr>
<tr>
<td>06 January 2012</td>
<td>3.8 / EE. / 15061 / f. / 4</td>
<td>Added Grinnell, removed Gustin Bacon</td>
</tr>
<tr>
<td>06 January 2012</td>
<td>3.8 / EE. / 15061 / o. / 5</td>
<td>Added Grinnell, removed Gustin Bacon</td>
</tr>
</tbody>
</table>
3.0 DFCM REQUIREMENTS

3.8 HVAC Systems

C. Steam

**REVISED:**

(10) Steam Meter

a. Refer to section 5.0 HPBS. For University projects see section 3.1 General, paragraph 3.1, J. University of Utah Design Requirements In General, subparagraph (7) Utility Metering and paragraph 3.8 DD, below for specific University requirements. Provide totalizing type meter which reads directly in pounds of steam.

F. Building Automation

**REVISED:**

(1) Direct Digital Control:

a. For new construction, use DDC with an open BACnet or LonTalk communication protocol in accordance with ASHRAE Standard 135.

b. For repair and alteration projects and new additions to existing projects, the following options are permitted:

   i. Installation of DDC with the BACnet or LonTalk protocol,

   ii. Integrating the existing system with customized gateways to the BACnet or LonTalk protocol.

   iii. Pneumatic control as an extension of an existing system, if specifically required by operating personnel

c. Provide digital metering of electrical, hot water, steam, and chilled water sources to each facility. Refer to section 5.0 HPBS.

d. Provide flow metering devices for hot and chilled water heating systems. Refer to section 5.0 HPBS.

**ADDED:**

N. Mechanical Equipment Rooms and Tunnels

1) Mechanical equipment rooms and tunnels shall be lighted, ventilated and supplied with adequate electrical outlets and floor drains.
2) Floor drains shall be located within 5 feet of equipment using water. Exposed drain piping which must be routed to floor drains must be organized so as not to trip or cause injury.

3) Emergency lighting shall be designed around a light producing tape or panel applied to walls and floors, which directs trapped occupants to the nearest exit. Approved manufacturer is Active Safety Corporation. The material shall be UL approved (UL 94U8) Active Safety Model PSL 11000 capable of producing 6 to 8 hours of emergency self-illumination. Apply with "Durabond 3001" permanent adhesive per manufacturer’s recommendations. Provide a 5 year warranty for material and workmanship.

b. Tunnels

Tunnels are to be designed for 7 foot walking height after all utilities have been installed and should allow adequate working space for any maintenance procedure required. Safety and egress should be considered in all cases.

c. High Temperature Water Equipment Rooms

High temperature water equipment rooms are to be ventilated with an exhaust system. An emergency high temperature water shut-off switch will be required outside of the HTW equipment room near the door. See GG. (3) k. in 3.8 HVAC.

ADDED:

O. University of Utah HVAC Design Criteria

a. Outside Design Temperatures

Outside design temperatures shall be 0 degrees F (-18 degrees C) winter heating and 97\textsubscript{WB}/62\textsubscript{WB} degrees F (36/18 degrees C) for summer cooling. Cooling tower design shall be based on 70 degrees F (21 degrees C) wet bulb.

b. Site Elevation

Equipment selections shall account for a site elevation of 4,750 feet (1,500 meters) above sea level, and equipment schedules shall indicate either "sea level" or "site elevation" capacity.

c. Indoor Design Temperatures

Indoor design temperatures shall be 72 degrees F for heating and 75 degrees F for cooling, unless superseded by the University Project Manager.
d. Ventilation Requirements

Ventilation air shall conform to the latest ASHRAE Standard 62 for Natural and Mechanical Ventilation. Air intakes shall be located so as not to introduce foul air (i.e. near cooling towers, exhausts, vehicle emissions, garbage dumpsters, etc.).

e. Heating Systems

1) The design for space heating will generally require the use of the University's high temperature hot water system (3.8 HVAC), or a secondary central steam system. In buildings located a distance from the high temperature water distribution lines, or which are unsuitable for connection to the system, heating may be provided by boilers (or hot air furnaces in small buildings). The primary fuel for such shall be natural gas. Boiler sizes are limited by current pollution regulations.

2) The Campus Master Plan intends that new heating systems shall be hot water heat exchangers utilizing high temperature water from the campus HTW distribution system. Steam systems shall generally not be generated by use of the HTW system. Low temperature (180° F) hot water heating systems are the preferred medium for heating all new or remodeled buildings. Where steam generators are approved, review the requirements described in 3.8 HVAC regarding HTW steam heat exchangers.

3) Where existing steam systems must be extended or revised, verify the existing demand and generation capacity before adding any steam equipment to the system. The A/E shall detail the locations for each connection point for the Contractor.

4) Since the University’s sanitary sewer system feeds directly into the Salt Lake City system, the A/E shall comply with Salt Lake City standards and requirements for pre-cooling hot condensate waste before it enters the University sanitary sewer system.

f. Humidification Systems

Humidification systems shall be provided which do not use corrosion inhibiting chemicals commonly found in central steam systems. Humidifier equipment shall only discharge potable water or potable steam.

g. Back-Up Systems

Back-up systems must be provided for projects where critical research, experiments, etc., require un-interruptible heating. Coordinate with the
University Project Manager for decisions pertaining to standby fuels or back-up systems.

h. Extensions / Modifications of Existing Systems

Building heating and cooling systems which are to be extended or modified will require analysis of the existing mechanical systems to determine the capacity available for expansion.

i. Common Piping for Hot / Chilled Water

Two pipe or three pipe systems utilizing the same piping for hot water and chilled water shall not be used.

j. Glycol Systems

Glycol systems shall be contained within mechanical rooms (except fire protection piping). Piping throughout the building shall contain no glycol. Any remote systems requiring glycol, service water shall be routed to the location with a plate and frame heat exchanger in a mechanical space with glycol introduced at that point.

k. By-Pass Feeders

Five gallon by-pass feeders shall be designed and shown on drawings at each secondary heating system, each chilled water cooling system, and each condenser water system.

l. Energy Conservation Designs

Systems shall incorporate energy conservation designs such as variable air volume distribution systems (VAV) and variable frequency drives (VFD) for fans and pumps.

m. VFD By-Pass Switch

Variable frequency drive systems shall be supplied with a by-pass switch allowing full speed operation upon VFD failure (see 3.5 Electrical).

n. VFD Fan System Pressure Relief Door

Fan systems served by VFD's shall have a pressure relief door installed in the supply main, set to relieve duct over-pressure when the VFD fails to full speed, and thereby protecting the duct seams downstream of the fan. The approved damper is Ruskin Model PRD18 Pressure Relief Door with a 12 gauge frame and door, and polyurethane foam seals around the door.
perimeter. Other approved manufacturers are Greenheck Fan Corporation and AJ Manufacturing. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid. Specific products furnished and installed into the project must be equal or superior to the specified Ruskin relief door.

o. Specifying VFDs

Variable frequency drive systems (VFD) shall be specified in the Electrical section of the design documents. University requirements for VFD is provided in 3.5 Electrical.

p. Roof-Top Units Require Approval

The use of rooftop units is to be approved in writing by Facilities Management through the University Project Manager prior to design. Approval will be based on unit visibility, maintenance access, noise (both interior and environmental), roof structure, building zone needs, and alternate designs.

q. Design Air Distribution Systems for Cooling Capacity

Air distribution systems shall provide adequate air quantities for cooling even though cooling may not initially be provided. Air shall be introduced into each space at less than 50 fpm in the occupied zone, and at RC values which do not exceed current ASHRAE limits found in ASHRAE Systems, Sound and Vibration Control.

r. Dual Duct Constant Volume Systems

Where constant volume dual duct systems are specified, require true constant volume controls on a single constant volume supply box (twin VAV boxes will not be approved).

s. No Fan Powered VAV Boxes

Fan powered VAV boxes are not to be used.

t. Access for Maintenance

1) Provide adequate maintenance clearance around all mechanical equipment, piping, valves, fittings, and accessory items. Also provide adequate clearances to allow for removal and re-installation of coils, tubes, tanks, etc. Provide unions and valves to permit disassembly of piping and equipment.
2) Provide adequate maintenance access to mechanical equipment. Access to each equipment item must be in accordance with current OSHA regulations. For elevated equipment design an appropriate platform for convenience and safety. If an access platform is not practical, coordinate with Facilities Management through the University Project Manager for an approved design of a lifting point or other means of maintenance access.

3) Pumps 3 HP and above, which are elevated overhead such that the distance from floor to top of pump/motor assembly is 8’ or higher, shall have an appropriate access platform with permanent ladders or steps designed and shown on the design drawings.

4) Equipment which requires an overhead access hatch at 6’ or more above the floor shall have an access platform with permanent ladders or steps designed and shown on the design drawings.

5) Air handlers with elevated access doors such that the distance from floor to bottom of the door is 3’ or higher shall have an appropriate access platform with permanent ladders or steps designed and shown on the design drawings.

6) Fans with a motors 3 HP and above, which are elevated such that the distance from floor to any maintenance point (access door, belt, motor, etc.) is 6’ or higher, shall have an appropriate access platform with permanent ladders or steps designed and shown on the design drawings.

u. Hydronic Flow Control Balancing Devices

Flow control devices shall be provided at all major terminal devices such as coils, converters, etc. Flow control devices are to have marked memory stop and handles are to be removed after balancing. Additional isolation valves are to be provided to prevent the use of flow control devices as shut-off valves. Pumps with variable speed drives shall not have flow control devices installed on them.

v. Refrigerants

Refrigerant systems are to be limited to HCFC-22 (only for reciprocating systems) or HCFC-123 and HFC-134a (only for centrifugal systems). Note that HCFC-22 screw machines are not to be considered unless directed by Campus Utility Services through Facilities Management and the University Project Manager. All applicable health and safety requirements for specified refrigerants shall be included in the design. These requirements shall include,
but not be limited to, ASHRAE safety items noted in Standards 34 and 35, and NIOSH Workplace Guidelines.

w. Replacing Chillers

For chiller replacements, the extent of response to prevailing code issues will be determined on a “case by case” basis. Project designers will be expected to meet with the University Project Manager for a review of code issues which may affect the replacement of chiller equipment. The University is designated as the “Building Authority” and, as such, will determine the extent of building/systems modifications required for each replacement project.

x. Refrigerant Relief Piping

Evaporator coils located near heating coils; and, pressure relief devices and fusible plugs shall have relief piping, sized and routed per the requirements of ASHRAE Standard 15 "Safety Code for Mechanical Refrigeration".

y. Mechanical Rooms as Return Air Plenums

Mechanical rooms containing refrigerant compressors, coils, tanks, piping, etc., shall not be used as return air plenums.

z. Campus West Side Chiller Loop

1) New or replacement cooling coils intended for areas served by the University's central chiller loop on the west side of the campus shall be sized for low flow and high temperature rise in the coils.

   a) Design the coils for multiple rows and 60 degree F return water temperature (16 degree rise), even if the actual use and intended operation may only require an 8 degree F rise. Computer coil selections shall certify coil operation at both conditions (8 degree rise and 16 degree rise).

   b) Size supporting piping for 8 degrees F temperature rise, effectively providing adequate size for the higher GPM.

   c) Design the coil controls with tight shut-off two-way valves which connect the coil to the central loop. Three-way coil valves will not be approved.

aa. Power for Controls

1) The electrical contractor shall be directed to have breaker circuits designated specifically for control power functions.
2) Provide an emergency power circuit for the control panels and individual room controls where emergency power generators are available.

3) The A/E should coordinate to provide control transformers supplying 24V AC control power for zone controls. Install transformers as needed to meet the requirements of the individual controllers.

bb. Motors for HVAC Service

1) Proper protection and control for all motors must be provided. Starters for 3 phase motors shall have overloads on all three phases. Provide fused protection utilizing properly sized dual element fuses. Starter control circuits must have properly sized fuse protection. Soft starting systems shall be provided for motors 25 HP and larger. Starting characteristics of motors shall be reviewed with Facilities Management (especially Campus Utility Services) through the University Project Manager during design.

2) All motors 1 HP and larger shall be specified as follows:
   a) Class B motor temperature rise
   b) Class H insulation
   c) Designed and warranted for inverter duty use, (Nema MG-31 certified) for VFD motors
   d) Premium efficiency rated
   e) 1.15 Service factor

c. HVAC Pumps

1) Pumps specified for University projects are to include the following:
   a) Base mounted pumps shall be specified to have bases grouted.
   b) All pumps shall be selected to operate at the Best Efficiency Point.
   c) Piping design at pumping systems shall be specified and shown to follow pump industry guidelines for pump inlet conditions. A minimum of 5 pipe diameters of straight pipe will be required, or appropriately designed suction diffusers will be used.
**ADDED – UNIVERSITY OF UTAH REQUIREMENTS:**

P. Compliance Verification in Operation and Maintenance Manuals

(1) ASME

American Society of Mechanical Engineers (ASME) Stamp shall be required on all items required by code or specified to conform to the ASME Code, and certificates will be included in the O&M manuals.

(2) Form U-1

Form U-1, the manufacturers’ data report for pressure vessels, is to be included in the operation and maintenance manuals. National Board Register (NBR) numbers shall be provided where required by code, and included in the manuals.

(3) UL or ETL

Underwriters Laboratories (UL) or equivalent ETL labels shall be applied to manufactured equipment represented by a UL classification and/or listing. Included certification in the O&M manuals.

Q. Review of Existing Systems

(1) Campus Site Resource Documents

The University Project Manager will provide resource documents such as building and site plans, when available. Contacts with University shops will be coordinated by the University Project Manager.

(2) Pre-Design Site Inspection / Research

The design consultant is responsible for its design. If insufficient resource material is available, the A/E will be required to research existing conditions at the project site and generate the data required for a complete and workable design.

(3) Existing Systems to Original Working Capacities

Modifications or extensions to an existing system require a thorough analysis and understanding of the impact on the original system. The A/E shall insure that its design includes adjustments to the original building systems (including "as-built" drawings with modified performance values shown) to return all adjacent systems to original working capacities. If the original condition cannot be determined, then the A/E must include the services of balancing technicians in his fee to determine the actual status of the existing systems.
Design Requirements

4. Energy Management Buildings

Many buildings on campus have been retrofitted with energy efficient equipment as part of an energy management plan. When remodeling any building, the energy efficiency and operating characteristics of existing and new equipment must not be diminished by the building revisions.

R. Drawings and Specifications

1. Scale

Contract drawings shall be drawn to scale no smaller than 1/8" = 1'-0" unless a smaller scale is specifically approved by Facilities Management through the University Project Manager.

2. Presentation

The drawing presentation is to be organized and sufficiently detailed to fully illustrate the work to be done.

3. Equipment Rooms / Congested Areas

Equipment rooms, fan rooms, chiller rooms or other congested areas shall be detailed fully with plans and sections showing all equipment. These drawings shall be no smaller than 1/4" = 1'-0".

4. Equipment Details

Provide details on drawings for equipment showing piping connections, clearance routing, appurtenances, supports, service clearance, and orientation.

5. Schedule of Building’s Rated Capacities

Each project shall include a schedule on one of the drawing sheets which lists the building's rated capacities for heating, cooling, ventilating and electrical services. Additionally, the schedule shall include the estimated excess capacity of each service for each zone to allow end users to determine the extent of additional load they can place within each zone.

6. Schedule of Equipment Capacity Requirements

Equipment capacity requirements shall be placed in appropriate schedules on the drawings, noted with catalog sea level performance or site performance at 4,750 feet elevation above sea level.

7. Schedule of Hydronic Balancing Valves
Balancing valves for hydronic system balance shall be scheduled on the drawings showing valve flow requirements, $C_v$ values, valve size, and maximum pressure drop at the balanced setting.

(8) Schedule of Plumbing Fixtures

A plumbing fixture schedules shall be provided on plumbing plans.

(9) Legend for Valves and Piping

A valve and piping legend shall be provided on plumbing plans.

(10) Legend for HVAC

An HVAC legend shall be provided on mechanical plans.

(11) Sequence of Operations

Sequence of operations for all equipment shall be located both on the drawings and in the specifications.

S. Submittals and Shop Drawings

(1) Six Copies, Marked

In the bidding documents, the Contractor shall be required to furnish six copies of marked catalog data and/or shop drawings for each item of material and equipment to be used on the project prior to commencing the work. Five copies are to be submitted to the A/E and one to the University Project Manager.

(2) One Copy, Concurrent Review

One copy of the submittals and shop drawings shall be delivered to the University Project Manager for concurrent review during the same time the A/E performs its review. Discrepancies and recommendations identified by Facilities Management shall be sent to the A/E.

(3) Submittal Approval

Submittal approval shall not relieve the Contractor of his responsibility to provide material and equipment which meet or exceed specified performance or duty and fit within the space allotted.

T. Equipment Approval

(1) Manufacturers Subject to University Approval
Manufacturers named in bidding documents are to be reviewed by the University Project Manager and approved by Facilities Management (especially Facility Operations) prior to bid.

(2) Requests for Prior Approval

a. In the contract documents, the Contractor shall be required to submit a request for prior approval on substituted material and equipment prior to the bid per the DFCM / University of Utah General Conditions.

1) The A/E shall be responsible for a complete review of requests for prior approval with Facilities Management through the University Project Manager. The University Project Manager will coordinate with Facility Operations and advise the A/E of approval/disapproval status of the items submitted.

2) Prior approval is to be issued for manufacturer's name only. If used in the bid, the substituted item must meet all conditions of the specifications and drawings. Any required adjustment costs for difference in size or arrangement must be borne by the Contractor or A/E, not the University.

(3) Unapproved Material or Equipment

The A/E will be liable for costs to remove or replace unapproved material or equipment installed by direction or approval of the A/E.

U. Factory Witness Tests of Equipment

The University Project Manager shall determine the need for a factory witness test of major equipment items.

V. Coordination of Drawings

The mechanical engineer shall be responsible for coordinating the mechanical and plumbing plans with all other disciplines. Claims by the Contractor resulting from lack of coordination shall be administered by the University with additional project costs to be charged to the A/E.

W. Layout

(1) Service Clearance for Equipment / Valves

a. Adequate service clearance shall be provided around all equipment.

b. All equipment including valves shall be installed so as to permit disassembly for maintenance purposes.
X. Integrity of Fire and Smoke Rated Partitions

The University has experienced a problem in many buildings where projects resulted in untreated penetrations of fire and smoke rated partitions. The designer is referred to 3.3 Architectural for instructions.

Y. Start-Up Strainers

When start-up strainers are replaced with specified strainers prior to test and balance, require the Contractor to place each removed start-up strainer near the pump or Y-strainer it served for inspection by the Facility Operations HVAC Shop Supervisor.

Z. Equipment, Pipe and Duct Identification

All plumbing, heating, air conditioning, automatic temperature control equipment (excluding thermostats and relays), and distribution systems shall be labeled. Electrical switches and starters for mechanical equipment shall also be labeled. See Section 15051 herein and 3.5 Electrical.

AA. Utility Interruptions and Digging Permits

(1) Digging Permits

a. The University has an extensive system of campus utilities into which most projects are connected. Other, non-University, entities also have a number of utility lines on campus.

b. As the project designer, be aware that a University Digging Permit is required before any digging may occur on campus. Contractors are instructed to request digging permits through the University Project Manager in accordance with the Supplemental General Conditions for University of Utah Projects. The request should include drawing(s) showing the contract limit lines and identifying the site work to be done.

c. The University permit will identify utilities known to exist within the affected area. The University will also mark the location of utilities at the site. During excavation, the equipment operator should have a copy of the Permit in his immediate possession for guidance and to document approval of the digging.

d. In addition to obtaining a University Digging Permit, the Contractor or other entity must contact Blue Stakes and other utilities for marking of underground utilities.

e. Designers should also be aware that there may be utilities in the ground of which the University has no record. Caution contractors that any digging, even with a permit, should be done with care.
(2) Utility Shutdown Permit

   a. The University has an extensive system of campus utilities into which most projects are connected. A Request for Shutdown is required whenever a shutdown is required including any time connections are made to any utility such as electric power and communication lines; gas, water, distilled water, steam and high-temperature water lines; and sanitary sewers or storm sewers. Utility Shutdown Request procedures are provided in the Supplemental General Conditions for University of Utah Projects. Encourage contractors to discuss shutdown needs with the University Project Manager well in advance. In many cases a utility shutdown is more than a simple inconvenience as many research projects are highly dependent on maintaining equipment functionality and/or climate control.

(3) Approval Required before Proceeding

Digging or shut down requests do not constitute an automatic approval by the University. The Contractor is not to proceed until approval is received from the University Project Manager assigned to the project. No fee is assessed for the permits.

BB. "As-Built" Drawings

(1) Due within 60 Days

Based upon information furnished by the Contractor, and room numbers provided by the University, prepare and furnish to the University within 60 days of the completion of the project, a complete set of record "as-built" drawings. The specific requirements for the submittal are provided in Design Process, 4.4 Design Stages, J. Stage 7 Construction, #4.

(2) Buried Utilities

   a. Buried utilities, including piping, conduit, and duct, shall be shown on the "as-built" drawings. The location of each item exposed during construction shall be accurately identified and include the following:

      1) Dimensions from prominent (permanent) landmarks
      2) The specific material buried
      3) The size of pipe, conduit, or duct buried
      4) Depth of elevation of each leg of the buried route

CC. Testing and Balancing of Systems
On larger projects, testing and balancing work may contracted separately by the University. This option is to be reviewed and approved by the University Project Manager during design. If this option is found to be in the best interest of the University, and if approved by the University Project Manager, a) include a separate line item cost in the project’s construction cost estimate; b) Facilities Management would then bid the testing and balancing later during construction; and, c) the A/E will be expected to include management and oversight of the third party contractor’s work in the A/E’s fee. If this option is accepted, the specifications must include instructions to the Contractor to fully cooperate with this third party contractor.

DD. System Commissioning

The A/E shall cooperate fully with the commissioning agent during all phases of the project from inception of design through final seasonal testing. Support shall consist of but not be limited to the following items:

1. Provide technical material and project documentation to the commissioning agent
2. Respond to project issues in the commissioning issues log on a timely basis
3. Participate in commissioning meetings and inspections
4. Collaborate with the commissioning agent and contractor to resolve commissioning findings

EE. Utility Meters

(1) All Buildings Shall Have Meters

a. The University requires all buildings to have meters installed for the following utilities as applicable:

1) Domestic water (fire lines into buildings need not be metered)
2) Irrigation water
3) Natural gas
4) High temperature water (HTW)
5) Heating water (HW)
6) Chilled water (CHW)
7) Electricity
8) Steam

(2) Meter Specifications and Drawing Location
a. A meter is to be specified and shown on the drawings for installation wherever the corresponding utility enters the building.

1) All water, gas and steam meters are required to have the capability of communication with the University’s automated Energy Information system using a digital contact closure pulse, a 4-20 milliamp signal or Modbus RTU protocol without the need for a purchase of an upgrade after installation.

2) All high temperature water, chilled water, heating, and electric meters are required to have the capability of communication with the University’s automated Energy Information system using only Modbus RTU protocol without the need for a purchase of an upgrade after installation.

3) All exterior under slab meter communication wiring shall be sealed in water tight conduit.

4) University preferences for Metering heating and high temperature water serving buildings shall be as follows:

   (a) V-cone differential pressure type meter on the primary side of the heat exchanger.

   (b) If metering on the primary side of the heat exchanger is not feasible, then all secondary utilities from the heat exchanger shall be metered and totalized.

   (c) If all secondary metering of utilities are not feasible, then ultrasonic type shall be installed on primary side of the heat exchanger

5) Documentation pertaining to each installed meter, including but not limited to design drawings and specifications, shall be a required responsibility of the Contractor. Both hard copies and digital copies of the Meter documents are to be approved by the designer and University Project Manager, and delivered to the University’s Utility Analyst as well as to the shop supervisor of the shop which manages the corresponding utility.

(3) Domestic Water Meters
a. Specify and show on the drawings a water meter location inside the building in a well-lit and easily accessible area.

b. Specify a by-pass system which will allow routine maintenance of all meters installed in-line.

c. Specify meter installation in accordance with manufacturer’s specifications (i.e., the distance of the meter from piping elbows, T’s, or valves in the water line).

d. An inline strainer is required for lines 3” and larger for meters installed in-line.

e. Specify meter display to be in cubic feet, 10’s of cubic feet, or 100’s of cubic feet as applicable to the designed use of the facility.

(4) Irrigation Water Meters

Use the same specification provided for domestic water meters. The meter may be installed inside the building or outside as close to the building as possible. If installed outside, the display for remote reading must be located inside the building. Route the communication lines which connect the sensor to the display through conduit.

(5) Natural Gas Meters

a. The natural gas meter should meet all Questar requirements even when applied to the University’s gas system. The gas meter should be installed outside the building at an easily accessible and well vented area away from any building air-intake.

b. Specify a by-pass system for routine maintenance on the meter. Design Requirements – 3.8 HVAC – University of Utah Supplement

c. The meter shall have at least 99% accuracy.

d. The meter shall be utility grade

e. Pressure test ports are required to be installed after any regulators

f. Require the Contractor to deliver meter submittals which include load sizing calculations. Inlet pressure, outlet pressure, pipe size, zone load capabilities, building maximum load, and average load calculations must be submitted for review and approval.

g. If the maximum input for the average load capability is found to be 1000 MBH or higher, then a roto, or rotary type meter is to be installed with an in-line strainer included.

h. Meters shall display no less than 100’s of cubic feet.
i. Terminate communication wiring inside the building. Route all communication lines connecting the sensor to the display through conduit.

(6) HTW Meters
High temperature water (HTW) meters are described in GG. below (3.8 HVAC).

(7) Chilled Water and Heating Water Meters
a. The University requires metering of CHW and HW
b. Building meters shall meter in ton-hours of refrigeration (ton-hr) and British Thermal Units (BTUs)
c. Meters shall provide instantaneous information via on-screen local displays as well as integrate into the University’s Energy Server.
d. Meters shall have the ability to provide instantaneous energy consumption in tons and Btu/h.
e. All CHW/HW meters shall guarantee the following performance levels at all operating (pressure and temperature) scenarios:
   1) Accuracy: ±2 percent
   2) Repeatability: ±1 percent.
   3) Pressure drop
   4) Flow sensor turndown: No less than 15 to 1.
   5) Volumetric flow rate shall be measured in gallons per minutes (gpm).
f. Meter and BTU computer shall be capable of communicating with the University’s building automation system and Energy Information System. The following data shall be provided:
   1) Ton-hrs
   2) Tons
   3) Fluid temperatures
   4) Flow (GPM)
   5) BTU
   6) Btu/h
g. Primary Flow Sensor

1) Flow element shall be an insertion-type magnetic-type flow element.

2) RTDs shall be provided to measure supply and return temperature at building interface piping or at building heat exchangers.
   (a) RTDs shall be 316 stainless steel.

3) Flow sensor size shall match installed pipe size.

h. Temperature Sensors and Transmitters

1) Spring-loaded dual element 100 ohm platinum resistance temperature detector (RTD) temperature sensor.
   (a) RTD accuracy: ±0.5 percent at 32 °F.
   (b) Temperature range: 40 °F to 400 °F.

2) Install RTDs with 316 stainless steel thermo-well.

(8) Electric Meters

Electric meters are described in 3.5 Electrical.

(9) Steam Meters

a. The type of meter to be used is dependent on where the steam is produced:

1) University Steam Plant
   A water meter with the ability to withstand 230 deg F temperature is to be installed in the steam condensate return line after the condensate return pump.

2) Building Gas Boiler
   A gas meter should be installed in the gas line feeding the boiler per University gas meter specs. The meter shall display no less than 100's of cubic feet.

3) Building Electric Boiler
   A power meter should be installed for the boiler per University electricity specs.

4) Building HTW Converter
If steam is produced by a HTW converter then it need not be metered directly. The energy usage can be obtained by the HTW Btu meter to the converter.

5) Other Applications

Obtain direction from the University Project Manager who will include the University utility analyst and the University staff mechanical engineer.

FF. The Guide Specification for Mechanical Systems

15050 Basic Materials and Methods

15051 Identification for HVAC Piping and Equipment

a. Equipment labels shall be black face Formica with white engraved lettering 3/16" high or larger, and shall be attached securely.

b. Equipment nameplates shall include the following minimum information:

1) Plan identification

2) Capacity specified at designed operating conditions

3) Actual capacity as balanced at site operating conditions

4) Area or zone served

5) Non-potable, industrial, DI/RO water outlets and faucets shall be labeled with 1” high white lettering with black background and read “NON-POTABLE WATER DO NOT DRINK HERE.”

c. All valves, regardless of size, shall have brass tags at least 1” by 3” in size and 0.051 inches thick. Lettering on the tag shall be engraved at least 1/8 inch high. Each valve on the drawing shall be identified separately, and valve tags shall match the drawing identification.

d. Valve tags shall be connected to valve stems by steel rings and include the following minimum information:

1) Plan identification

2) Normal position

3) Duty
4) Area served

5) Valve type

6) Additionally, heating water valves, steam valves, and all valves located in the secondary (low pressure) side of HTW heat exchangers shall include the manufacturer, size, grade, and pressure-temperature service rating.

e. All accessible duct and piping shall be color coded and identified with wording and arrows every 50 feet, at each riser, at each junction, at each access door, and where required to easily identify the medium transported.

f. Duct and piping systems shall be identified by:

1) Background color

2) Lettering color, and

3) Flow direction arrow

h. Duct and piping background color shall be applied to all exposed piping (either over bare pipe or the insulation) in mechanical rooms. Identifying lettering and arrows shall then be added as indicated above, and as necessary to be visible from anywhere in the room.

1) For duct in mechanical rooms, chases, and other exposed areas, as well as piping routed in other exposed areas such as chases, background color shall be applied in a two foot (2'-0") wide band with identifying lettering and a flow direction arrow.

2) Background and lettering shall be semi-gloss enamel paint by DeVoe (Mirrolac), Pratt and Lambert, Glidden, Rust-Oleum, Sherwin Williams or prior approved equal. The colors specified herein shall not vary.

<table>
<thead>
<tr>
<th>Color</th>
<th>Sherwin Williams</th>
<th>Pratt &amp; Lambert</th>
<th>Rust-Oleum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>SW4081 Safety Red</td>
<td>1007 Vibrant Red</td>
<td>964 Federal Safety Red</td>
</tr>
<tr>
<td>Orange</td>
<td>SW4083 Safety Orange</td>
<td>S4507 Safety Orange</td>
<td>956 Federal Safety Orange</td>
</tr>
<tr>
<td>Yellow</td>
<td>SW4084 Safety Yellow</td>
<td>1732 Spectrum Yellow</td>
<td>944 Federal Safety Yellow</td>
</tr>
<tr>
<td>Color</td>
<td>SW/Color</td>
<td>Background Color</td>
<td>Identifying Lettering</td>
</tr>
<tr>
<td>-----------------</td>
<td>-----------------</td>
<td>------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>Green</td>
<td>SW4085 Safety Green</td>
<td>Safety Green</td>
<td>933 Federal Safety Green</td>
</tr>
<tr>
<td>Blue</td>
<td>SW4086 Safety Blue</td>
<td>1228 Anchors Aweigh</td>
<td>925 Federal Safety Blue</td>
</tr>
<tr>
<td>Purple</td>
<td>SW4080 Plum</td>
<td>Bright Medium</td>
<td>Bright Medium</td>
</tr>
<tr>
<td>Silver (Aluminum)</td>
<td>B59S11 Silver Brite</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Black</td>
<td>Black</td>
<td>Effecto Black</td>
<td>634 Black</td>
</tr>
<tr>
<td>White</td>
<td>White</td>
<td>Effecto White</td>
<td>2766 White</td>
</tr>
<tr>
<td>Brown</td>
<td>SW4001 Bolt Brown</td>
<td>2278 Char Brown</td>
<td>--</td>
</tr>
</tbody>
</table>

University experience has shown that Mirrolac works well in this application, being durable with excellent coverage.

3) Identifying lettering shall be painted or stenciled on duct or pipe over the background color. Self-adhesive or glue-on type labels are acceptable. Letters shall be 2” high for duct and larger piping 3” or more, 1” high for 1-1/4” to 2-1/2” pipe, and 1/2” high for 1” pipe and smaller.

4) Arrows to indicate direction of flow shall be painted over the background color in the same color as the lettering. The arrow shall point away from the lettering. On duct and large piping 3” or more in diameter, the "shaft" of the arrow shall be 2” long and 1” wide. Smaller piping, 2-1/2” or less, shall have arrows with a shaft 1/2” wide and 2” long. Use a double-headed arrow if the flow can be in either direction.

5) Piping and duct shall be identified with the following colors:

<table>
<thead>
<tr>
<th>Medium in Pipe or Duct</th>
<th>Background Color</th>
<th>Identifying Lettering</th>
<th>Lettering Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressed Air</td>
<td></td>
<td></td>
<td>Black</td>
</tr>
<tr>
<td>Lab Service</td>
<td>Silver</td>
<td>COMPRESSED AIR</td>
<td>Black</td>
</tr>
<tr>
<td>Automatic Controls</td>
<td>Silver</td>
<td>CONTROL AIR</td>
<td>Black</td>
</tr>
</tbody>
</table>

Compressed Gas
<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen</td>
<td>Brown</td>
<td>HYDROGEN</td>
<td>Black</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>Brown</td>
<td>NATURAL GAS</td>
<td>Yellow</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>Silver</td>
<td>NITROGEN</td>
<td>Black</td>
</tr>
<tr>
<td>Oxygen</td>
<td>Brown</td>
<td>OXYGEN</td>
<td>Black</td>
</tr>
</tbody>
</table>

**Refrigerant**

| Freon                   | Black| FREON            | White             |

**Steam – Low Pressure (0 – 15 PSIG)** (*Note: No bands for Low Pressure*)

| Steam – Low Pressure     | Orange| LOW-PRESS. STEAM | Black             |

**Steam – High Pressure (over 15 PSIG)** (*Note: Two black bands required for High Pressure*)

| Steam – High Pressure    | Orange| HI-PRESS. STEAM | White             |

**Vacuum**

<p>| Vacuum                  | Silver| VACUUM          | Black             |</p>
<table>
<thead>
<tr>
<th>Medium in Pipe or Duct</th>
<th>Background Color</th>
<th>Identifying Lettering</th>
<th>Lettering Color</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Note:</strong> Directional arrows are required on HTW Piping.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Water</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boiler Blow-Off</td>
<td>Yellow</td>
<td>BLOW-OFF WATER</td>
<td>Black</td>
</tr>
<tr>
<td>Chilled Water Supply</td>
<td>Blue</td>
<td>CHILLED WATER SUPPLY</td>
<td>White</td>
</tr>
<tr>
<td>Chilled Water Return</td>
<td>Blue</td>
<td>CHILLED WATER RETURN</td>
<td>White</td>
</tr>
<tr>
<td>Condenser Water Supply</td>
<td>Blue</td>
<td>COOLING WATER SUPPLY</td>
<td>White</td>
</tr>
<tr>
<td>Condenser Water Return</td>
<td>Blue</td>
<td>COOLING WATER RETURN</td>
<td>Black</td>
</tr>
<tr>
<td>Condensate Return</td>
<td>Orange</td>
<td>CONDENSATE RETURN</td>
<td>Black</td>
</tr>
<tr>
<td>(Note: One white band is required for Steam Condensate Return.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cold Water (Potable)</td>
<td>Green</td>
<td>DOMESTIC COLD WATER</td>
<td>White</td>
</tr>
<tr>
<td>Non Potable</td>
<td>Green</td>
<td>UNSAFE WATER</td>
<td>Black</td>
</tr>
<tr>
<td>Domestic Hot Water (Potable)</td>
<td>Green</td>
<td>DOMESTIC HOT WATER</td>
<td>White</td>
</tr>
<tr>
<td>Domestic Hot Water Return</td>
<td>Green</td>
<td>DOMESTIC HOT WATER RETURN</td>
<td>White</td>
</tr>
<tr>
<td>Fire Protection Water</td>
<td>Red</td>
<td>FIRE PROTECTION</td>
<td>White</td>
</tr>
<tr>
<td>Glycol Solution</td>
<td>Purple</td>
<td>GLYCOL SOLUTION</td>
<td>White</td>
</tr>
<tr>
<td>High Temperature Supply</td>
<td>Yellow**</td>
<td>HIGH TEMPERATURE WATER SUPPLY</td>
<td>Black</td>
</tr>
<tr>
<td>High Temperature Return</td>
<td>Yellow**</td>
<td>HIGH TEMPERATURE WATER RETURN</td>
<td>Black</td>
</tr>
<tr>
<td>Secondary Heating Water Supply</td>
<td>Brown</td>
<td>HEATING WATER SUPPLY</td>
<td>White</td>
</tr>
<tr>
<td>Secondary Heating Water Return</td>
<td>Brown</td>
<td>HEATING WATER RETURN</td>
<td>White</td>
</tr>
<tr>
<td>Deionized</td>
<td>Green</td>
<td>DEIONIZED WATER</td>
<td>White</td>
</tr>
<tr>
<td>Distilled Water</td>
<td>Green</td>
<td>DISTILLED WATER</td>
<td>White</td>
</tr>
<tr>
<td>Reverse Osmosis</td>
<td>Green</td>
<td>REV. OSMOSIS WATER</td>
<td>White</td>
</tr>
<tr>
<td>Softened</td>
<td>Green</td>
<td>SOFTENED WATER</td>
<td>Black</td>
</tr>
<tr>
<td>Roof Drain</td>
<td>Green</td>
<td>ROOF DRAIN</td>
<td>White</td>
</tr>
<tr>
<td>System Make-Up</td>
<td>Green</td>
<td>MAKE-UP WATER</td>
<td>White</td>
</tr>
<tr>
<td>Treated Water</td>
<td>Green</td>
<td>TREATED WATER</td>
<td>Black</td>
</tr>
</tbody>
</table>
Design Requirements – 3.8 HVAC – University of Utah Supplement

<table>
<thead>
<tr>
<th>Medium in Pipe or Duct</th>
<th>Background Color</th>
<th>Identifying Lettering</th>
<th>Letter Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acid-Resistant</td>
<td>(unpainted)</td>
<td>ACID WASTE</td>
<td>White</td>
</tr>
<tr>
<td>Building Waste</td>
<td>(unpainted) or Black</td>
<td>WASTE</td>
<td>White</td>
</tr>
<tr>
<td>Polluted Water</td>
<td>Black</td>
<td>POLLUTED</td>
<td>Yellow</td>
</tr>
<tr>
<td>All Equipment or Piping Located Outside Buildings</td>
<td>Brown</td>
<td>- -</td>
<td>- -</td>
</tr>
</tbody>
</table>

**15060 Pipe and Pipe Fittings**

**a. General**

1) All piping and fittings shall be of domestic manufacture unless approved in advance by Facilities Management through the University Project Manager.

2) Fittings shall be seamless only.

3) All piping in mechanical rooms shall be exposed. Do not conceal or imbed pipe in walls, floors, or other structures.

4) Changes in direction and changes in pipe size shall be accomplished with manufactured pipe fittings.

5) Anchor and support piping with allowance for free expansion and movement without causing damage to piping, equipment, or the building. Pipe expansion and contraction shall be controlled by expansion loops. No mechanical expansion joints will be allowed in any system.

6) All pipe shall be installed parallel to walls and ceilings. The installation shall present a uniform appearance, and long lengths of pipe shall be grouped together.

7) Piping in the mechanical room shall be arranged to maintain adequate head room and clear passageways.
8) Provide unions or flanges at connections to equipment, valves, etc., as shown to facilitate maintenance.

9) Install piping full size through shutoff valves, gas cocks, balancing valves, etc.

10) Where changes in the pipe size are required at equipment connections, change the pipe size within a maximum length of three pipe size diameters of the final connection. Where changes in pipe sizes occur in horizontal straight lengths of pipe, install eccentric reducers with the straight side on top for water, and the straight side on the bottom for steam piping.

11) Pull Tees in copper pipe (formed by pulling out a section of pipe to form a connection point) are not acceptable.

b. All piping shall be installed to insure proper drainage.

1) Steam mains and condensate mains shall be pitched down in the direction of flow, a minimum of 1" per 20 feet.

2) Steam branch lines to equipment shall have a slope at a minimum of 1" per 20 feet back towards the main.

3) Vacuum and compressed air piping shall pitch down in the direction of flow a minimum of 1" per 40 feet.

4) Domestic water, chilled water, heating water, and condenser water piping shall slope down a minimum of 1" per 40 feet towards the drains.

5) Dry standpipes shall pitch down to the fire department connections at a minimum of 1" per 40 feet.

6) Refrigerant suction lines shall slope a minimum of 1/2" per 10 feet. Slope the pipe in the direction of gas flow (discharge line sloping to the condenser, and suction line sloping towards the compressor).

7) Soil, waste, and vent lines shall slope in accordance with the requirements of State adopted codes.

8) Roof drain lines shall slope down a minimum of 1/4" per foot on all University projects.

c. Welding Certification
1) Each welder shall have passed a qualification test in accordance with ASME Boiler and Pressure Vessel Code, ASME, and ANSI within the past 6 months. The test shall be in accordance with the ASME Boiler and Pressure Vessel Code, Section IX, "Welding Qualifications", ASME Section VIII, and ANSI 313.

2) The test report shall certify that the welder is qualified to weld the material to be used at the job site.

3) The Contractor shall submit three copies of each welder's qualification test report to the University Project Manager for approval prior to commencing the work. No welder shall be used on the project until so certified.

d. Welding

1) Electric metallic arc process shall be used on all welding. End preparations shall conform to ANSI and ASTM Standards.

2) Use only one welder for each joint.

3) Weld slip-on flanges on both front and back sides.

4) Thermometer wells and test wells shall be back welded.

e. Piping Tests

1) Prior notification of at least 10 days will be required for an intent to perform hydrostatic testing. The Contractor's notice shall be reviewed and approved by the University Project Manager prior to commencement of the required testing.

2) Piping tests shall be performed in accordance with the ANSI Code for Pressure Piping.

3) Piping tests shall be completed prior to painting, insulating, or covering the pipe.

4) At option of the Contractor, welds not hydrostatically tested may be x-ray tested. Each test shall comply with the requirements of industry standards, prior notification, and bid allowance Inspector as specified above.

5) The University may elect to hire a third party testing company for piping tests. During the design phase determine who will be responsible for piping tests and include this information in the specifications.
f. The allowable depth of bury for piping below grade should be determined by consultation with the University Project Manager. Generally the following minimum depths of bury will apply:

<table>
<thead>
<tr>
<th>BURIED PIPE</th>
<th>DEPTH of BURY</th>
</tr>
</thead>
<tbody>
<tr>
<td>HTW and Steam</td>
<td>60&quot;</td>
</tr>
<tr>
<td>Storm Drain</td>
<td>36&quot;</td>
</tr>
<tr>
<td>Water</td>
<td>36&quot;</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>24&quot;</td>
</tr>
<tr>
<td>Sanitary Sewer</td>
<td>36&quot;</td>
</tr>
</tbody>
</table>

g. Direct buried domestic water piping mains and branch mains shall be no less than 6" pipe size.

h. Water service piping connections to existing mains and branch mains shall include saddle taps and service valves. Service valves are to be located at the connection and fully accessible via curb boxes. The service valve shall be submitted for approval before installation.

**15061 Piping Material (Above Grade - "a.g.")**

a. High Temperature Hot Water (HTW)\textsubscript{a.g.}

See 3.8 HVAC.

b. High Pressure Steam (125 to 250 PSIG)\textsubscript{a.g.}

1) Specify ASTM A53 Grade B seamless black steel pipe, Schedule 80 for pipe 2" and smaller, and Schedule 40 for pipe 2-1/2" and larger. Grade A shall be specified for pipe 1-1/2" and smaller.

2) For 2" and smaller specify 300 LB malleable iron screwed fittings or socket weld fittings.

3) For 2-1/2" and larger specify ASTM A234 standard weight forged steel butt weld fittings.

c. Medium Pressure Steam (15 to 125 PSIG)\textsubscript{a.g.}

1) Specify ASTM A53 Grade B Schedule 40 black steel pipe. Grade A shall be specified for pipe 1-1/2" and smaller.

2) For 2" and smaller specify 125 LB cast iron screwed fittings or 150 LB malleable iron screwed fittings.
3) For 2-1/2” and larger specify ASTM A234 standard weight forged steel butt weld fittings.

d. Low Pressure Steam (15 psig or less)

1) Specify ASTM A53, Grade B Schedule 40 black steel pipe. Grade A shall be specified for pipe 1-1/2” and smaller.

2) For 2” and smaller specify 125 LB cast iron screwed fittings or 150 LB malleable iron screwed fittings.

3) For 2-1/2” and larger specify ASTM A234 standard weight forged steel butt weld fittings.

e. Steam Condensate

1) Specify ASTM A53, Grade B, Schedule 80 black steel pipe. Grade A shall be specified for pipe 1-1/2” and smaller.

2) For 2” and smaller specify 300 pound screwed malleable iron fittings.

3) For 2-1/2” and larger specify ASTM A234, ASA B16.9, ASA B10, Grade B, Schedule 80 forged black steel butt weld fittings.

f. Hot Water Heating

1) Specify one of the following materials: a. ASTM A53, Grade B, Schedule 40, black steel pipe. Grade A shall be specified for pipe 1-1/2” and smaller. b. ASTM B 88, type K copper pipe with brazed or Propress style fittings.

2) For 2” and smaller, specify 150 pound, screwed, malleable iron fittings.

3) All specified EPDM gaskets shall have temperature ratings from -30° F to +230° F.

4) For 2-1/2” and larger, specify ASTM A234 standard weight forged steel butt weld fittings, or 150 pound malleable iron fittings with mechanical grooved pipe couplings.

g. Chilled Water

Same requirements as for hot water heating.

h. Condenser Water (Cooling Tower)

1) Specify ASTM A53, Grade B, Schedule 40 black steel. Grade A shall be specified for pipe 1-1/2” and smaller.
2) For 2” and smaller specify 150 LB screwed malleable iron fittings.
3) For 2-1/2” and larger specify ASTM A234, ASA B16.9, ASA B10, Grade B, Schedule 40 forged black steel butt weld fittings; or, grooved pipe and couplings may be specified.

i. Cold Water, Domestic Hot Water, and Recirculating Domestic Hot Water

1) Specify Type L hard drawn copper with wrought copper fittings and lead free solder.
2) Where existing lines are galvanized, specify Type L hard drawn copper, wrought copper fittings, and dielectric unions; or, ASTM A53 Schedule 40 galvanized steel with 150 LB galvanized malleable iron screwed fittings.
3) Copper piping is preferred over galvanized piping for domestic water where possible.
4) All automatic faucets and flush valves shall be piped with copper tube or pipe (No plastic tubing is allowed).

j. Soft Water

Type L hard drawn copper with wrought copper fittings and lead free solder.

k. Compressed Air and Vacuum

Specify Type L hard drawn copper with wrought copper solder fittings and lead free solder; or, ASTM A53 Grade A or B, Schedule 40 galvanized steel with 150 LB galvanized malleable iron screwed fittings.

l. Medical Gases

Specify Type L hard drawn seamless copper pipe chemically cleaned, degreased, evacuated, capped, and especially prepared for oxygen usage as required in NFPA pamphlet No. 56F. Specify wrought copper fittings and lead free solder.

m. Medical Acetylene

Specify stainless steel only. Neither copper nor alloys with any copper content will be allowed.

n. Natural Gas

1) Specify ASTM A53, Grade B, Schedule 40, black steel pipe. Grade A shall be specified for pipe 1-1/2” and smaller.
2) For 2” and smaller specify 150 LB malleable iron screwed fittings.
3) For 2-1/2” and larger specify ASTM A234, ASA B16.9, Grade B Schedule 40 forged black steel butt welding fittings.

4) All exterior above ground natural gas piping shall be painted with an exterior grade gray protective paint suitable for the intended purpose.

o. Fire Protection a.g.

1) All piping shall meet the ASTM standards as listed in NFPA 13.

2) Schedule 40 black steel pipe or Allied Tube-Sprinkler “Dyna-Thread” pipe shall be specified for piping sized 2” and smaller. Schedule 10 black steel pipe shall be specified for piping sized 2-1/2” and larger. The use of “Dyna-Flow” and other types of thin-wall pipe are not approved.

3) The use of CPVC pipe is acceptable for use in Residential Occupancies and Light Hazard Occupancies. CPVC pipe must be used according to its listing as prescribed by the manufacturer’s specifications. Approved manufacturer is Lubrizol BlazeMaster. All other manufacturers / products must be reviewed and approved by the University Fire Marshal prior to bid.

4) For 2” and smaller specify 150 LB malleable iron, screwed fittings.

5) For 2-1/2” and larger specify 150 LB malleable iron fittings with mechanical grooved pipe couplings. Approved manufacturers are Victaulic, Gruvlok, and Grinnell. All other manufacturers must be reviewed and approved by the University Fire Marshal prior to bid.

p. Soil, Waste and Vent all a.g.

1) For 2” and larger (above ground), specify cast iron pipe and fittings, with resilient gasket joints; or, 'no-hub' cast iron pipe and fittings with stainless steel bands. Piping located 6” above the ground may be ASTM A53 Schedule 40 galvanized steel pipe with screwed cast iron drainage fittings.

2) Do not allow plastic pipe or fittings except as noted below, and except for approved acid waste piping systems as described in this supplement to the DFCM Manual.

   a) For temporary or short term projects that have a building or system life cycle of less than 25 years, alternate materials may be considered. A variance request for these considerations shall be submitted to the Design Standards
Committee through the University Project Manager for approval.

3) Indirect piping shall be Type L hard drawn pipe with wrought copper fittings and lead free solder.

4) Ejector pump discharge lines shall be Schedule 40 galvanized steel pipe with 150 LB galvanized malleable iron screwed fittings.

q. Acid Resistant Waste and Ventg.

1) Three options are approved for installation at the University.

2) The designer is responsible for choosing suitable piping material based on the type of acids which will be used in the pipe.

3) CPVC is generally acceptable but not approved for use in hydrofluoric applications.

4) Where hydrofluoric chemicals will be used, the designer shall meet with the University Project Manager and the Plumbing Shop Supervisor to review design limitations and system requirements during the Design Development phase.

5) The three approved options, considering the above limitations, are:

   a) Tempered and annealed borosilicate glass Fed. Spec. DD-G-541-A with stainless steel compression fittings, Buna-N rubber compression liners, and tetra-fluoro-ethylene seal rings. Approved manufacturers are Kimax, CHEM Flowtronics, or H.S. Martin, Inc.. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid.

   b) Schedule 40 flame retardant polypropylene using socket weld fittings and electric fusion coil or mechanical joint couplings. Approved manufacturers are GSR Fuseal, Enfield, or Orion. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid.

   c) CPVC (chlorinated poly [vinyl chloride]) pipe and fittings specifically designed for acid waste systems, using solvent cement welded joints, suitable for intermittent non-pressure drainage to 220° F, with a 25/50 flame spread/smoke development rating. Solvent cement shall be the product of the CPVC manufacturer,
specifically designed for the acid waste piping system. Approved manufacturer is Spears LabWaste. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid.

r. Roof Drain \(_{a,g}\):
   1) Specify the same pipe as specified for soil, waste and vent.
   2) As an option, specify Schedule 40 ASTM A53 Grade B galvanized pipe with 150 pound galvanized iron fittings. Mechanical grooved pipe couplings may also be used.

s. Refrigerant (Freon)\(_{a,g}\).

Specify Type L hard drawn copper tubing, degreased, scaled-at-the-mill, with wrought copper refrigerant fittings. Specify 15% Sil-Fos solder or with wrought copper refrigerant fittings. Specify 15% Sil-Fos solder or 45% silver solder. Piping shall be cleaned, dehydrated, charged with nitrogen, and sealed at the mill.

t. Cooling Coil Condensate Drain \(_{a,g}\).

Specify Type L hard drawn copper with wrought copper solder fittings.

u. Distilled Water, Deionized Water, Demineralized Water, Reverse Osmosis Water \(_{a,g}\).

1) Coordinate with the University Project Manager prior to specifying the pipe required for these services. The level of water purity shall dictate the type of pipe material required (\textit{i.e.} polyethylene or polypropylene).

2) Most cases will require polypropylene pipe with the following properties:
   a) Pipe and fittings shall be GSR/Sloan fusion coil type virgin un-pigmented polypropylene pipe grade material manufactured to Schedule 40 iron pipe dimensions. Additional approved manufacturers are Harvel and Pure Tech Plastics. The products of other manufacturers not listed here will be considered only after successful site testing at the University. Specific products furnished and installed into the project must be equal or superior to the specified GSR/Sloan product.
   
   b) The addition of normal antioxidants or slip agents will not be allowed.
c) The pipe shall be furnished in 10 foot lengths; shall be cylindrical and straight; and, shall be sterile capped at the time of manufacture.

d) The pipe and fittings shall meet ASTM D2146 (but without additives), and be manufactured to meet dimensional tolerances of ASTM D2447-74.

e) Long straight lengths of polypropylene pipe will require expansion joints. Piping installed in a cold environment will require expansion joints.

f) Support horizontal piping with continuous channel or angle iron.

v. Ultra-Pure Water<sub>a.g.</sub>

Ultra-pure process piping and fittings are to be specified low-extractable PVC with a Cell Classification of 12343 per ASTM D1784, Schedule 80 with a Type II pressure rating. Manufacturing Company. Additional approved manufacturers are Harvel and Pure Tech Plastics. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid. Specific products furnished and installed into the project must be equal or superior to the Spears product as defined herein.

w. Fuel Oil (supply & return)<sub>a,g.</sub>

Specify Type L soft copper with flare fittings.

15062 Piping Material (Underground or Below Grade - "b.g.")

a. Buried Site Piping, Trace Wire, Warning Tape, Sand Cover Over Pipe

1) All underground conduit and pipe exterior to the building 4” diameter and larger shall be installed with an 18 gage continuous copper wire 8” over the pipe to serve as trace wire.

2) See 3.2 CIVIL / L. SITE UTILITIES FOR CAMPUS PROJECTS / (3) for specific design instructions including warning tape, approved methods for trace wire terminations, testing requirements, buried plastic or natural gas piping, sand cover, etc.

b. Domestic Water and Fire Protection<sub>b,g.</sub>

1) Specify PVC or Class 150 ductile iron cement lined pipe and fittings, with mechanical joint couplings for piping 4” and larger.
2) PVC Pipe shall not be installed any closer than 10 feet from the outside building line.

3) Copper will be approved for the smaller piping. Specify Type K with brazed joints for areas where high and or heavy traffic is anticipated.

c. Sanitary Waste and Roof Drainages

Specify HDPE pipe, cast iron "no-hub" pipe and fittings or cast iron pipe and fittings with bell and spigot joints using resilient seals such as "Ty-Seal" gaskets. (The pipe and gasket shall be of the same manufacturer). The “no-hub” couplings shall have ASTM C 564 neoprene gaskets. .008” stainless steel shields with transverse corrugations cross longitudinal corrugations, standard 304 stainless steel clamps and 305/ s/s screws. All underground “no-hub” couplings shall be specified with “extra heavy duty” bands. Entire assembly shall accommodate deflection.

d. Acid Resistant Waste and Ventileg.

1) Specify Schedule 40 flame retardant polypropylene using socket weld fittings and electric fusion coil, or CPVC solvent cement welded pipe and joints specifically designed for acid waste systems.

2) The designer is responsible for choosing suitable piping material based on the type of acids which will be used in the pipe.

3) CPVC is generally acceptable but not approved for use in hydrofluoric applications.

4) Where hydrofluoric chemicals will be used, the designer shall meet with the University Project Manager and the Plumbing Shop Supervisor to review design limitations and system requirements during the Design Development phase.

5) Where CPVC is used, solvent cement shall be the product of the CPVC manufacturer, specifically designed for the acid waste piping system.

6) Approved CPVC manufacturers are GSR Fuseal, Enfield, Orion, or Spears LabWaste. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid.

e. Natural Gas
1) For each project, the A/E shall obtain the current Questar approved specification for plastic pipe. The pipe specification

2) No gas lines shall be run under-ground down-stream of the building regulator/meter set.

3) Projects that install new plastic gas lines, that replace old steel lines, shall install new cathodic protection to the remaining steel pipe.

4) All gas risers shall be anoidless style for (1/2”-2”).

5) If new plastic piping is to be routed under any road, the pipe must have a PVC or sewer pipe sleeve two pipe sizes larger than the gas line it will protect.

6) If new plastic piping is to be routed through a wall, the pipe must have a protective sleeve and the pipe/sleeve system must be completely sealed to prevent water from entering the building.

7) See 15351 NATURAL GAS PIPING ON CAMPUS herein for more information.

f. Fuel Oil (supply & return)h,g.

Specify Type K soft copper with flair fittings.

g. Refrigerant Pipingh,g.

Specify the same materials specified for "above grade" service, but route in oversize PVC conduit. Bury the system in sand backfill.

h. Heating Water Pipingh,g.

Piping shall be schedule 80 seamless steel pipe.

i. Chilled Water Piping

Piping material shall be one of the following:

1. AWWA C900 PVC pressure class 235 psi (DR 18) pipe or prior approved equal. Fuse joints and slip joints are permitted. Install per manufacturer’s installation guide.

2. ASTM D3035-08 HDPE joined by fusion welding. Pipe joined by fusion welding shall be reamed to remove flashing from the weld site.
3. ASTM F2389-10 polypropylene pipe joined by fusion welding. Pipe joined by fusion welding shall be reamed to remove flashing from the weld site.

15063 Protective Coatings for Pipe

a. Natural gas pipe below grade should be plastic pipe without additional coating. Where black steel pipe is approved for use, pipe shall be wrapped and bitumen or plastic coated. Provide anode bags for cathodic protection of buried steel piping.

b. Cast iron soil, waste, and roof drain piping shall be coated inside and out with coal tar pitch.

c. Ductile iron pipe shall be capsulated in polyethylene wrap.

15064 Pressure Tests

a. All water mains and services to the PRV valve will be hydrostatic tested to 200 psi for two hours. All interior water (domestic & industrial), heating and steam lines will be hydrostatic tested to 150 psi for two hours in addition to code requirements. All pressure tests will be witnessed by Facility Operations personnel. Soil pipe, roof drain, waste, vent, and acid waste and vent piping shall be tested in accordance with the IPC and AWWA Standards.

b. Hot water heating, chilled water, high pressure steam, low pressure steam, steam condensate, condenser water, fire protection water, compressed air, and vacuum lines shall be tested in accordance with the IMC (International Mechanical Code).

c. Natural Gas lines shall be tested in accordance with NFPA 54.

d. Medical Gases, Medical Vacuum, and Lab Gases shall be tested in accordance with NFPA Pamphlet 99 Standard for Health Care Facilities.

e. Test requirements for high temperature water (HTW) systems are found in 3.8 HVAC.

f. Oxygen Piping systems shall be pressure tested in strict accordance with NFPA #56F. Specific attention is directed to the absolute prohibition of the use of oil pumped compressed air or oil pumped nitrogen, and the prohibition of the use of a hydrostatic test. The testing medium must be water pumped compressed air or vapor pumped nitrogen.

g. Refrigeration piping shall be tested in accordance with the IMC and ASHRAE 15.
15065  **Pipe Hangers and Supports**

a. All piping is to be supported in accordance with the International Plumbing and International Mechanical Codes.

b. Approved manufacturers are ITT Grinnell, B-Line, and Anvil International. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid.

**15066 Piping System Cleaning, Filling, and Treatment**

a. All new piping systems for heating hot water, steam, chilled water and condenser water shall be thoroughly flushed and cleaned before being placed into service.

1) Do not flush into the storm drain system. Piping shall be cleaned with an appropriate cleaning agent certified to remove all construction debris and oxidized metal by a University authorized water treatment specialist. The chemical applied should be guaranteed to be compatible with all system piping, gasket and component materials. A written procedure for the correct application of the chemical including all safety precautions and methods for confirming success of the application must be provided. Supervision of the cleaning process shall be provided by the chemical supplier or a designated contractor.

2) The cleaning of these piping systems shall be accomplished only by the University’s current chemical treatment contractor. The designer shall contact the University’s HVAC shop via the University Project Manager to obtain the latest contact information for the specific chemical treatment contractor currently under contract with the University, and include this information in the construction documents.

b. After the cleaning and flushing procedure has been completed, heating hot water and chilled water systems shall be filled with softened water which includes appropriate chemicals or antifreeze compatible with the contents of the existing system before isolation valves are opened to the building system. Steam systems shall be filled with treated make-up water as described in 3.8 HVAC. Condenser water systems shall be filled with cold water.

c. The cleaning of domestic systems is specified in Section 15400 Plumbing Systems.

d. Closed loop systems shall have the correct level of a chemical corrosion inhibitor fed into the system as determined by the University’s authorized water treatment specialist. The University’ specialist shall confirm the correct level of protection through analytical testing.
e. Open loop systems shall have the correct level of a chemical corrosion inhibitor fed into the open loop system as determined by the University’s authorized water treatment specialist. Additionally, sodium hypochlorite should be added to achieve a tested level of 0.5 to 1.5 ppm free residual chlorine. The University’s specialist shall confirm the correct level of protection through analytical testing.

f. Glycol systems shall use industrial type inhibited propylene glycol (minimum of 30%) such as Jeffcool P150, Dowfost, or prior approved equal. Automotive type ethylene glycol shall not be used.

15090 Floor Penetrations

All floor penetrations to be water tight in addition to meeting other code requirements. Depending on project specific conditions, some penetrations will require a sleeve or other device extended a certain distance above finish floor to be above an anticipated water level.

15100 Valves and Accessories

a. General: The following requirements apply to all valves:

1) Isolation Valve

The University will require an isolation valve near the main pipe line on branch piping which serves each specific area of the building (such as a single toilet room or a single lab, and at each floor) for all supply systems serving the building. The designer is to provide direction to the Contractor to locate these valves for easy access, allowing local isolation for repairs without affecting adjacent areas.

2) Access Door

All valves must be accessible. Specify an “approved” access door for any valve located above a hard ceiling or in a wall.

3) Pressure Reducing Valve Location

a) All pressure reducing valves (PRV) are to be located in an accessible space 5 feet above finished floor for servicing. All pressure reducing valves shall have a PVC drain line from the device to an approved floor sink.

b) All pressure reducing valves shall have PSI gages on the upstream and downstream side of the valve.

4) Valves 2-1/2" and larger must be flanged.
5) Specify valve stem installation to be horizontal or higher than the valve.

6) All valves of the same type shall be specified to be of the same manufacturer.

7) Valves shall be domestically manufactured wherever possible.

8) Control valves must be specified to be compatible with either Johnson Controls, Inc., Trane US, Inc., or Wasatch Controls Honeywell, as described in the Controls section of this supplement. No others will be approved except where the controls of another vendor/manufacturer must be matched on an existing facility.

9) Specify heating water valves, steam valves, and all valves located in the secondary (low pressure) side of HTW heat exchangers to have end bores matching the pipe bore.

10) Valves shall meet all applicable MSS Standards.

b. High temperature water valves are described in 3.8 HVAC.

c. Low Pressure Steam (15 PSIG or less) and Steam Condensate Valves

1) Gate valves 2" and smaller (MSS SP-80) for steam and condensate service shall be based on Nibco T-111, bronze, threaded, 125#, with solid wedge disc and rising stem. If clearances will not allow a rising stem valve, specify a Nibco T-113 non-rising stem valve. Additional approved manufacturers are Crane, Stockham and Powell. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid. Specific products furnished and installed into the project must be equal or superior to the Nibco gate valve.

2) Gate Valves 2-1/2" and larger (MSS SP-70) for steam and condensate service shall be based on Nibco F-617-O, iron body, flanged, 125#, OS&Y valve with bronze trim. If clearances will not allow a rising stem valve, specify a Nibco F619 non-rising stem valve as a basis for the specification. Additional approved manufacturers are Crane, Stockham and Powell. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid. Specific products furnished and installed into the project must be equal or superior to the Nibco gate valve.

3) Globe Valves 2" and smaller (MSS SP-80) for steam and condensate service shall be based on Nibco T-235-Y, bronze, threaded, 150# with
No. 1 replaceable composition disc. Additional approved manufacturers are Crane, Stockham and Powell. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid. Specific products furnished and installed into the project must be equal or superior to the Nibco globe valve.

4) Globe Valves 2-1/2" and larger (MSS SP-85) for steam and condensate service shall be based on Nibco F-718-B, iron body, flanged, 125#, with No. 1 replaceable composition disc. Additional approved manufacturers are Crane, Stockham and Powell. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid. Specific products furnished and installed into the project must be equal or superior to the Nibco globe valve.

5) Check Valves 2" and smaller (MSS SP-80) for steam and condensate service shall be based on Nibco T-413-B, bronze, threaded, Y-pattern, 125# steam swing check valve with replaceable disks. Additional approved manufacturers are Crane, Stockham and Powell. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid. Specific products furnished and installed into the project must be equal or superior to the Nibco check valve.

6) Check Valves 2-1/2" and larger (MSS SP-71 Type 1) for steam and condensate service shall be based on Nibco F-918-B, iron body, flanged, 125#, with bronze trim with replaceable disks. Additional approved manufacturers are Crane, Stockham and Powell. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid. Specific products furnished and installed into the project must be equal or superior to the Nibco check valve.

7) Strainers 2" and smaller for steam and condensate service shall be based on Watts No. 77S, 250 LB iron body, threaded, Y-pattern, 20-mesh stainless steel screen, with a full size drain connection and gate valve (described elsewhere herein). Additional approved manufacturers are Conbraco and Armstrong International. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid. Specific products furnished and installed into the project must be equal or superior to the Watts strainer.

8) Strainers 2-1/2" and larger for steam and condensate service shall be based on Watts No. 77F-125, 125 LB iron body, flanged, Y-pattern, stainless steel screen, with a full size drain connection and gate valve (described elsewhere herein). Additional approved manufacturers are
Conbraco and Armstrong International. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid. Specific products furnished and installed into the project must be equal or superior to the Watts strainer.

9) Unions 2" and smaller for steam and condensate service shall be specified as 300 LB ground joint malleable iron, hexagonal, threaded.

10) Unions 2-1/2" and larger for steam and condensate service shall be specified as flanged (raised face), and bolted with gaskets to suit the specific service.

11) Dielectric unions for steam and condensate service shall be specified to be rated for 175 PSIG WSP at 250° F

d. High Pressure Steam (greater than 15 PSIG)

1) Gate Valves 2" and smaller (MSS SP-80) for high pressure steam service shall be based on Nibco T-154-SS, bronze, threaded, 200#, with Exelloy seats and rising stem. If clearances will not allow a rising stem valve, specify a Nibco T-176-SS non-rising stem valve. Additional approved manufacturers are Crane, Stockham and Powell. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid. Specific products furnished and installed into the project must be equal or superior to the Nibco gate valve.

2) Gate Valves 2-1/2" and larger (MSS SP-70) for high pressure steam service shall be based on Nibco F-667-O, iron body, flanged, 250#, OS&Y valve with bronze trim. If clearances will not allow a rising stem valve, specify a Nibco F-669 non-rising stem valve. Additional approved manufacturers are Crane, Stockham and Powell. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid. Specific products furnished and installed into the project must be equal or superior to the Nibco gate valve.

3) Globe Valves 2" and smaller (MSS SP-80) for high pressure steam service shall be based on Nibco T-256-AP, bronze, threaded, 200# plug type with stainless steel removable seat and disc. Additional approved manufacturers are Crane, Stockham and Powell. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid. Specific products furnished and installed into the project must be equal or superior to the Nibco globe valve.

4) Globe Valves 2-1/2" and larger (MSS SP-85) for high pressure steam service shall be based on Nibco F-768-B, iron body, flanged, 250#,
with bronze trim. Additional approved manufacturers are Crane, Stockham and Powell. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid. Specific products furnished and installed into the project must be equal or superior to the Nibco globe valve.

5) Check Valves 2" and smaller (MSS SP-80) for high pressure steam service shall be based on Nibco T-453-B, bronze, threaded, 200# steam swing check valve with replaceable disks. Additional approved manufacturers are Crane and Stockham. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid. Specific products furnished and installed into the project must be equal or superior to the Nibco check valve.

6) Check Valves 2-1/2" and larger (MSS SP-71 Type 1) for high pressure steam service shall be based on Nibco F-968-B, iron body, flanged, 250#, with bronze trim with replaceable disks. Additional approved manufacturers are Crane and Stockham. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid. Specific products furnished and installed into the project must be equal or superior to the Nibco check valve.

7) Strainers 2" and smaller for high pressure steam service shall be based on Watts No. 77S, with a 250 LB iron body, threaded, Y-pattern, 20-mesh stainless steel screen, with a full size drain connection and gate valve (described elsewhere herein). Additional approved manufacturers are Conbraco and Armstrong International. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid. Specific products furnished and installed into the project must be equal or superior to the Watts strainer.

8) Strainers 2-1/2" and larger for high pressure steam service shall be based on Watts No. 77F-250, 250 LB iron body, flanged, Y-pattern, stainless steel screen, with a full size drain connection and gate valve (described elsewhere herein). Additional approved manufacturers are Conbraco and Armstrong International. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid. Specific products furnished and installed into the project must be equal or superior to the Watts strainer.

9) Unions 2" and smaller for high pressure steam service shall be specified as 300 LB ground joint malleable iron, hexagonal, threaded.

10) Unions 2-1/2" and larger for high pressure steam service shall be specified as flanged (raised face), and bolted with gaskets to suit the specific service.
e. Hot Water Heating, Chilled Water, and Condenser Water Valves:

1) Ball Valves (MSS SP-110) shall be rated for 125 psig WOG at 220° F, with bronze construction, threaded ends, full port, bubble tight teflon seat (at 100 psig under water), with a hard chrome plated brass or stainless steel ball. Specify the valve to operate with flow in either direction and tight shut off.

2) Gate Valves (MSS SP-80) are to be specifically identified on construction drawings, due to their limited approval for use at the University.

3) Globe Valves 2” and smaller (MSS SP-80) shall be bronze, threaded, 200# WOG, with No. 6 replaceable composition discs. For all applications, specify the composition disc to be suitable for hot water up to 220° F maximum.

4) Globe Valves 2-1/2” and larger (MSS SP-85) for heating water, chilled water and condenser water service shall be iron body, flanged, 200# WOG, with No. 6 replaceable composition disc. For applications, specify the composition disc to be suitable for hot water up to 220° F maximum.

5) Butterfly Valves 2-1/2” and larger shall be 150 LB and rated for a minimum of 200 degrees F, full lug type, with a carbon steel or case iron body, 316 stainless steel disc material, and EPDM seat material. Specify gear operation for all valves 8” and larger. Butterfly valves shall not be specified for balancing valve service.

6) Swing Check Valves 2” and smaller (MSS SP-80) shall be bronze, threaded, Y-pattern, and rated for 200# WOG.

7) Swing Check Valves 2-1/2” and larger (MSS SP-71 Type 1) shall be iron body, flanged, 200# WOG, valve with bronze trim.

8) Non-Slam Check Valves 2” and smaller shall be 125 psig WSP, silent, spring loaded, and all stainless steel.

9) Non-Slam Check Valves 2-1/2” and larger shall be 125 psig WSP, silent operating, with semi-steel body, bronze trim and discs. Specify the bronze seats to have a center guide and be "renewable" with special reseating tools. Specify the spring for operation in any position.
10) Strainers 2” and smaller shall be 250 LB iron body, threaded, Y-pattern, 20-mesh stainless steel screen, with a full size drain connection and ball valve.

11) Strainers 2-1/2” and larger shall be 125 LB iron body, flanged, Y-pattern, stainless steel screen, with a drain connection and ball valve. Note that condenser water lines require a basket type strainer rated for 125 PSIG WSP, cast semi-steel body, flanged ends, stainless steel basket with 1/8” perforations.

12) Balancing cocks 2” and smaller shall be 175 PSIG WOG, with a cast iron body, square head, screwed ends, wrench operated and pre-lubricated.

13) Balancing cocks 2-1/2” and larger shall be 200 PSIG WOG, with a cast iron body, square head, flanged ends, wrench operated and pre-lubricated.

14) Balancing valves for shall be positive shut-off valves with a memory stop on the valve and a locking tamper proof setting. Specify valves to be supplied with preformed polyurethane insulation. As stated in other sections, gate valves and butterfly valves shall not be used as balancing valves. The valve manufacturer shall provide documentation showing the flow-pressure relationship for the valve.

Domestic Cold Water Valves, Domestic Hot Water Valves, Domestic Hot Water Return Valves, and Industrial Hot and Cold Water Valves in Copper Pipe:

1) Ball valves (MSS SP-110) for use in domestic water applications (copper pipe) shall be specified as Watts B-6080 rated for 125 PSIG WOG at 220° F, with bronze construction, threaded ends, bubble tight teflon seats (at 100 PSIG under water), with a hard chrome plated brass or stainless steel ball. Ball valves must be full port valves. Additional approved manufacturers are Nibco or Apollo. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid. Specific products furnished and installed into the project must be equal or superior to the Watts ball valve.

   a) Specify the valve to operate with flow in either direction, suitable for both throttling and tight shut off.

2) Gate valves (MSS SP-80) for use in domestic water applications (copper pipe) shall be specifically shown on construction drawings, due to their limited approval for use at the University. Ball valves are preferred over gate valves for 2” and smaller sizes. Specify butterfly valves for 2-1/2” and larger sizes. Gate valves must never be specified for balancing service. When required for valves 2” and
smaller, gate valves shall be based on Nibco T-111, Crane 428, bronze, threaded, 200# WOG, with solid wedge disc and rising stem. If clearances will not allow a rising stem valve, specify Nibco T-113 or Crane 438 non-rising stem valve. Other valves must be reviewed by Facilities Management and approved before being added to project specifications.

3) Globe valves for use in domestic water applications (copper pipe) shall be specified as Crane Model No. 7TF or Nibco S-235, bronze, threaded, 200# WOG, with TFE discs. Specify the composition disc to be suitable for hot water up to 200° F maximum.

4) Butterfly valves for use in domestic water applications (copper pipe) shall follow the University’s requirements for heating water service. Valve selections shall be rated suitable for potable water applications.

5) Check valves for use in domestic water applications (copper pipe) shall be based on Crane Model No. 37 or Nibco S-480-B, bronze, threaded, Y-pattern, and rated for 200# WOG. Selections shall be rated suitable for potable water applications.

6) Strainers for use in domestic water applications (copper pipe) shall be based on Watts No. 777, specified with a WWP of 250 PSIG at 210° F, with a cast bronze body, threaded ends, solid retainer cap, and a 20 mesh stainless steel screen (except the 3” size must have 3/64” perforations).

g. Compressed Air Valves:

1) Ball valves for use in compressed air piping shall follow the University’s requirements for domestic water applications.

2) Butterfly valves for use in compressed air piping shall be based on Crane “Monarch” 21 (molded seat), ductile iron body, 200# WOG valve with bronze disc and type 304 stainless steel stem. The seat shall be specified Buna N rubber. Note that valves 5” and smaller are to be specified with 10-position locking levers; and, valves 6” and larger are to be specified with manual gear operators. Butterfly valves must be rated for temperatures up to 180° F maximum and must be capable of tight shut-off at rated pressure without the need for downstream blind flanges. Additional approved manufacturer is Nibco (WD2100 or LS2100). All other manufacturers must be reviewed and approved by University Facilities Management prior to bid. Specific products furnished and installed into the project must be equal or superior to the Crane “Monarch” butterfly valve.

3) Check Valves in compressed air service are “tricky” and should be engineered for each application.
a) Lift check valves 1-1/2" and smaller or use in compressed air piping shall be based on Crane Model No. 117 ATJ bronze, threaded, and rated at 150 PSI at 200°F maximum. Specify horizontal lift check valves with PTFE replaceable composition disc.

b) Swing check valves 2" and smaller for use in compressed air piping shall be based on Crane No. 41TF, bronze, threaded, Y-pattern, 200# WOG at 200°F maximum, with PTFE disc.

c) Swing check valves 2-1/2" and larger (MSS SP-71 Type 1) for use in compressed air piping shall be based on Nibco F-918-B, Crane 373, iron body, flanged, 200# WOG, with bronze trim.

4) Strainers for use in compressed air piping shall follow the University requirements for heating and air conditioning water service.

h. Vacuum Valves:

1) Ball valves for use in vacuum piping shall follow the University requirements for domestic water applications.

2) Butterfly valves for use in vacuum piping shall follow the University requirements for heating and air conditioning water service, except that all sizes are to be specified for non-leakage performance up to and including 29.9 inches of mercury (Hg).

i. Natural Gas Valves:

1) Natural gas valves 2" and smaller shall be specified as Apollo Ball Valves G-B-10 series. Nibco GB1A or GB2A may be used for ½" and ¾" sizes. Other valves must be reviewed by Facilities Management and approved before being added to project specifications. Specify three piece dielectric unions where applicable.

2) Natural Gas Valves 2-1/2" and larger shall be specified all iron, 125 PSIG WOG, with square head and flanged connections. Specify three piece dielectric unions, where applicable.

3) Earthquake actuated automatic gas shut-off valves are to be required downstream of each meter set. Each valve shall be specified with a UL label and be capable of complete gas line closure within 5 seconds of a wide amplitude seismic disturbance. Specify three piece dielectric unions where applicable. Include in the specifications a requirement that the valve shall allow short duration nuisance bumps without disturbing the gas supply. The manifold assembly must be
designed with supports and appropriate barriers to isolate the valve and prevent vandalism. Approved manufacturer is PSP California KOSO. State that other manufacturers will be considered after University monitored field testing on campus.

a) Earthquake actuated automatic gas shut-off valves are to be required downstream of each meter set.

b) Each valve shall be specified with a UL label and be capable of complete gas line closure within 5 seconds of a wide amplitude seismic disturbance. Include in the specifications a requirement that the valve shall allow short duration nuisance bumps without disturbing the gas supply.

c) Specify three piece dielectric unions where applicable. The manifold assembly must be designed with supports and appropriate barriers to isolate the valve and prevent vandalism.

d) Do not locate valves on or next to loading docks or other areas where vehicles can cause the valve to shut off.

e) Approved manufacturer is PSP California KOSO. State that other manufacturers will be considered after University monitored field testing on campus.

j. Refrigeration Valves and Accessories:

1) Expansion valves used in refrigerant piping shall be specified as Alco pressure type distributors, externally equalized, with a stainless steel diaphragm. Specify the same refrigerant in the thermostatic elements as is found in the system. Size the valves to provide the rated capacity of the cooling coil being served. Additional approved manufacturers are Parker Hannifin (including Sporlan), Henry Technologies, and Mueller Refrigeration. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid. Specific products furnished and installed into the project must be equal or superior to the Alco expansion valve.

2) Filter-driers 5/8” and smaller shall be specified as an Alco sealed filter drier using sweat copper fittings, full line size. Additional approved manufacturers are Parker Hannifin (including Sporlan) and Mueller Refrigeration. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid. Specific products furnished and installed into the project must be equal or superior to the Alco filter drier.
3) Filter-driers 3/4” and larger shall be specified as an Alco replaceable core filter drier with nonferrous casing and Schraeder type valves, full line size. Additional approved manufacturers are Parker Hannifin (including Sporlan) and Mueller Refrigeration. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid. Specific products furnished and installed into the project must be equal or superior to the Alco filter drier.

4) Sight glasses used in refrigerant piping shall be specified Alco and have combination moisture and liquid indicator with a protection cap. The sight glass shall be full line size. Additional approved manufacturers are Parker Hannifin (including Sporlan) and Mueller Refrigeration. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid. Specific products furnished and installed into the project must be equal or superior to the Alco sight glass.

5) Solenoid valves used in refrigerant piping shall be specified Alco O.D.F. type with manual opening stem and shall be completely moisture proof. The designer shall size the valve to adequately meet equipment tonnage requirements. Coordinate the voltage required on the valve operator to match the requirement for automatic temperature controls. Additional approved manufacturers are Asco and Parker Hannifin (including Sporlan). All other manufacturers must be reviewed and approved by University Facilities Management prior to bid. Specific products furnished and installed into the project must be equal or superior to the Alco solenoid valve.

6) Manual refrigerant shut-off valves shall be specified Apollo Conbraco ball valves with cap seals designed for refrigeration service, full line size. Specify installation of these valves on each liquid and suction line at the condenser. If service valves are supplied as integral part of the equipment served, additional service valves are not required. Additional approved manufacturers are Superior Refrigeration Products, Mueller Refrigeration, Henry Technologies, and Virginia. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid. Specific products furnished and installed into the project must be equal or superior to the Conbraco valve.

7) Flexible connectors used in refrigerant piping shall be designed specifically for refrigerant service with bronze seamless corrugated hose and bronze braiding. Specify flexible connectors on each liquid line and suction line, both at the condensing unit and at the evaporator on systems larger than 5 tons. Direct the Contractor to anchor the pipe near each flexible connector. Approved manufacturers are
Packless Vibration Absorbers Model VAF and Style "BP" Spring-flex freon connectors by Vibration Mountings and Controls.

k. Distilled Water Valves, Deionized Water Valves, Reverse Osmosis Valves, and Demineralized Water Valves:

1) Approved manufacturer is Chicago Model 869A. PVC valves will not be approved. All isolation valves must be specified as “ball-type” valves with valve materials matching the pipe material and system service requirements. Valves of other manufacturers must be prior approved after review and approval by University Facilities Management before bidding.

l. Medical gas piping shall be served by ball valves (4" and smaller) rated at 400 PSIG WOG, with solder joints, conforming to NFPA 56F. Specify each valve to have a double o-ring stem seal, teflon seat, service identification on handle (see valve tagging requirements herein), and shall be a swing-away design. Approved manufacturers are Chemtron and Ohio Medical.

15106 Flow Meters and Temperature & Pressure Gauges

a. Provide where shown, venturi flow meters with meter fittings and a metal identification tag showing location, GPM and pressure drop to 2% accuracy.

1) Venturis 2" and smaller shall be brass with screwed connections. Units larger than 2" shall be steel machined for butt welding.

2) Venturi flow meters for heating and air conditioning water service shall be Armstrong APV, Rinco, or Barco.

b. Provide where shown, glass thermometers, constructed of a die cast aluminum case, finished in baked epoxy enamel, glass front, spring secured, and 9" long.

1) The tube and capillary shall be Mercury filled with magnifying lens, 1% scale range accuracy, shock mounted.

2) The scale shall be satin faced, non-reflective aluminum, with permanently etched markings.

3) Approved manufacturers include Ametek, Marsh, Marshalltown, Trerice, and Weiss. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid.

c. Provide where shown, pressure gauges, bourdon tube type, stress relieved, constructed of Grade A phosphor bronze, with joints silver brazed, and the socket and tip of brass.

1) The scale shall be white coated aluminum with permanently etched markings.
2) Provide pressure gage cocks between the gauges and gage tees. Gage cocks shall be 1/4" female NPT forged brass compact ball valve (equal to Apollo 77-100). Syphons, if required, shall be brass.

3) Provide a snubber of 1/4" brass, including a corrosion resistant porous metal disc, selected for the pressure rating and fluid served.

4) Approved manufacturers include Ametek, Marsh, Marshalltown, Trerice, and Weiss. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid.

d. Provide where shown, pressure/temperature connector plugs pressure rated for 500 psi and 200° F.

1) Plugs are to be nickel plated brass with 1/2" NPS fittings.

2) The valve core is to be a self-sealing neoprene gasketed orifice, suitable for inserting a 1/8" O.D. probe assembly.

3) Provide a gasketed screw cap with a chain permanently affixed to the plug.

4) For insulated lines, provide plugs with neck extensions of a length equal to the insulation thickness.

5) Approved manufacturer is Flow Design Inc./Super Seal. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid.

e. Chilled and Heating Water BTU Meters.

1) The University requires metering of chilled water service to its buildings. Analyze the proposed system and estimate the total building load and capacity. Specify an appropriately sized Fluxus ADM 7407 Liquid Ultrasonic Digital Flowmeter. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid.

2) When the system is designed for both high temperature water service and chilled water, select and specify an appropriate dual channel meter.

3) Provide load calculations and product specifications to the University Project Manager for each project. Copies of computer programming, wiring diagrams, manuals, and certifications are required. Submit these to the HVAC Shop and University Utility Analyst.
4) **BTU meters** shall be wall mounted for fixed installation, and include a BTU computer, BTU totalizer, and display device capable of measuring and reporting. The BTU computer shall be a microprocessor unit to calculate, store, and display the following properties:

   a) Water flow rate
   b) Supply and return temperatures and the difference between
   c) Instantaneous MBH
   d) Password protected MBtu totalizer which uses an even multiplier of 10,000 Btu, 100,000 Btu or 1,000,000 Btu

5) **BTU meters** must be capable of transmitting calculated flow rate, energy flow rate, supply and return temperatures and an energy totalizer to the campus central computer using Modbus Rtu protocol.

6) Loss of main power or battery back-up must not erase Btu total.

7) Locate the BTU meter display in the mechanical room and not in a high temperature water mechanical equipment room due to high ambient temperature and humidity in the HTW room.

8) **BTU meters** must be capable of operation at a water temperature range 0-100° F chilled water and 0-250° F heating water.

9) Specify that the Contractor is responsible for parts not specified, but required for meter installation and wire terminations.

10) The flow sensor element can be installed in either the return line or the supply line in a location approved by flow meter manufacturer to guarantee performance. The flow sensor is to be clamped on rather than welded. Sensors requiring silicone grease which will then require scheduled maintenance are not acceptable. Pilot tube or orifice plate technology is not acceptable.

11) The Contractor must provide upstream/downstream straight piping distances as required by piping specifications and manufacturer’s guidelines.

12) Minimum accuracy of the flow transmitter, unless more stringent accuracy is required by the University, should be +/- 0.8% of reading with +/- 0.2% repeatability of flow rate.
13) A minimum of 2 temperature sensors shall be furnished and installed in heavy duty stainless steel wells which are back welded in locations approved by the meter manufacturer.

   a) Temperature sensors shall be resistance type, 100 ohm RTD. Signals should be transmitted to the Btu computer via separate wiring with system accuracy of +/- 0.1%. Temperature measurements using gas or mercury filled bulbs are not allowed for Btu calculations.

   b) Supply and return RTD’s shall be a matched pair and connected directly to the flow computer. The Contractor shall follow the meter manufacturer’s specifications, including the number of wires transmitting the signal from the RTD to the calculator.

14) Specify installation by a trained instrument service engineer and require special supporting documentation. The trained service engineer shall determine the location of the flow meter and temperature element at the site prior to installation of the Contractor’s piping; and, shall calibrate all instruments and certify accuracy of installation. System start-up and wire terminations at the field instrument location and panel location shall be accomplished by the trained service engineer.

   a) A record of this information along with a copy of the Btu computer’s programming, wiring diagrams, manuals and certifications shall be included in O&M manuals, marked to show the accessories and appurtenances installed at the site, and the building name and number.

   b) Include any manufacturer’s web-based information with URL address clearly marked. Specify that in addition to the O&M information, 2 extra copies of these documents shall be bound separately and addressed to the HVAC shop and the University’s Utility Analyst respectively with the building name and number designated on the covers.

15) **Tanks**

   a. General

   1) Tanks shall be shop fabricated and ASME Coded and stamped as required to meet the State of Utah Boiler and Pressure Vessel Rules and Regulations.

   2) The tanks shall be arranged and piped as shown on detail drawings included with 3.8 HVAC.
3) All piping connections and openings shall be welded both externally and internally. Connections and openings shall be fabricated from ASTM A53 Grade A or B steel. Connections shall match the grade and quality of pipe for which intended.

4) Provide structural steel and/or pipe supports. Include cradles of welded construction arranged for bolting to the floor, structure, or slab.

b. Condensate Receivers

1) Size each condensate receiver for a minimum storage capacity of 10 minutes.

2) Unit construction shall be based on ASTM A283 Grade C steel plate. In addition to the required openings and connections, include an access port sized for inspection entry, cleaning, and coating maintenance.

3) Condensate receiver tanks shall have protective coatings. The exterior shall have the manufacturer's shop coat suitable for the operating temperatures expected. The interior shall have a protective coating suitable for the pressure, temperature, and material stored in the tank.

4) Prior to start-up, thoroughly clean the tank.

c. Blowdown Tanks

1) Fabricate blowdown tanks using ASTM A283 Grade C steel plate and/or ASTM A53 Schedule 40 pipe with welded end caps. The assembly shall have a minimum wall thickness of 0.365" (plate or pipe wall).

2) In addition to necessary openings and connections, coat the tank exterior with the manufacturer's shop coil suitable for the anticipated operating temperatures.

3) Prior to start-up, thoroughly clean the tank.

4) Note that all blowdown tanks shall be supplied with soft water for cooling to reduce calcium deposits in the tank and drains.

15200 Seismic Restraints
a. All mechanical equipment, piping and ductwork shall be braced, anchored, snubbed, or supported to withstand seismic disturbances and remain operational.

b. All supports, hangers, bases, anchorage and bracing for all isolated equipment shall be designed by a professional engineer employed by the restraint manufacturer or supplier, qualified with seismic experience in bracing for mechanical equipment.

c. Submittals shall include shop drawings, calculations, and printed data for all isolators, seismic restraints, snubbers, concrete inertia bases and anchors.

15250 Insulation - General

a. Insulation shall conform to the current Utah Energy Code.

b. No insulation shall be applied to piping or ductwork until all pressure tests are complete, leaks repaired, and the system is successfully retested.

c. Insulation shall be installed in accordance to manufacturer's recommendations.

15251 Piping Insulation

a. Insulation for systems other than HTW piping shall be fiberglass one-piece preformed pipe insulation with an all-purpose (ASJ) fire retardant jacket.

b. Insulation for HTW equipment and piping is described in 3.8 HVAC.

c. Insulate all refrigerant suction piping and fittings with flexible foam pipe insulation equal to Armaflex.

d. Fittings and valves shall be insulated and covered with Zeston covers.

e. All cold water, chilled water, condenser water, roof drains, and any pipe line which could carry cool water upon which condensate moisture could form, shall have a vapor-proof jacket over the insulation. In lieu of fiberglass insulation, foam glass, thermacell, and expanded polyurethane are also approved for these systems.

f. Fire and smoke hazard for a complete insulation system shall not exceed:

1) Flame spread - 25
2) Fuel contribution - 50
3) Smoke development - 50
g. Insulation protection inserts and shields equal to Grinnell Fig. 167 shall be installed on all insulated pipe 1” and larger. Insulation inserts shall be the same length as the protection shields. Hangers shall not contact the pipe where insulation specified.

1) Seismic points of support shall be protected by a 360° sheet metal shield. Insert insulation shall be of the same thickness as the adjoining pipe insulation.

2) The seismic sheet metal shield wrapped around the insert shall be fabricated to the following lengths and gauge thicknesses:

<table>
<thead>
<tr>
<th>PIPE SIZE</th>
<th>SHIELD LENGTH</th>
<th>MINIMUM GAUGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2&quot; TO 1-1/2&quot;</td>
<td>4&quot;</td>
<td>20 GA.</td>
</tr>
<tr>
<td>2&quot; TO 6&quot;</td>
<td>6&quot;</td>
<td>20 GA.</td>
</tr>
<tr>
<td>8&quot; TO 10&quot;</td>
<td>9&quot;</td>
<td>16 GA.</td>
</tr>
<tr>
<td>12&quot; TO 18&quot;</td>
<td>12&quot;</td>
<td>16 GA.</td>
</tr>
<tr>
<td>20&quot; AND LARGER</td>
<td>18&quot;</td>
<td>16 GA.</td>
</tr>
</tbody>
</table>

h. Minimum pipe insulation for fiberglass systems shall be as follows:

<table>
<thead>
<tr>
<th>PIPE SIZE</th>
<th>BRANCH #to 2&quot;</th>
<th>Up to 1&quot;</th>
<th>1-1/4&quot; to 2&quot;</th>
<th>2-1/2&quot; to 4&quot;</th>
<th>5&quot; and 6&quot;</th>
<th>8&quot; and LARGER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steam, High Press.</td>
<td>1.5&quot;</td>
<td>2.5&quot;</td>
<td>2.5&quot;</td>
<td>3.0&quot;</td>
<td>3.5&quot;</td>
<td>3.5&quot;</td>
</tr>
<tr>
<td>Steam, Med. Press.</td>
<td>1.5&quot;</td>
<td>2.0&quot;</td>
<td>2.5&quot;</td>
<td>2.5&quot;</td>
<td>3.0&quot;</td>
<td>3.0&quot;</td>
</tr>
<tr>
<td>Steam, Low Press.</td>
<td>1.0&quot;</td>
<td>1.5&quot;</td>
<td>1.5&quot;</td>
<td>2.0&quot;</td>
<td>2.0&quot;</td>
<td>2.0&quot;</td>
</tr>
<tr>
<td>Steam Condensate</td>
<td>1.0&quot;</td>
<td>1.0&quot;</td>
<td>1.5&quot;</td>
<td>2.0&quot;</td>
<td>2.0&quot;</td>
<td>2.0&quot;</td>
</tr>
<tr>
<td>Heating Water</td>
<td>0.5&quot;</td>
<td>1.0&quot;</td>
<td>1.0&quot;</td>
<td>1.5&quot;</td>
<td>1.5&quot;</td>
<td>1.5&quot;</td>
</tr>
<tr>
<td>Chilled Water</td>
<td>0.5&quot;</td>
<td>0.5&quot;</td>
<td>0.75&quot;</td>
<td>1.0&quot;</td>
<td>1.0&quot;</td>
<td>1.0&quot;</td>
</tr>
<tr>
<td>Domestic Hot Water</td>
<td>--</td>
<td>1.0&quot;</td>
<td>1.0&quot;</td>
<td>1.5&quot;</td>
<td>1.5&quot;</td>
<td>1.5&quot;</td>
</tr>
<tr>
<td>Recirculating</td>
<td>--</td>
<td>0.5&quot;</td>
<td>0.5&quot;</td>
<td>1.0&quot;</td>
<td>1.0&quot;</td>
<td>1.0&quot;</td>
</tr>
<tr>
<td>Domestic Cold</td>
<td>--</td>
<td>0.5&quot;</td>
<td>0.5&quot;</td>
<td>0.5&quot;</td>
<td>0.5&quot;</td>
<td>0.5&quot;</td>
</tr>
<tr>
<td>Roof Drain</td>
<td>--</td>
<td>0.5&quot;</td>
<td>0.5&quot;</td>
<td>0.5&quot;</td>
<td>0.5&quot;</td>
<td>0.5&quot;</td>
</tr>
</tbody>
</table>

*BRANCH PIPING TO INDIVIDUAL TERMINAL UNITS NOT EXCEEDING 12 FEET IN LENGTH.*

15258 Duct Insulation

a. High velocity ducts shall be insulated externally with 1-1/2" thick fiberglass faced duct wrap Type IV with factory applied flame retardant foil reinforced Kraft facing FRK-25, U.L. Label.
b. Insulation on high velocity ducts shall be wrapped snugly on the duct while maintaining the maximum thickness specified. All circumferential joints shall be butted and longitudinal joints overlapped a minimum of 2". Adhere insulation with 4" strips of insulation bonding adhesive at 8" on center.

c. On circumferential joints of high velocity duct insulation, the 2" flange of the facing shall be stapled with 9/16" flare-door staples on 6" centers and taped with 3" wide (minimum) foil reinforcing Kraft tape.

d. On longitudinal joints of high velocity duct insulation, the overlap shall be stapled (9/16" flare door staples) on 6" centers and taped with 3" wide (minimum) foil reinforced Kraft tape. All pin penetrations or punctures in facing shall also be taped.

e. Acoustical Duct Lining

All supply, return, toilet room exhaust (where appropriate), mixed air and outside air ductwork shall be lined with acoustical insulation. The lining shall be one inch thick fiberglass, 1-1/2 pounds per cubic foot density, a minimum noise attenuation factor of NRC = 0.55 per ASTM C 1071 and NFPA 90A and 90B, and shall have a resistance to fungal and bacterial growth per ASTM C 665 and ASTM G21 and G22. The lining shall have a maximum heat conductivity (k factor) of 0.28 Btu-in/hr-ft²-F at a mean temperature of 75°F. The required fire hazard classification is flame spread not over 25, and smoke developed not over 50 per U.L. 723 test. The following products are approved: Schuller (formally Johns-Manville) "Permacote Linacoustic," CertainTeed "Ultralite with Certa*Edge Coat," and Owens Corning "QuietR". All other manufacturers / products must be reviewed and approved by University Facilities Management prior to bid.

15350 Special Piping Systems

15351 Natural Gas Piping on Campus

a. General:

1) When work is required on any gas line, require the Contractor to submit for prior approval worker qualification sheets for each worker in accordance with Pipeline Safety Regulations Part 191 and Part 192, published by The Department of Transportation Research and Special Programs Administration, Office of Pipeline Safety, current edition. See 15062 PIPING MATERIAL (UNDERGROUND OR BELOW GRADE) / e. NATURAL GAS herein for more information.

a) Require the Contractor to submit qualification sheets to the A/E, then the A/E shall submit two sets to the University Project
Manager, who will submit one set to the Supervisor of the Plumbing Shop for review and approval.

2) Questar Gas Company owns and maintains some natural gas fuel piping found on campus. Each piping system supported by Questar Gas has a meter set. Most of the natural gas lines on the campus, however, are the University's own distribution system. The Contractors will be required to provide coordination with Questar Gas and pay all required fees associated with Questar Gas line extensions, where applicable.

a) The contractors will be required to verify system pressure requirements prior to construction. The pressure varies according to location and system, and may range from 1 PSIG to approximately 50 PSIG pressure. Much of the distribution system carries intermediate high pressure natural gas at approximately 38 PSIG.

b) All natural gas piping on the campus should be in accordance with the latest edition of Questar Gas Company's "Good Practices for Gas Piping and Appliance Installations," regardless of the system to which it is being connected.

c) A gas meter shall be installed for each building on the campus.

d) When new plastic piping is routed under any road, the pipe must have a PVC or sewer pipe sleeve two pipe sizes larger than the gas line it will protect.

e) For underground natural gas piping exterior to the building, direct the Contractor to install an 18 gage continuous copper wire over the pipe. See 3.2 CIVIL / L. SITE UTILITIES FOR CAMPUS PROJECTS / (3) for specific design instructions including warning tape, approved methods for trace wire terminations, testing requirements, buried plastic or natural gas piping, sand cover, etc.

15352 Compressed Air Equipment

a. Laboratory Air Compressors

1) Laboratory air compressors shall be capable of scrubbing inlet air with water and delivering a minimum of Grade “D” air. Units are to be factory tested prior to shipment. Certified test data, performance curves, and spare parts lists are to be included in the operation and maintenance manuals. Include the following:
a) Single stage, oil-free, positive displacement, non-pulsating liquid ring operation.

b) Capacity adjusted for elevation.

c) Matched motor and power loadings such that motor overload will not occur at any operating pressure.

d) An electrical control panel in a NEMA 12 enclosure with starter(s); automatic lead-compressor alternator (if multiple compressors are specified) which will start the next compressor in sequence if the lead compressor fails to carry the load; sequencing control to prevent more than one compressor from starting at any one time; a hand-off-automatic selector switch; a 115 volt control transformer; and, a fused disconnect switch. Also include safety shut down on high receiver water level; and, compressor shut down/lag compressor start on high separator water level.

e) An external display including indicator lights to show each compressor “ON” and warning lights with horn and reset buttons to show thermal overload, high receiver water level, and high separator water level.

f) For each compressor, include inlet check valve; a discharge separator with integral ball float valve; relief valve; gauge glass; level switch; discharge check valve; discharge filter with automatic drain trap; pressure switch; flow control valve; 115 volt solenoid valve; strainer and backflow preventer; and, an inlet manifold serving all compressors with a common filter.

g) An ASME and National Board Stamped 125 PSIG working pressure galvanized steel pressure control tank or receiver with pressure gauge, safety valve, gauge glass, high-level float switch, and automatic drain trap.

h) Accessories including shock arrestor, flexible inlet connections, flexible discharge connection(s), flexible seal water line connection(s), inlet air filter, flow switch, and constant pressure valve.

i) Each lab shall be supplied with a separate readily accessible dryer and oil separator.

j) Each lab shall be supplied with a separate readily accessible dryer and oil separator.
b. Control Air Compressors

1) Control air compressors provide compressed air for control systems at 90 psi and shall include the following:

a) An automatic bleed to drain water from the storage tank. The valve shall have a dedicated receptacle and the piping run to drain.

b) An oil and water separator between the compressor and the building.

c) An air drier designed for a leaving air pressure dew point of 40° F. Dryer shall have a by-pass for maintenance.

d) System shall have a pressure transducer providing an input to the controls system in a 0-10v or 4-20mA signal.

e) An alarm through the BAS and shown on the graphics indicating low pressure.

f) Tank must be ASME stamped.

c. Acceptable manufacturers for both general laboratory and control air compressors are Quincy Compressor, FS-Curtis Air Compressors, and Ingersoll-Rand Company. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid.

15353 Vacuum Systems Equipment

a. Vacuum pumps are to be packaged central vacuum systems capable of passing fluids and soft solids through the vacuum pump directly to waste. Units are to be factory tested prior to shipment. Certified test data, performance curves, and spare parts lists are to be included in the operation and maintenance manuals. Include the following:

1) Single stage, oil-free, positive displacement, non-pulsating liquid ring operation.

2) An electrical control panel in a NEMA 1 enclosure with starter(s); automatic lead-pump alternator (if multiple pumps are specified); sequencing control to prevent more than one pump from starting at any one time; a hand-off-automatic selector switch; a 115 volt control transformer; and, a fused disconnect switch.

3) An external display including indicator lights to show each compressor “ON” and warning lights with horn and reset buttons to
show thermal overload, high receiver water level, and high separator water level.

4) For each pump, include inlet check valve; a discharge separator-silencer; vacuum switch; strainer; flow control valve; 115 volt solenoid valve; and an anti-siphon fitting (this fitting may be common to multiple pumps).

5) An ASME and National Board Stamped painted steel vacuum control tank with vacuum gauge, relief valve, and gauge glass.

6) Accessories including shock arrestor, flexible inlet connections, flexible discharge connections(s), flexible seal water line connection(s), and flow switch.

7) Acceptable manufacturers are Quincy Compressor, FS-Curtis Air Compressors, and Ingersoll-Rand Company. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid.

15400 Plumbing Systems

a. General: Piping and valves are specified elsewhere in this document.

1) All exposed branch water supply piping in toilet rooms and custodial rooms shall be chromium plated.

2) Water hammer arresters shall be provided on both hot and cold water lines serving fixtures and equipment using flushometer valves or quick-closing valves. One water hammer arrester may serve more than one fixture. These devices must be installed in the upright position. Where utility access has not been provided, access panels shall be provided for access to maintain these devices.

3) Maximum water velocity in pipes shall be 7 fps.

4) Backflow preventers and vacuum breakers shall be installed as required by the Utah Plumbing Code and as required by the University.

a) Install two (2) full size reduced pressure backflow preventers piped in parallel at the building water entry of lab and research buildings. Install one (1) full size and one (1) half size reduced pressure backflow preventer in parallel at the building water entry of office and classroom buildings.

b) Parallel reduced pressure backflow preventers are also required on all make-up water lines. One reduced pressure
backflow preventer shall be full line size and the other one shall be one pipe size smaller.

c) All devices shall be tested. Test Reports shall be submitted to the University Project Manager before Substantial Completion.

d) Approved devices are as follows:

<table>
<thead>
<tr>
<th>DEVICE TYPE</th>
<th>APPROVED MODELS</th>
</tr>
</thead>
<tbody>
<tr>
<td>REDUCED PRESSURE TYPE</td>
<td>Febco Model 825Y, Watts Series No. 909*</td>
</tr>
<tr>
<td>((PRESSURE TYPE))**</td>
<td>((Febco Model 765, Watts Series No. 800))**</td>
</tr>
<tr>
<td>ATMOSPHERIC TYPE</td>
<td>Febco Model 710/715, Watts Series No. 288A***</td>
</tr>
<tr>
<td>DOUBLE CHECK TYPE</td>
<td>Febco Model 805Y, Watts Series No. 700***</td>
</tr>
</tbody>
</table>

* Required by the University.
** Generally not approved for use at the University unless special conditions warrant.
*** For Atmospheric and Double Check Type devices, all other manufacturers and models must be reviewed and approved by University Facilities Management prior to bid.

5) Transformer vaults and electrical rooms shall have no water, waste, storm drain nor any other pipe conveying water (except fire sprinkler systems required for the vault).

6) Vending machine areas shall have a minimum of one floor drain or floor sink for every 10 feet of wall length. Each vending machine area shall also have a 1/2 inch (minimum) cold water line with a hose bib and atmospheric vacuum breaker at 4’-0” above the finished floor.

7) Cross connections (any connection or arrangement of piping between two otherwise separate piping systems, one of which contains potable water and the other non-potable water or industrial fluids of questionable safety) may cause non-potable fluid to enter the potable water system by either backflow, backpressure, or backsiphonage, and shall not be allowed without protection as required by code. Reduced pressure backflow prevention devices shall be installed so as to be accessible for testing. Adequate drainage shall be provided near each device. These devices shall be located on a wall at approximately 4’6” above the floor. All devices installed shall be "Approved". "Approved" is defined as those devices appearing on a current list issued by the Foundation for Cross Connection Control and Hydraulic Research of the University of Southern California, the Utah Department of Health, and Facilities Management through the University Project Manager.
b. Disinfection of Piping Systems shall be in accordance with Utah State Department of Health requirements and AWWA C651 Standard for Disinfecting Water Mains (Table of Required Flow and Openings to Flush Pipelines).

1) Require the Contractor to flush the piping system with clean, potable water until dirty water is no longer observed at all outlets.

2) Require the Contractor to sterilize domestic water system with a solution containing at least 50 PPM of chlorine. The solution shall remain in the system for 24 hours (or 200 ppm for 3 hours). All valves, faucets, etc. shall be opened and closed during this time.

3) Require the Contractor to contact the Salt Lake City Sewer Department prior to discharge. Salt Lake City must be notified that highly chlorinated water is coming to them.

4) Require the Contractor to flush the system with clean water until the residual chlorine content equals the ppm level of the domestic water supply on campus.

5) The water system will not be accepted until a negative bacteriological tests are obtained from water taken from the system (two tests are required, 24 hours apart).

6) For piping smaller than 4" (smaller pipe sizes are not shown in the AWWA Table) the University will require the blow-off line to be one pipe size smaller than the line size down to 2" main or branch size pipe. For 2" main or branch size pipe or smaller, the blow-off line is to be line size.

15401 Cold Water Systems

a. Install a water pressure regulator where shown on the drawings. Water pressure shall not be reduced below 45 PSIG (or 15 PSIG at the farthest connection in the building).

1) The pressure regulator shall be a diaphragm type of bronze construction. Regulator pressure shall be adjustable. An inlet strainer shall be provided.

2) Approved manufacturers are Watts Model U5B for 2" and smaller, and CLA-VAL Model 790 for units larger than 2".

b. Install a positive displacement, direct reading water meter at each building. The meter shall be located inside the building in an accessible location and approximately 4’ from the floor.
c. A valve and valve box shall be provided on the water service line to the building close to the main line.

d. No water line shall be less than 1/2”, except where shown on drawings.

e. Provide an isolation valve on branch piping to each toilet room which shall be located within each restroom in a 2 ft. x 2 ft. access door two (2) feet above finished floor in the plumbing chase wall, each lab, etc., and at each floor of the building. Valves shall be provided so that distinct areas may be isolated without affecting the remainder of the building.

15405 Soil and Waste Piping Systems

a. Building Waste Systems:

1) All horizontal drainage piping shall be run in practical alignment and a uniform slope of not less than 1/4 inch per foot (2%) toward the point of disposal. Drainage piping 4” and larger may slope at 1/8” per foot with approval by administrative authority (the University Project Manager and the Supervisor of the University Plumbing Shop).

2) All waste piping exposed below sinks or fixtures shall be chromium plated.

3) Vents shall extend full size through roof and shall project 18” (minimum) above the roof. "Flag-poling" of vents is not approved.

4) All fixture traps shall be provided with vents.

5) No water having a temperature greater than 140° F shall be discharged into the sanitary sewer.

6) Special venting for island sinks is discouraged. If an island sink is required, it should discharge into an approved floor sink below the counter, except for acid waste which shall not be allowed to be drained in this manner. This floor sink shall be accessible and shall have at least a half grate.

7) No sanitary sewer or sanitary waste systems shall be pumped except as a last resort and then only with permission of the University Project Manager. A duplex pump system shall be used if a pumped system is approved.

8) Trap primers shall not be used. Where a trap is subject to loss by evaporation, a deep-seal trap consisting of a 4-inch seal shall be installed. However, a cold water hose bib installed in the restrooms shall be acceptable as per the IPC.
9) Cleanouts shall be installed at the base of all vertical stacks, at each change of direction if the total aggregate change exceeds one hundred and thirty five (135) degrees, and on straight piping runs not to exceed 50 feet apart.

10) No floor drains or floor sinks are allowed in built-up fan systems.

11) Floor drains, floor sinks, etc., shall be provided with 30" square safety pans.

b. Acid Resistant (AR) Waste Systems:

1) Acid resistant waste systems shall be provided in all lab areas or other areas such as lecture rooms, etc. using chemicals.

2) AR waste systems shall be installed in accordance with current adopted codes and approved acid resistant material shall be used.

3) Neutralization tanks shall be used on systems less than eight (8) fixture units or 30 gallons per day.

4) Dilution tanks shall be used on system greater than eight (8) fixture units or 30 gallons per day.

5) Where movable laboratory ventilation systems are used they shall discharge into an approved AR floor sink through an approved air gap, except acid waste which shall not drain into the floor sink.

6) AR systems shall be directly connected to drain. Indirect drain systems shall not be acceptable.

c. Manholes requiring an inside drop connection and flow diversion device shall be specified with a Royal IntraFlow device manufactured by Royal Environmental Systems. Specify a slim design no greater than 7 inches, 90° sweep at the invert, EPDM gasketed joints, removable inspection hood, polyethylene construction, and H2S gas containment cover (where applicable).

15422 Roof Drainage

a. Roof drains shall not be less than 3 inches.

b. Horizontal roof drainage pipe shall be installed at a uniform slope of not less than 1/4 inch per foot (2%) toward the point of disposal.

15435 Water Conditioning Systems

a. All water conditioning systems shall have totalizing water meters on the inlet line and on the conditioned water supply line.
b. Verify water pressure at the conditioning system. Feed pressure at the inlet shall exceed the manufacturer’s recommended minimum pressure by 20%.

c. The design of all water conditioning systems shall include a hose bib in close proximity to installed equipment for mixing and tank filling activities. Include a floor drain when chemicals will be used in the equipment.

d. Water softeners shall have duplex resin tanks, a single brine tank which shall not exceed 48" in height, and an automatic regeneration system activated by the amount of flow, not by time clock. Provide sufficient floor space adjacent to the water softener for storage of bags of salt.

1) Water softening or conditioning equipment shall be based on GE Osmonics, or equal by Pacific Water Incorporated, Water Specialties, or McCook Sales. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid.

e. Automatic blowdown and chemical feed systems are to maintain a desired level of dissolved solids concentration in the water of the shell side of HTW steam generators with the use of a Lakewood conductivity controller.

1) Provide a Lakewood Model 250 Conductivity Controller with a Worcester Motorized Ball Valve and Orifice Union.

2) The chemical feed system shall include a Neptune Model 500 or 500A chemical feed pump and tank assembly complete with foot valve, check valve, pressure relief valve, and strainer. The system shall be mounted under a non-metallic 55 gallon chemical mixing tank, complete with agitator, low level switch, hinged tank cover, and suction assembly. The chemical feed tank shall have soft water for mixing.

3) Both the solenoid valve (located on the air line controlling the regulator valve) and the chemical feed pump shall be wired into the steam generator's level controller. When the steam generator calls for water, the chemical feed pump and blowdown system will begin operation (only upon activation of the make-up feed system). This system shall stop operation when the make-up valve serving the steam generator is closed.

4) The system is to include a liquid sample cooler. The device shall cool blowdown samples from 220°F to 100°F.

5) The approved water treatment supplier is W.E.S.T., Water and Energy Systems Technology. Other suppliers must be prior approved with University field tests before bidding.
f. Chiller condenser water chemical treatment shall utilize a controller designed to continuously protect the condenser water system from the harmful effects of scaling, corrosion, and microbiological growth. The controller shall operate via microprocessor technology and shall be Pulsafeeder PULSAtrol MCT210-B-C-F-L1-M3-WE. The products of other manufacturers will be considered only after successful site testing at the University. Any other prior approved product furnished and installed into the project must be equal or superior to the specified Pulsafeeder product. The controller shall include:

1) High resolution 10 bit A/D converter with adjustable analog sample sensitivity for accurate sensor inputs

2) Control of conductivity (user selectable scales 0-500, 0-2000, 0-5000, 0-10000, and 0-20000 micromhos

3) Fully isolated differential inputs for all circuits to prevent ground loops

4) Keyboard activated hand/off/auto control of all relays

5) Modular hardware and software for easy access and service

6) Pre-wired NEMA 4X enclosure

7) Hi-Lo alarm indicator

8) Mounted flow assembly

9) Selectable chemical feed timer: "percent", "limit", or "pulse"

10) 28 day dual biocide feed

11) Serial line with communications software

12) 4-20 mA isolated programmable proportional output for remote monitoring of system conductivity

13) 110/220/1/60 power requirement

15450 Plumbing Fixtures and Trim

a. All water closets, urinals, and lavatories in rest rooms shall be wall hung. Any intent to use countertop lavatories shall be prior approved with the University during design of the facility.

b. Provide floor type service sinks in custodial closets
c. Atmospheric vacuum breakers shall be provided on all sink outlets in lab areas; or, where shown on plans, a branch line backflow preventer may be installed in a water line supplying an area of a lab or labs. When a branch line backflow preventer is used, the water piping downstream of the device must be labeled as "non-potable water."

d. Provide floor drains within 5'0" of all mechanical equipment which has water connections or use.

e. Provide atmospheric vacuum breakers for all service sinks.

f. All sinks, lavatories and wash basins shall have stainless steel braided flex tube and chrome plated ¼ turn ball valves.

g. All lavatories in public toilet room shall be provided with open grid strainers and not pop-up or other type of closeable drains.

h. All floor sinks shall be provided with at least a half grate.

i. Fixtures in one building shall be of one manufacturer.

j. Approved manufacturers for fixtures and trim:

1) Emergency Eye Wash and Emergency Shower Fixtures

   Haws, Bradley or Guardian Equipment. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid.

2) Fixtures

   American-Standard (including Eljer), Kohler, Zurn, and Elkay. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid.

3) Floor & Roof Drains, Carriers, Etc.

   Zurn, J. R. Smith, Josam, and Wade. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid.

4) Trim

   Chicago Faucets, Elkay, and T & S Brass. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid.

5) Flush Valves
a) Each flush valve selected for the design shall be verified to match the fixture manufacturer’s model it will serve.

b) Manual flush valves shall be specified except for urinals and ADA toilets as described below.

(i) Manual valves shall be lever operated diaphragm flush valves manufactured by either Sloan or Zurn (if Zurn, specify valves from the Z6000 Series only), or approved equal as described below.

c) Urinals and ADA water closet fixtures are preferred to be specified with automatic flush valves. Specify battery operated valves equal to Zurn ZERK-CPM or TC HDM-TC-401186.

(i) Select automatic flush valves that can be refitted with a standard lever operator.

(ii) Each automatic flush valves shall include a manual flush button for use when the valve fails to function automatically.

d) Piston type operators shall not be allowed.

e) Valves by other manufacturers may be approved after site testing by the Plumbing Shop at the University.

6) Automatic Faucets

Automatic faucets are not allowed except for handicapped lavatories (wash basins), and only for no more than one lavatory in each restroom. The automatic faucets are to be specified with integral battery packs and not hard wired.

k. Provide at least one set of hose bibbs (hot and cold) under the lavatories in each public toilet room.

l. Provide a floor sink near the drains of automatic sprinkler systems.

15500 Fire Protection - General

a. Fire lines serving each building shall be separately connected to the water main.

b. Each fire line shall be hydraulically engineered.
c. No part of any building shall be more than 150 feet from a fire hydrant.

d. The automatic fire protection for computer rooms shall be the standard sprinkler system at a minimum.

e. Automatic fire sprinkler plans and subsequent submittals shall be submitted to the University Fire Marshal, who is also a Deputy Utah State Fire Marshal, for approval prior to installation.

f. At a minimum, fire extinguishers shall be located at each required exit stairwell on each floor, and shall be monitored by the fire alarm system.

g. Fire extinguisher special-hazard areas as mentioned in Section 906.1, item 6 IFC (2009) shall include the following: laboratories, primary electrical and mechanical rooms, computer server rooms, kitchens/kitchenettes, and chemical storage areas.

h. The University Fire Marshal shall inspect and witness all fire alarm and automatic sprinkler system tests.

i. The University Fire Marshal shall reserve the right to inspect the installation, material, and equipment at any time or phase of the project.

15501 Automatic Fire Extinguishing Systems

a. See Section 15061 Piping Material (Above Grade – “a.g.”) o. Fire Protection.a.g. for approved piping usage.

b. The University does not permit automatic fire sprinkler systems to be fabricated in combination with systems for heating or cooling, such as water source heat pumps connected to fire sprinkler piping.

c. The fire department connection to the automatic fire sprinkler system shall be located on the "front" or main access side of a building at a maximum distance of 100 feet from a fire hydrant.

d. Each valve in the fire protection system shall be provided with an approved supervisory switch or "tamper" switch (including post indicator valves and antifreeze loop control valves) wired into the fire alarm system of the building.

e. Each valve switch is to report on a separate zone.

f. A flow switch shall be required at the main riser and at each isolated zone. New systems shall be separated into a different zone at each floor with a floor control assembly that shall include a flow switch, control valve and main drain tie-in. Each flow switch shall include an automatic flow switch tester.
and shall be monitored as required by NFPA 13. The flow switch testing assembly is to be UL listed or FM approved.

1) Approved system is the Zonecheck Automatic Flow Switch Tester by Global Vision, Inc. or equivalent. All other manufacturers / products must be reviewed and approved by the University Fire Marshal prior to bid.

2) The system is to be installed in accordance with the manufacturer’s instructions. An example of the installation requirements can be found at http://www.systemsensor.com/pdf/A05-0272.pdf.

g. Fire protection non-glycol sprinkler systems require drain valves at all low points and a system test/drain valve at the building riser.

h. The design is to include a floor sink at all drains discharging from non-glycol sprinkler systems, including the inspector’s test drains, low point drains and the system drain at the building riser. Connect the floor sinks to the nearest sanitary sewer or storm drain system, and provide an air gap at the floor sinks. The system drain requires a larger line designed for quick drainage, and it is advisable to locate the riser close to the building sewer main, if possible.

i. Where antifreeze is used in an automatic fire extinguishing system, that section of the system which has the antifreeze shall be protected from the rest of the system with a reduced pressure backflow preventer. Antifreeze loops shall be separated from the remainder of the system with an isolation valve.

j. Glycol fire sprinkler system drain/test valves are to be located where a container can be provided to catch the glycol solution for reuse. Provide a sanitary sewer floor sink in the area to collect spillage, etc. Do not run a glycol system test/drain line to a storm sewer.

k. Sprinkler heads in equipment rooms, storage rooms, etc. shall be furnished with guards.

l. The use of flex heads shall be approved by the University of Utah’s Fire Marshal on a case by case basis.

15532 Hose Cabinets

Refer to State adopted codes.

15535 Fire Extinguishers

a. A minimum 4A:40BC rated fire extinguisher shall be provided in all corridors. The maximum distance to any fire extinguisher shall be 75 feet.
b. "4:40BC" rated fire extinguishers shall be provided in kitchens.

c. The top of the fire extinguisher, or cabinet if used, shall comply with code requirements.

**15554 Computer Rooms and Other Applications**

a. Computer rooms and all other applications requiring fire protection shall be provided with standard sprinkler systems.

b. All electrical systems serving the computer room shall cease to operate prior to the release of water.

c. Coordinate with the University Project Manager regarding fire extinguishing systems in other areas such as kitchen hoods, etc.

**15650 Refrigeration - General**

a. Window units shall be Comfort-Aire or Amana.

b. Split systems are to be Fujitsu or Mitsubishi.

c. Ducted split systems shall include suction and discharge service valves, crankcase heaters, liquid sight glass, filter driers, vibration isolation, lift traps, and solenoids.

d. Room side noise shall be limited to RC values found in ASHRAE Systems, Sound and Vibration Control.

e. Evaporator coils located near heating coils, pressure relief devices, and fusible plugs shall have relief piping, sized and routed per the requirements of ASHRAE Standard 15, "Safety Code for Mechanical Refrigeration."

f. Mechanical Rooms which contain mechanical refrigeration shall be ventilated; and, shall have sensors and alarms installed per ASHRAE Standard 15, "Safety Code for Mechanical Refrigeration."

**15670 Chillers**

a. New chillers shall operate with EPA approved refrigerants. Required refrigerant sensors, alarms, and controls shall be supplied and installed in the Mechanical Room in accordance with current UMC, ASHRAE, etc., standards. Additionally, install a visual alarm outside the Mechanical Room near the entry. Refrigerant alarms are to include an interface connection for the campus central control system. Relief/purge systems shall be piped outdoors.
b. Acceptable refrigerants are those with an ozone depletion potential (ODP) of 0.02 or less, and a global warming potential (GWP) of 700 or less (GWP based on CO$_2$ = 1).

c. All new piping shall be thoroughly flushed and cleaned before being placed into service. The cleaning of these piping systems shall be accomplished by the Contractor using the University’s approved water treatment supplier.

d. Reciprocating chillers shall include the following features:

1) Provide dual independent refrigerant circuits complete with lead-lag switch.

2) Unit shall be factory tested at full and part load conditions.

3) Unit shall be factory charged with a certified leak test.

4) The chiller shall be UL or ETL listed.

5) Provide thermal protection on all three phases of the compressor motor, where applicable.

6) Compressor accessories shall include suction and discharge service valves, oil crankcase heater, suction strainer, oil strainer, oil sight glass, and oil charging connection.

7) Compressors shall be mounted on vibration isolation pads to minimize noise and vibration transmission.

8) Evaporator shell shall be insulated with 3/4” closed cell insulation.

9) The evaporator shall be designed, constructed, tested and stamped in accordance with ASME requirements.

10) Condensers shall be cleanable thru-tube type.

11) Condenser accessories shall include liquid shut off valve, removable water heads, vent and drain plugs, purge valve, and spring loaded relief valve per ANSI/ASHRAE 15 Safety Code.

12) The condenser shall be designed, constructed, tested and stamped in accordance with ASME requirements.

13) Provide a minimum of 15° F. sub-cooling through a sub-cooling circuit in the condenser.

14) Control panel shall have dead front panel doors to protect service personnel against accidental contact with line voltage components.
15) Power and starting components shall include separate fusing for the control circuit, starting contactors per compressor, solid state overload protection in all three phases, and solid state compressor sequence start timers.

16) Safety and operating controls shall include an external unit control stop switch with indicating lights, recycling pump-down control, manual pump-down switch, compressor lead lag switch, oil safety switch, high and low pressure switches, water temperature controller, freeze protection thermostats, five minute solid state lock-out timer, and unloaders.

17) Unit controls and wiring shall be completely factory labeled for ease of service and replacement.

18) Factory installed refrigerant piping shall include insulation on the suction lines, filter/drier with replaceable core, liquid sight glass/moisture indicator, liquid line solenoid valve, manual liquid line shut-off valve with charging connection, and thermal expansion valve. Each compressor circuit is to be independent and should include a complete set of these items.

19) Factory installed gauges, each with its own manual isolation valve, shall be provided for displaying high and low side refrigerant pressures and oil pressures.

20) Approved manufacturers for reciprocating chillers are Carrier, Trane, or York. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid.

21) The piping design supporting the chiller and any air handler in the vicinity shall include a hose bib in close proximity to installed equipment for cleaning coils, etc.; and, shall include a floor drain to the sewer system (not the storm drain system) when chemicals will be used in equipment.

e. Centrifugal chillers shall have the following features:

1) KW meter for measuring the electrical input to the chiller.

2) Soft start or VFD control on chillers 480V and above.

3) Chiller controls shall communicate with the campus building automation system.
4) Provide service valves or other factory-installed accessories required to facilitate transfer of refrigerant from the chiller to a remote storage and recycling system.

5) Provide automatic purge system on sub-atmospheric refrigerants.

6) Condenser and evaporator tubes shall be smooth internal finish and enhanced exterior finish.

7) Supply an adequate lifting attachment point for head removal.

8) Epoxy coat the end bells on the condenser at the factory.

9) Provide 5 years parts and labor warranty on the unit, and 3 years on the compressor.

10) Approved manufacturers for centrifugal chillers are York, Trane, and Carrier. All manufacturers must be reviewed and approved by University Facilities Management prior to bid.

11) The piping design supporting the chiller and any air handler in the vicinity shall include a hose bib in close proximity to installed equipment for cleaning coils, etc.; and, shall include a floor drain to the sewer system (not the storm drain system) when chemicals will be used in equipment.

f. Rotary screw chillers will not be approved.

15680 Cooling Towers

a. Provide a concrete structure or fiberglass structure modular induced draft cooling tower as shown on the drawings. Only specify cooling towers with ceramic fill.

b. All tower fans shall be controlled on supply water temperature via VFD.

c. Towers used for “free cooling” during winter months shall have a provision for de-icing.

d. Tower blow-downs shall be fitted with a meter and information recorded on controls graphic.

e. Concrete cooling towers shall include:

1) Basin floor slab of continuous pour high density type II air entrained concrete. The mix shall meet a compressive strength test of 4,000 psi minimum (28 days).
2) Reinforcing steel shall be designed for use in the basin structure.

3) A continuous stripping of molded polyvinyl plastic water-stop (6" dumbbell) is to be located on the centerline position of all basin wall sections, basin floor slab intersections, and at all other cold pour joints, including vertical wall joints.

4) Standard curing measures shall be used to protect the concrete while "green".

5) Basin wall sections shall be constructed in a second continuous pour, with structural steel as designed by a structural engineer.

6) Wall sections shall interlock with the water-stop seal in the basin slab to form a completely waterproof basin.

7) All exposed concrete shall be rub-finished to provide a smooth and uniform surface free of form marks and defects. No honeycomb concrete will be allowed.

8) Provide tile fill and cast iron fill support lintels guaranteed for 25 years.

9) Provide a minimum of 3 pass cellular type PVC mist eliminators. Free water carryover shall not exceed 0.0005% of the design water flow.

10) Eliminator access doors shall be stainless steel.

11) Provide a vibration switch with a time delay for start-up.

12) Gear type speed reducers shall be provided with an oil level alarm switch, sight glass, fill/drain line, and vent line. These appurtenances shall terminate outside the tower stack for maintenance.

13) All wetted parts shall be non-corrosive. Fan blades shall be stainless steel or fiberglass reinforced resin. Drive shafts shall be carbon fiber with stainless steel. plate type flexible couplings. Pulleys, if used, shall be stainless steel.

14) Each drive shaft coupling shall be provided with a galvanized steel guard to protect the tower from shaft failure.

15) Motors shall be TEFC, and one size larger than selected for the rated duty of the tower.
16) Distribution system shall have no metal parts. Piping, fittings and nozzles shall be low pressure distributor type PVC or fiberglass reinforced resin. ABS nozzles may be used. Nozzles shall be bayonet coupling style with o-ring seal.

17) The fan deck shall be concrete constructed to the same specifications as the basin and walls.

18) Provide an aluminum fan screen for the tower stacks.

19) Provide adequate tower access via galvanized steel access doors and ladder rungs cast in concrete.

20) Cooling towers are to be designed with remote sumps to prevent freezing. Where impractical, provide a basin heater sized to maintain 40 degrees in the basin at an ambient temperature of -10 degrees F.

21) Cooling tower fans are to be controlled by water temperature and shall shut down when water is not present.

22) Approved manufacturers are Tower Engineering, Inc.; Marley Cooling Technologies; and, Composite Cooling Solutions, L.P. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid.

23) The piping design supporting the tower shall include a hose bib in close proximity to facilitate cleaning and tank mixing activities; and, shall include a floor drain to the sewer system (not the storm drain system).

f. Fiberglass structure cooling towers shall include:

1) Casing, fan deck, internal supports, and basin shall be fire retardant glass reinforced polyester resin.

2) All structure connecting surfaces and attachments shall be stainless steel (s.s.), including s.s. bolts.

3) All joints shall be sealed with a continuous type sealant.

4) All interior and exterior surfaces shall be coated with an all weather material to protect against UV deterioration on the outside, and to protect against wear on the inside.

5) The tower shall be built to withstand 160 degrees F. and 30 PSF wind loading. Flame spread shall be 25 or less.
6) Provide tile fill and fiberglass reinforced polyester fill support lintels guaranteed for 25 years.

7) Provide PVC mist eliminators with free water carryover not to exceed 0.02% of the design water flow.

8) Provide a vibration switch with a time delay for start-up.

9) All wetted parts shall be non-corrosive. Fan blades shall be stainless steel, fiberglass reinforced resin, or aluminum. Pulleys, if used, shall be stainless steel.

10) Motors shall be TEAO, chemical duty, with sealed non lubrication bearings, when the motor is in the air stream otherwise the motor shall be TEFC, and one size larger than selected for the rated duty of the tower.

11) Distribution system shall have no metal parts. Piping, fittings and nozzles shall be low pressure distributor type PVC or fiberglass reinforced resin. ABS nozzles may be used. Nozzles shall be bayonet coupling style with o-ring seal.

12) Provide an aluminum fan screen for the tower stack.

13) Provide adequate tower access via access doors.

14) Provide ABS air intake louvers to shield the interior from sunlight and eliminate tower basin splash.

15) Provide a stainless steel or fiberglass ladder mounted to the tower exterior.

16) Cooling towers are to be designed with remote sumps to prevent freezing. Where impractical, provide a basin heater sized to maintain 40 degrees in the basin at an ambient temperature of -10 degrees F.

17) Cooling tower fans are to be controlled by water temperature and shall shut down when water is not present.

18) Approved manufacturers are Tower Engineering, Inc.; Marley Cooling Technologies; and, Composite Cooling Solutions, L.P. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid.

19) The piping design supporting the tower shall include a hose bib in close proximity to facilitate cleaning and tank mixing activities; and, shall include a floor drain to the sewer system (not the storm drain system).
g. Metal cooling towers shall include:

1) Low noise, low vibration, high efficiency fan.

2) All stainless steel construction.

3) Hinged access doors.

4) Distribution system shall have no metal parts. Piping, fittings and nozzles shall be low pressure distributor type PVC or fiberglass reinforced resin. ABS nozzles may be used. Nozzles shall be bayonet coupling style with o-ring seal.

5) TEAO motor.

6) Approved manufacturers are EVAPCO, BAC and Marley Cooling Technologies. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid.

7) The piping design supporting the tower shall include a hose bib in close proximity to facilitate cleaning and tank mixing activities; and, shall include a floor drain to the sewer system (not the storm drain system).

15700 Heat Transfer

a. Pulse combustion, high-efficiency condensing, copper finned water tube, and scotch marine type boilers shall be designed in accordance with the American Gas Association; manufactured in accordance with the ASME Power Boiler Code, Section I; and shall meet the Utah State Boiler Code - CSDI.

1) Boilers shall be furnished with an adequate number of tappings and inspection openings to facilitate internal inspection and cleaning.

2) Include a factory installed insulated metal jacket, with 2" (minimum) fiberglass insulation, and a heavy gauge (18 GA minimum), rust-resistant, zinc coated steel casing, painted with heat resisting primer and finish coat. The jacket assembly shall be easily removable for maintenance.

3) Provide unions or flanges in all connecting piping for future maintenance. Factory furnished trim shall include gauges, controllers, air and gas safeties, Industrial Risk Insurers (IRI) gas train, UV sensor combustion safeties, and alarm contacts for the University's central controls computer.
4) Hydronic / steam boilers 90,000 to 1,000,000 BTUH input shall be pulse combustion or copper-finned water tube type. Approved manufacturers are Fulton, RBI, KN Lochinvar or approved equal

   a) Boiler and burner shall be the product of the same manufacturer.
   b) Provide ASME safety valves

5) Hydronic / steam boilers above 1,000,000 BTUH input shall be scotch marine fire-tube or water-tube types equipped with an ultralow NOX modulating burner. Approved manufacturers are Cleaver Brooks, Burnham, Rite Boilers, and Hurst or approved equal.

b. Fully Condensing Hot Water Boilers

1) Minimum Required Certifications

   a) ASME certification (an ASME Stamp on the product), and a completed and signed data sheet.
   b) ASME CSD-1 certification in the form of a completed data sheet.
   c) CSA or UL certification in the form of a label affixed to the product.
   d) For any factory tests specified by the A/E, require verification that the tests have been satisfactorily performed and include confirming test data.
   e) For any field tests specified by the A/E, require verification that the tests have been satisfactorily performed and include confirming test data.

2) Condensing Boiler Fabrication Requirements

   a) Condensing boilers shall be specified to be “compact” with a non-aluminum heat exchanger.
   b) The boiler pressure vessel shall be completely insulated with a minimum of 2” of insulation and shall be encased in an 18 gauge metal cabinet with powder coated finish or equal. Specify that external convection and radiation heat losses to the boiler room from the boiler shall be less than 0.5% of the rated input. Boiler submittals shall verify this requirement.
c) Boiler design shall include a heating water system that will operate at condensing temperatures during off peak seasons.

3) Venting

a) The boiler shall be specified to be UL certified as an indirect or direct vent boiler.

b) Require stainless steel, double-wall vent piping installed in accordance with applicable national and local codes.

c) Specify that the Contractor shall perform or provide a boiler venting analysis. The analysis shall include combustion air shop drawings to ensure that boilers will operate properly and to manufacturer’s specifications with the size and routing of vent and combustion air ducting.

4) Emissions

a) The equipment shall be guaranteed to limit NOx emissions to the best available control technology (BACT). The BACT requirement shall be based on the current State of Utah requirements.

b) Specify that written documentation of the emission levels from the manufacturer will be required as part of the University’s permitting process. Verification via stack testing will only be required for large, central heating plant boilers.

c) NOx emission levels shall not be exceeded at full operating conditions and at designed turndown of the burner.

5) Computerized Control System

a) The boiler shall include a computerized control system which shall be integrated into the campus building automation system (BAS) through BacNet communication.

b) Coordinate with Facility Operations through the University Project Manager for specific system requirements in addition to Section 15900 in EE. THE GUIDE SPECIFICATION FOR MECHANICAL SYSTEMS.

6) Condensing Boiler Warranties and Guarantees

a) The package boiler shall be warranted for a period of one year from date of substantial completion.
b) The pressure vessel shall be guaranteed against thermal shock for 20 years when utilized in a closed loop hydronic heating system with a temperature differential of 120 °F or less. The boiler pressure vessel shall be guaranteed accordingly without a minimum flow rate or return water temperature requirement. The boiler shall not require the use of flow switches or other devices to ensure minimum flow.

c) The pressure vessel (heat exchanger) shall be guaranteed against flue gas corrosion and materials/workmanship for a period of 10 years.

d) The condensate collection box shall be guaranteed for 20 years.

e) The burner cylinder shall be warranted for a period of 5 years.

f) All parts not covered by the above warranties shall carry a 1 year warranty from date of substantial completion. This shall include all electrical components and burner components.

7) Hydrostatically test the boiler and piping in accordance with the ASME Boiler and Pressure Vessel Code. Provide the services of an inspector certified by the National Board of Boiler and Pressure Vessel Inspectors during the boiler site tests.

8) Boiler start-up shall be performed by a factory authorized service representative. Require copies of certification and test results prior to start-up / commissioning, and require that these be included in project O&M manuals per the Supplemental General Conditions.

9) The factory authorized service representative shall instruct the University in the operation of the boiler. The operation demonstration shall include a review of the operating and maintenance manual, a description of the preventative maintenance schedule and procedures, an outline of the process required to obtain repair parts, and the method of contacting factory trained technicians for technical assistance. The representative shall demonstrate all phases of operation including start-up and shut-down for the University's maintenance technicians.

10) The contractor shall schedule an inspection by the Utah State boiler inspection at the completion of installation and shall correct all deficiencies identified by the inspector.
15701  **Hot Water Heating Systems**

a. Provide a reverse return piping system to equalize pressure at each terminal.
b. Air separators and expansion tanks shall be provided on all hot water heating systems. The air separator shall be located on the suction side of the pump.
c. Manual air vents shall be located at all high points in the piping system. Auto air vents are allowed only in mechanical spaces. Drain valves shall be provided at low points.
d. The piping system shall allow for expansion through the use of expansion loops, swing joints, offsets, etc. as may be required.
e. If hot water is used for preheat coils, provide an additional converter and use an inhibited propylene glycol system. Plate and frame type heat exchangers are preferred.
f. An outdoor thermostat shall reset the system hot water temperature with respect to the outside air temperature.

15702  **Chilled Water Piping Systems**

a. Chilled Water:

1) Air separators and expansion tanks shall be provided on all hot water heating systems. The air separator shall be located on the suction side of the pump.

2) Manual air vents shall be located at all high points in the piping system. Auto air vents are allowed only in mechanical spaces. Drain valves shall be provided at low points.

3) All chilled water systems shall include an automatic water treatment system.

4) Isolation valves shall be provided at each riser and each building level.

5) Pressure and temperature test ports (PTs) shall be provided across each device in the pipe system.

b. Condenser Water (Cooling Tower) Systems:

1) Provide remote sumps or basin heaters for cooling tower freeze protection.
2) Adequate vertical elevation shall be maintained between the cooling tower sump and inlet of the pump to maintain the proper NPSH of the pump.

3) A suction strainer equipped with inlet and outlet pressure gauges shall be provided between the cooling tower and the pump. A sidestream solids separator with nozzles in the sump shall be provided.

4) Make-up water shall be provided through an automatic electric ball valve serving a fill line connected inside the building and actuated by sump probe control. Make-up water shall not be routed outside.

5) Free cooling condenser water systems shall use a plate and frame heat exchanger between the condenser water and chilled water side.

c. Glycol Cooling Systems:

1) Any piping system with components exposed to freezing temperatures shall be protected. Glycol solutions shall be used in outdoor-mounted applications subject to freezing. Heat tape is prohibited.

2) Glycol shall be industrial type inhibited propylene glycol. ethylene glycol is prohibited.

15703 Steam Heating Systems

a. Two pipe steam systems shall be provided. One-pipe steam systems are not acceptable.

b. Duplex condensate pumps shall be provided where necessary to return condensate to boiler or converter.

c. All steam radiation shall be individually valved and trapped.

15710 Hot Water Specialties - Pumps

a. Pumps shall be the centrifugal type with mechanical seals.

b. Install pressure gauges with gauge cocks as close to pump suction and discharge as possible.

c. Provide a suitable balancing valve on the pump discharge, with lock down memory stop and removable handle on all non-VFD controlled pumps. Balancing valves shall not be installed on VFD controlled pumps provide additional isolation valves.
d. Provide suction diffusers on floor mounted pumps. Include strainers except for condenser water systems where a separate basket strainer shall be installed.

e. Floor mounted pumps are to include back pull-out of all pump parts without disturbing system piping.

f. Hand/off/auto switches are required for all pumps (primary and secondary). These shall be specified in 3.5 Electrical.

g. Acceptable manufacturers are B&G, Taco, Paco, and Armstrong. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid.

h. Provide redundant pumps on the secondary systems for HTW heating converters. Redundant pumps allow for standby and alternating use. Maintain secondary water circulation through HTW converter at low use times to prevent damage and extend the life of the converter. Provide lead/lag controls for pumps.

i. All base mounted pumps shall be grouted unless the manufacturer recommends against it.

15730 Heat Exchangers and Converters

a. High temperature water heat exchangers are described in the high temperature water section. 3.8 HVAC.

b. Steam generated from the University's HTW system shall not be used to generate hot water.

c. Plate and frame heat exchangers are preferred over shell and tube type. However, note that only shell and tube heat exchangers shall be used with high temperature water. Specifications for plate and frame heat exchangers shall include:

1) 150 LB ASA rated flanged ports.

2) ASME code Section VIII stamp on the unit. Also include Form U-1 in the O & M manuals.

3) Computerized selection to be included in submittals and O & M manuals. Also, include the plate material, plate type, and pricing for additional plates and gaskets.

4) Approved manufacturers are Tranter Bell and Gossett, Armstrong and Alfa-Laval. All other manufacturers must be reviewed and approved.
by Facilities Management through the University Project Manager prior to bid.

15740 Terminal Units - Variable Air Volume

a. The variable air volume terminal box shall be a factory manufactured assembly with external control linkage.

b. Coordinate with the control specifications to provide controls which match the operation specified and approved manufacturer; and, coordinate with the University Project Manager to determine if the Systems Operations Shop desires to install and prove the controls. Otherwise, installation and proving will be done by Contractor.

c. Variable air volume terminal units shall be pressure independent and shall adjust to any air flow between zero and the maximum catalogued CFM.

d. Dampers on terminal units shall not exceed 2 percent leakage as rated by ADC standards.

e. Terminal units shall be internally lined with a minimum of 1 inch 1-1/2 pound insulation.

f. Design layout of VAV terminal boxes shall include noise attenuating ell's and lined duct as required to meet ASHRAE RC criteria in the occupied space.

g. Units shall be Anemostat, Krueger or Titus. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid.

h. Fan powered terminal boxes are not allowed at the University.

i. VAV terminal boxes may not be used on existing constant volume systems unless the VAV terminal boxes are controlled in the constant volume mode.

j. VAV terminals shall be provided with a removable velocity cross for flow measurement and a discharge temperature sensor.

15750 Heating and Cooling Coils

a. Heating and cooling coils must be designed to prevent freezing. Inhibited propylene glycol may be required. If cooling coils are to be drained to prevent freezing, they should drain completely. Where heating coils are combined with cooling coils, the heating coil shall be first in the air stream to prevent freezing.

b. Provide gauge cocks on inlet and outlet of all coils.
c. A drip pan shall be provided under each section of every field assembled cooling coil. Pans shall extend at least 12” beyond the leaving face of coil. The drain pan shall meet all IPC requirements.

d. Coils are to be selected, submitted, and approved with an ARI certified computer program.

e. Coils are to be selected with a fin spacing equal to or less than 10 FPI.

f. Coils are to be factory tested at 350 PSI prior to shipment.

g. The space between and around coils must be at least 24” to allow cleaning. Provide access doors for cleaning and maintenance.

h. Coil filters shall be easily accessible. Where pre-filters protect higher efficiency filters downstream, either set of filters must be easily replaced without disturbing the other set.

15755 Terminal Units - Heating

a. All terminal heating units shall have automatic control valves and isolation valves, accessible for maintenance.

b. Exposed cabinets shall be 14 gauge with institutional grade construction.

c. Ceiling concealed units are to be provided with secondary drip pans under the valves and fittings, with drain piping to protect ceilings.

d. All direct drive units shall be selected to provide design capacities at low or medium speed.

15770 Packaged, Rooftop, and Custom Air Handling Units

a. Access doors for inspection and cleaning must be provided for all internal parts including dampers. Coils are to have access to both inlet and outlet air sides. Doors shall be hinged and open against pressure.

b. Dampers are to be low leak type. Leakage rate for new dampers should be designed to meet 3 cm/sf at 1” W.C. per AMCA Standard 511.

c. Provide fans with easy removable belt guards (including internal mounted drives).

d. Provide a 120 V duplex convenience outlet with ground fault protection, a 220v outlet, and a hose bib in the vicinity for coil cleaning.

e. Sump pumps are required to be low profile and completely submerged. Ball
f. If indirect coils are installed they shall be run from both sides and must not be installed back to back. Coils shall be run from one side of the unit to the other.

g. Units shall have stainless steel drain pans that are positively sloped. Slope shall be 1/8’ per foot, and sloped front to back and side to side.

h. Air Washers to be stainless steel.

i. Copper piping should be used for air wash.

j. Provide unit with auto blown down system and auto rinse.

k. Provide unit with a water detection system, to send an alarm and shut off the water supply to the evaporative cooling module.

l. The minimum outside air must have an air flow monitoring system.

m. Reinforcing must be designed into the damper bank to ensure that dampers do not flex.

n. Freeze stats must protect entire coil surface.

o. Unit shall be designed to prevent snow and water carry over into the filter bank. At minimum, intermediate space should be provided between the snow and water intrusion and the filter bank with drains located within that space.

p. Specify that upon substantial completion a new set of filters shall be provided for each unit.

q. Minimum MERV rating for filters shall be MERV 13.

r. Coil tubing wall thickness shall be .035”

s. Units shall be provided with a differential pressure transfer meter across each filter, fan, and coil. The meter shall be connected and monitored by the campus BAS system.

t. Soft water shall not be designed to run to the air wash medium.

u. Cooling coils shall be design with a minimum delta T of 16 degrees.

v. All units shall be provided with a pre-heat coil. The heating water circulating through the pre-heat coil shall contain a minimum 30% propylene glycol.

floats will not be acceptable.
w. Minimum outside air must be covered by a pre-heat coil, if the pre heat coil does not cover the entire unit then it must be supplied with its own fan.

x. Fans are to be welded construction only.

y. Motors over 5hp must have a rigging point included as part of the design.

aa. No scaffolding or structure may be designed on top of fans. Scaffolding or structure that interferes with the proper operation of equipment including seismic and vibration devices, is prohibited.

bb. Units shall be supplied with access to all sections and levels. Larger units may require cat walks to reach coils. Cat walks and platforms shall provide access to all equipment sections and points that require maintenance. Access shall not be by ladder.

c. Units shall be a minimum 4” of double wall insulated construction. Insulation shall not be visible within the unit.

d. LED lighting shall be provided in each section of the units, and provide a 5 foot candle minimum light level.

e. All floors of the units shall be welded construction to prevent leakage.

ff. Floors and Walls shall be constructed from 18 gauge metal. The unit shall be constructed of the following materials:

1) Floors shall be 18 gauge, 316 stainless steel diamond plate or greater if required by application.

2) Walls shall be 20 gauge galvanized steel or greater if required by application.

gg. Equipment that is not directly related to the unit shall not be mounted anywhere on the unit.

hh. Provide 3 years parts and labor warranty on the unit.

15775 Computer Room Units

Liebert shall be the basis for design of computer room units. Other manufacturers will be considered only after an on-site inspection and “hands-on” demonstration on the alternate equipment for the A/E, University HVAC Shop, and Facilities Management engineers (Facility Operations and Construction Project Delivery).
15800  Air Distribution - General

Air intakes are to be located away from exhausts, vehicle emissions, cooling towers, flues, etc.

15821  Built Up Fan Systems

a. Centrifugal fans are to include belt guards and protective screens around drives and fan wheels. Include vibration isolation bases for the fans and drives. Approved manufacturers are New York Blower, Alladin, Barry Blower, or Pace. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid.

b. The use of vane-axial fans must be prior approved by Facilities Management through the University Project Manager. Prior approval for such designs will be based on noise, maintenance, application, and alternative design considerations. Manufacturers to be considered are Strobic-Air and Joy fans.

c. Provide ample clearance around the fan for servicing of bearings, replacement of wheel, motor, drives, and cleaning.

d. Motors for belt driven fans shall operate at speeds not to exceed 1800 rpm. Motors on high velocity fan systems and variable air volume systems shall be provided with variable frequency drive (VFD) motor speed controls including power factor correction capability, as specified in 3.5 Electrical.

e. Built-up fan enclosures shall be a sandwich shell design equal to IAC (Industrial Acoustics Company), designed and constructed to withstand 8” wg static pressure or one and one-half times the pressure of the fan, whichever is greater. Access doors should be limited in size to approximately 20” wide by 54” high and shall open against air pressure.

f. There shall be a set of filters upstream of any coil, fan or evaporative media.

15829  Exhaust Fans

a. Roof mounted exhaust fans which are visible from other locations must be painted char brown. Visibility of these devices must be limited.

b. Exhaust fans are to be located at or near the termination of the discharge of the exhaust system. Such systems shall be installed with additional capacity to allow for future additions to the exhaust system. Exhaust fans should be installed in a location that eliminates the need to install exhaust duct under positive pressure (i.e. past the fan discharge) in an interior space. This arrangement will decrease the likelihood of discharging hazardous materials into the building interior.
c. Fume hood exhaust systems are described in 3.8 HVAC.

d. Prepare a comprehensive equipment schedule for use on project drawings, and label each fan in the schedule to match a corresponding label location on the drawings.

e. All exhaust fans with motors larger than 5hp, and any exhaust fan having the motor installed higher than 6 feet over the working surface, shall be designed with a platform or rigging in order to remove and transport the motors and that will allow safe access to all service points on the fan and motor without the use of a ladder.

f. Exhaust Fan Selection

1) Select fans from manufacturers that provide fan ratings based on tests made in accordance with AMCA Standard 210 and are licensed to bear the AMCA Certified Ratings Seal for Air Performance.

2) All fans designed for the project shall be UL or ETL Listed.

3) Fans selected for the project shall have a sharply rising pressure characteristic extending throughout the operating range to assure quiet and stable operation from wide open to closed off.

4) Select fans from manufacturers that provide fan equipment tested for sound power level ratings in accordance with AMCA Standards 300 and 301. Select fans which have been tested in an accredited AMCA laboratory, and with sound power ratings provided in decibels.

g. Exhaust Fan Specifications

1) Fans shall be specified as single-width single-inlet and capable of operating over the entire Class II range as defined in AMCA Standard 99-20408.

   a) Designs not in accordance with AMCA Standard 99-240 1 are not acceptable.

   b) Fans representing other styles may only be used in the design after approval is received via the Design Standards Project Variance Request Form submitted through the University Project Manager.

2) Select fans with fan housings that are heavy gauge, continuously welded, and reinforced with rigid bracing to increase structural integrity and prevent vibration. Housings with lock seams or partially welded construction are not acceptable. Aluminum housings are not acceptable.
3) Housing inlet cones shall be aerodynamically designed and spun providing a minimum separation of air flow. All part connections shall be welded in lieu of riveting. No aluminum parts are to be allowed.

4) Fan wheels shall utilize non-overloading flat, single thickness blades in all sizes. Wheel diameters and outlet areas shall be in accordance with the standard dimensions adopted by AMCA for centrifugal fans.
   a) Require fan wheels to be dynamically balanced on precision balancers at the factory. Prior to shipment, completed fans shall receive a final test balance at the specified operating speed.
   b) Fan guards shall be specified as quick release type.

4) Bearings are to be specified as precision anti-friction ball self-aligning type, 4 lug or pillow block. All bearings are to be specified as grease lubricated and provided with Zerk fittings. Select fans from manufacturers that locate the Zerk fittings in places to allow sufficient maintenance clearance.

5) Shafts are to be specified as ASTM A-108 steel, grade 1040/1045, precision turned, ground and polished. Grade 1018 steel is not acceptable. The shaft's first critical speed shall be at least 120% of the fan's maximum operating speed. The drive end of the fan shaft shall be counter-sunk for tachometer readings.

6) Corrosion resistant fasteners. Bearings and drives mounted on a minimum 10 gauge welded steel power assembly. The motor shall be mounted on a minimum 14 gauge steel motor base welded to a minimum 14 gauge welded steel fan housing. Minimum 10 gauge adjustable motor plate. Minimum 16 gauge motor weather cover.

**15840 Ductwork**

a. HVAC Duct shall be fabricated from galvanized steel in accordance with SMACNA requirements. Abrasive, corrosive, or hazardous materials shall be conveyed by systems described in Industrial Ventilation, latest edition, in harmony with 3.8 HVAC. Nonmetallic duct shall not be used.

b. All seams of ducts shall be sealed with mastic or mastic plus tape or gasketing as appropriate to limit the air leakage to SMACNA requirements.

c. Flexible ductwork shall only be used at terminal units and shall not exceed eight feet. Hard turns, offsets, or kinks will not be allowed. Provide duct supports every three feet.
d. High pressure ductwork shall be galvanized steel spiral lockseam construction.

e. The high pressure duct and fittings shall be manufactured by the same firm.

f. High pressure ductwork shall be tested and total allowable leakage of the system shall not exceed SMACNA requirements.

15848 Duct Lining

a. All supply air, return air, mixed air, and outside air ductwork shall be internally lined with 1" thick acoustical duct liner, as specified above.

b. Dimensions shown on plans of ductwork with duct liner shall be "inside clear dimensions" and shall be so noted on the drawings.

15860 Duct Accessories

a. Filters shall be specified to have a minimum efficiency of MERV 9 for pre-filters and MERV 11 for final filters by ASHRAE standard 52.5 Minimum Efficiency Reporting Value. Filter face velocity shall not exceed 350 FPM.

b. Coil filters shall be easily accessible. Where pre-filters protect higher efficiency filters downstream, either set of filters must be easily replaced without disturbing the other set.

c. A diaphragm actuated direct reading dial type differential pressure gauge shall be installed with static pressure tips across each filter section. The differential pressure gauge shall be similar to Dwyer 605 Series with appropriate operating range.

d. All roof hoods, roof exhausters, louvers and fresh air intakes shall include insect screens or bird screens. Louvers shall be anodized extruded aluminum.

e. Sound traps shall be installed wherever NC levels in the occupied space cannot be reduced to ASHRAE limits by other means.

f. Manual balancing dampers shall be opposed blade type, galvanized steel, and shall have locking quadrant operators or extended concealed ceiling operators where access is limited.

g. Fire dampers and/or fire/smoke dampers shall be installed in locations required by code and/or as directed by the Code Official. Combination fire/smoke dampers shall be auto-reset via the fire alarm panel. No pipes or conduits shall pass through any fire damper. Access doors shall be provided for all such dampers.
h. Flexible duct connections shall be installed where ducts connect to fans or other units which may cause vibration.

i. All non-motorized outside air dampers shall have spring return features.

**15870 Air Outlets and Inlets**

a. Provide aluminum registers, grilles, and diffusers where humid conditions may occur.

b. Grilles, registers and diffusers shall be selected to perform without distracting noise. Throw, drop, and NC valves shall be analyzed during design layout.

c. Grilles and diffusers shall generally not include attached opposed-blade dampers. Air balance shall be accomplished by branch dampers in the duct.

**15900 ATC - Automatic Temperature Control Systems, General**

a. The University Master Plan for control systems is based on the following:

1) The Automatic Temperature Control (ATC) systems will be either "Metasys" by Johnson Controls, Inc; Trane US, Inc.; or, "Honeywell" controls furnished and installed by Wasatch Controls. The most recent revision level of either of these three manufacturers shall be used as a basis of design and operation. Five revision updates shall be provided by the Contractor at no additional charge.

2) The campus building automation system (BAS) will be either "Metasys" by Johnson Controls, Inc; Trane US, Inc.; or, "Honeywell" controls by Wasatch Controls. The most recent revision level of either of these three manufacturers shall be used as a basis of design and operation.

3) Modifications or additions to the campus central communications system which provides direct communication to both a) building-to-building, and b) building-to-System Operation's Central Control, shall be compatible with the fiber optic networks established for either the three "Metasys", Trane, or "Honeywell" systems. The extension or remodel shall include the electronic interface required to provide fully operational fiber optic communications to the central control point.

4) The integration of the control system shall be compatible with the University’s BACnet data communication protocol, unless existing conditions require differently.
b. The controls work shall include all programming and fine tuning of the ATC system, including interfacing with the central campus automation system, and in coordination with Facility Operations.

c. Control systems software shall not interfere with any other control software installed on any servers/computers.

15901 ATC - Remodeling and/or Additions to Existing Buildings

a. Large additions or major remodeling projects will require the use of ATC and BAS systems described under the general heading 15900.

b. Mechanical equipment (air handlers, pumps, chillers, etc.) may require a compatible extension of the BAS system in the building. In such cases, the vendor’s submittal shall provide information detailing compatibility with competitors’ systems.

c. ATC installation on small remodeling projects may be accomplished by Facility Operations at their option. The University will require each pre-qualified controls vendor to allow University installed systems using the vendor’s products, and honor warranty and service commitments described herein.

d. Coordinate with the University Project Manager for central control requirements when new controls are to be specified for buildings not managed by Facility Operations (such as University Student Apartments).

e. Decommissioning of any points or processes no longer used shall be included in the ATC ad BAS system described under general heading 15900.

15902 ATC - Controllers

a. Controllers for the ATC system shall be either "Metasys" by Johnson Controls, Inc; Trane US, Inc.; or, "Honeywell" by Wasatch Controls.

b. ATC system controllers shall communicate via trunks to the BAS system panel.

c. For any controller being installed, the controller may not exceed 80% of the CPU usage to prevent over programming.

15903 ATC - Wiring Methods

a. Exposed wiring in equipment rooms (both line and low voltage) shall be routed in conduit per the National Electric Code. Installation shall be square with the walls of the buildings.
b. In concealed locations such as return air ceiling plenums, follow applicable codes.

c. All control wiring and pneumatic tubing shall be labeled and the labeling shown on the control drawings.

**15904 ATC - Control Power Sources**

a. Provide an emergency power circuit for the control panels and individual room controls where emergency power generators are available. The electrical contractor shall be directed to have breaker circuits designated specifically for control power functions.

b. New transformers shall have a design load not to exceed 75% of maximum load to provide for future expansion.

c. Since all control circuits on campus require University pre-approved sine wave tracking filters, the vendor’s submittal should address the use of EFI, Inc. or equal by the ATC manufacturer.

d. All control cabinets shall be provided with UPS power.

**15905 ATC - Control Valves**

a. Control valves shall be by valve manufacturers approved in the valve descriptions in the DFCM Design Manual, University of Utah Supplement.

b. Valves for the control of terminal units (VAV reheat, fan coils, unit ventilators, etc.) shall be characterized ball valves.

**15906 ATC - Dampers**

Damper motors may be pneumatic or electric. Pneumatic motors will require an air supply system. Electric spring return damper actuators shall be direct coupled type which require no crank arm and linkage and be capable of direct mounting to a jackshaft up to a 1.05” diameter. The actuators must be designed so that they may be used for either clockwise or counterclockwise fail-safe operation. Actuators shall have a manual positioning mechanism accessible on its cover. Actuators shall use a brushless DC motor and be protected from overload at all angles of rotation. Run time shall be constant and independent of torque. If required, 2 SPDT auxiliary switches shall be provided with one switch having the capability of being adjustable. Actuators must be constructed to meet the requirement for double insulation so an electrical ground connection is not required to meet agency listings. Actuators shall be UL listed and CSA certified, have a 5 year warranty, and be manufactured under ISO International Quality Control Standards.
15907  ATC - Sensors

a. At terminal units, central fan controls, etc., flow measurements shall be made by thermal anemometry or differential pressure transmitters. High resolution and repeatability in low velocity regions are required. All devices shall be easily removed for cleaning. All supply air terminal units will have an outlet temperature sensor.

b. Humidity transmitters shall have an accuracy of +/- 3%.

c. Duct mounted sensors must be easily accessed by maintenance personnel. Wall mounted thermostats in common areas are to have no means for occupant adjustment. Office areas may have adjustment capability.

d. Pneumatic systems are normally open on heating, normally closed on cooling.

e. When installing wireless thermostats or any other control devices, the devices shall be permanently attached using anchors, screws, etc. The use of double stick tape or other adhesives will not be permitted.

15908  ATC - Control Panels

a. All controllers, relays, switches, etc., located in equipment rooms shall be mounted in enclosed control panels with hinged locking doors. Key locks for all panels shall be CAT-38 or CAT-102 (Corbin cabinet locks).

b. Indicating devices shall be mounted on the face of the control panel door.

c. All control devices, including digital indicators, located in areas subject to outside weather conditions shall be mounted inside weatherproof enclosures.

d. The location of each panel is to allow convenient access for maintenance. Panels shall be mounted in specified equipment rooms, not in offices or public access areas.

e. Name plates of engraved plastic or metal shall be permanently attached beneath each panel mounted control device describing the function of the device.

f. Power control switching must be located inside the panel (never mounted on the panel face).

g. Controllers within the cabinet are to be fully labeled.

15909  Building ATC Controller (ATCC)

a. The ATCC shall be housed in a NEMA 12 enclosure.
b. The ATCC panel shall include the following features:

1) The panel shall contain battery backup for CMOS RAM memory and the real time calendar clock. The battery shall have a minimum installed life of eight years. In the event of a power failure, the ATCC’s application database, stored data, and real time clock calendar shall be maintained for a minimum of six months.

c. The ATCC shall contain the complete building operating system and operate as a stand-alone system. Failure or disconnection of the central system computer shall not affect the ATCC.

d. The University’s operator is to be able to rapidly retrieve information by using the central PC or central computer.

e. The ATCC shall be capable of communicating over the fiber optic trunk to the central control station maintained by the University.

f. The ATCC shall be capable of receiving a new program or database from the central PC or central computer.

g. A manual control menu shall be provided to allow the University’s operator to start, stop, adjust values, set to local control, or release points to automatic mode at any time.

h. The network trunk shall be installed into each controller location to provide access to the network at any point.

15910 ATC Controller (ATCC) Software and Operation

a. The controller software shall be Microsoft Windows compatible to the current revision level.

b. Diagnostics

The system shall self-diagnose ATCC failure automatically without necessary query by the University’s operator. In the event of communications failure or power failure, the system shall notify a local operator of the specific occurrence.

15911 Graphical User Interface

a. The graphical user interface shall be fully functional and have the following features:

1) All graphics shall be part of the controls submittal package for each project and must be approved by Facility Operations before implementation.
2) All set points shall be shown on the graphics.

3) Components shown on the graphics that are adjustable shall link to that adjustment.

4) All data on the graphics shall be properly labeled. Labeling shall be such that a University technician can easily identify the information.

5) All alarms shall so indicate (change color, flash, etc.) on the appropriate graphic.

15995 Testing and Balancing of Systems

a. System balance shall be performed by a licensed balancing contractor representing an agency certified by the Associated Air Balance Council (AABC) or the National Environmental Balancing Bureau. The Contractor shall have a minimum of five years’ experience in work similar to that required by this project. All work done by this agency shall be performed by qualified technicians under the direct supervision of the AABC Certified Test and Balance Engineer.

b. Testing and balancing shall be performed in complete accordance with current AABC, NEBB and ASHRAE standards.

c. All instruments used by the Contractor shall have been calibrated within the previous 12 months. The final balance report shall contain copies of calibration documents showing calibration tolerances, date of calibration and calibrating firm.

d. Air and water quantities shall be balanced to within 10% of the quantities shown. The balancer shall report discrepancies to the mechanical engineer, who shall resolve them.

e. Balance air flow at duct branch damper with outlet dampers full open.

f. Test, adjust and record fan RPM to design requirements, and record initial and final readings after adjustment.

g. Test and record motor amps and, initial and final readings after adjustment.

h. Make pitot tube traverse readings of main ducts and obtain design CFM for supply, return, outside air, relief air and exhaust systems by adjusting fans and dampers.

i. Test and record the system’s static pressures at both, suction and discharge points. ; Record initial and final readings after adjustment.
j. Test and adjust each terminal unit. Check and record inlet static pressures and modulation limit CFM values, initial and final readings after adjustments.

k. The balancing contractor shall have a controls mechanic available at all times to assist the balancing personnel in adjusting control devices.

l. Clearly mark the final position of all dampers, diffusers, reheat boxes, and other adjustable devices. With permanent identification material, neatly applied so as to be easily read and understood. Balancing valve settings shall be marked on the valve tags.

m. All mechanical HVAC systems, air and water, shown on the plans shall be tested and adjusted to design flow. If heating air flow values are different than cooling, provide certification that heating CFM values are within design.

n. Replace sheaves and drives where required to meet design conditions.

o. Copies of a formal balance report shall be prepared and submitted to the mechanical engineer and the University project manager within 10 working days for inclusion in the operation and maintenance manuals. The report shall contain a complete, legible schedule of:

1) All equipment outlets/inlets and their respective flows
2) Pitot tube traverse readings and associated calculations
3) Reheat box settings, GPM and CFM
4) Box static pressures at inlets
5) Box CFM limits (maximum and minimum)
6) Status of each pump and fan, including RPM, AMPS, suction and discharge static pressures, flow
7) A set of master plans shall be bound with the schedules (11" x 17" maximum) identifying the location of each inlet/outlet and device tested.
8) Calibration documents

p. The test and balance contractor shall include an extended warranty of 90 days after the completion of the project, during which time the University may request a recheck or re-set of any outlet, inlet, control, or mechanical unit.
GG. Laboratory Ventilation

(1) Basis of Design

a. The American National Standard for Laboratory Ventilation ANSI/AIHA Z9.5 – 2012 (www.aiha.org) shall be the basis of design for Laboratory Ventilation Systems. The following exceptions and or amendments shall apply:

b. Requirements which are noted as ADDED or CHANGED or CLARIFICATION are special University of Utah requirements supplemental to The American National Standard for Laboratory Ventilation ANSI/AIHA Z9.5-2012.

1.4 ADDED Alternative Design

Codes, Ordinances, and Industry Standards: In accordance with the 2012 International Building Code, Section 104.11, and the University Building Official has approved this Laboratory Ventilation chapter as an Alternative Design which meets all enforceable Code (IBC, IFC, IMC, etc.) requirements. Approvals from the State Building Official, Campus Fire Marshal, Director of Risk Management and Office of Legal Counsel have been obtained for this alternative design.

The Alternate Design is to provide a continuously exhausted laboratory laboratory ventilation system system for new and existing research and educational laboratories
under fire alarm and loss of primary building power conditions. This Alternate Design will apply only to laboratories classified as Group B occupancies where the types and quantities of hazardous materials both stored and used per Control Area do not exceed quantities listed in Tables 307.71 (1) and 307.71.(2) of the 2012 IBC. Laboratory ventilation system supply and exhaust systems will be allowed to penetrate fire-rated exhaust shafts without fire and smoke dampers. Upon activation of the fire alarm and notification system or loss of primary electrical building power, the laboratory ventilation system supply and exhaust systems will operate at 50% of their maximum capacity.

Prescriptive Code requirements specify installation of fire and smoke dampers at the penetration of fire-rated shafts and floor assemblies with few exceptions. The intent of the Code for the installation of fire and smoke dampers is to prevent the spread of fire, smoke and fumes through these penetrations to other parts of the building. This requirement effectively cuts off the supply and exhaust air for laboratory ventilation systems under both alarm and loss of primary power conditions. The closure of fire and smoke dampers, when actuated, would prevent the exhausting of hazardous materials thus creating a more hazardous condition by allowing these materials to permeate the laboratory. The Comparison Chart identifies specific Code requirements and the equivalent design characteristics of the Alternate Design. As noted in
the Comparison Chart, the Alternate Design will not deviate from the Code Requirements except for the provisions of the IBC Section 716.5.3.1.

In summary, the following outlines the required characteristics of the Alternate Design.

- The Alternate Design applies only to Group B occupancy laboratories.
- Fire and smoke dampers shall not be installed at the penetration of fire rated shafts and horizontal assemblies serving laboratory ventilation systems.
- The laboratory ventilation systems for new buildings shall include an adequate power source for the laboratory ventilation system, which will operate at 50% of their maximum capacity for a 90 20 minute time period following loss of primary building power.
- Alterations or additions to laboratory ventilation systems in existing buildings shall be connected to an existing alternate power source where available and where spare capacity exists. Otherwise, connection to the building’s primary power is permitted.
- Alterations to an existing laboratory ventilation system that affect 50% or more of a floor or building shall be connected to an alternate power source.
- Any laboratory ventilation system associated with a Group H Occupancy shall comply with all prescriptive code requirements found in the International Code Council set of codes as adopted by the State of Utah.

3.1.1.4 CHANGED Auto Sash Closers
Automatic Sash Closers: Automatic sash closers are not required.

3.1.1 ADDED Backflow Protection
Whether or not non-potable water is supplied to the hood, a spill-proof pressure vacuum breaker for high hazard application, with test ports shall be provided on the supply line outside each laboratory ventilation system. The backflow preventer shall be visible and easily accessible for testing. The backflow preventer shall be located 18” to 24” below the ceiling on the outside of the laboratory ventilation system or on an adjoining wall, and its critical line shall be a minimum of 6” above the highest outlet. The installing contractor shall test the backflow preventer and submit results to the University Project Manager.
3.1.1.4 ADDED Existing Auxiliary Supplied Air Hoods
Existing auxiliary supplied air hoods currently installed shall be converted to conventional or bypass hoods.

3.1.3 ADDED Vacuum Breakers
Vacuum breakers shall not be installed inside laboratory ventilation systems.

3.1.4 ADDED Work Surface
Existing laboratory ventilation systems shall be retrofitted to include provisions for spill protection.

3.2.3 CHANGED Auxiliary Supplied Air Hoods
Auxiliary supplied air hoods shall not be installed.

3.2.7 ADDED Hood Manufacturers
Approved manufacturers include Hamilton, Kewaunee, Labconco, ALC-Collegedale, or Mott Manufacturing, Ltd. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid.

3.2.8 ADDED Radioisotope Hoods
Radioisotope hoods shall be conventional hoods or bypass hoods. The University Radiological Health Department (RHD) shall be informed of each new radioisotope hood being planned for a project, or any such hoods to be modified or upgraded to radioisotope status. RHD will review the hood application and determine if any special treatment is required, such as charcoal or HEPA filters, nonstandard face velocities, etc.

3.3.1 CHANGED Face Velocity
The face velocity basis of design shall be 100 fpm at a sash height of 18” above the work surface.

The final product shall provide containment below a control level of AU (As Used) 0.1 ppm as determined by methods described in the ANSI/ASHRAE 110-1995 Method of Testing Performance of Laboratory ventilation systems.

3.3.3.1 ADDED Air Flow Monitoring
Air Flow Monitoring shall be mounted on the hood so as to be readily seen by the hood user. The indicator shall sense face velocity either directly or indirectly (belt driven sash sensors are not acceptable). The device shall provide digital display indicating face velocity with low/high flow audible and visual alarms (adjustable). Approved manufacturers include Phoenix Controls, TSI, or approved equal.

3.3.4 CHANGED Hood Location
All hoods should be located to minimize cross currents and turbulence from laboratory furniture arrangements and busy walkways.
3.4 ADDED Asbestos
Do not use materials containing asbestos in new hoods and cabinet installations. Existing laboratory ventilation systems containing asbestos materials can remain provided the asbestos is in good condition. All modifications to a hood that impact the asbestos materials shall be performed by a certified asbestos contractor.

3.5 ADDED Venting
Corrosive and flammable storage cabinets installed under laboratory ventilation systems shall be as follows:
- Corrosive Cabinets
  Provide a vent pipe from the back of the cabinet to the work surface. The pipe must be located in the space behind the baffle. The vent pipe shall extend 0.5” above the work surface.
- Flammable Cabinets
  Two vent pipes shall be connected to the back of the flammable cabinet through factory-installed bungs, one high and one low, and joined at a common vent pipe (minimum 1-1/2” steel) which shall extend to the hood exhaust duct. The vent pipe shall be connected between the venturi damper and exhaust fan rather than between the laboratory ventilation system and the venturi damper.
  - Install a flame arrester in the flammable cabinet’s vent opening.

5.2.4 ADDED System Capacity
New makeup air systems are required in all existing buildings where sufficient make-up systems do not exist. Transfer air from other portions of the building is not an acceptable source of make-up air. A thorough investigation of make-up air sources shall be performed prior to installing new laboratory ventilation systems.

5.2.5 ADDED Hoar Frost
Make-up air systems shall include provisions to prevent hoar frost build-up at intake louver and pre-filters.

5.2.6 ADDED Hydronic Coils
Cooling and heating coils installed in make-up air handlers shall have a glycol solution to prevent the coil from freezing. See 3.5 Mechanical Part 1 for glycol systems requirements.

5.2.7 ADDED Electric Heating Coils
Electric heating coils are discouraged due to the higher energy cost. If electric heat is necessary, minimum two stages heating is required.
5.2.8 ADDED Air Filters
   Energy Recovery coils in exhaust fans shall have air filters and access to service filters.

5.3.1.2.1 ADDED Duct Material
   Duct material shall be 16 or 18 gauge Stainless Steel Series 316, welded with "MIG" or "TIG" method. Screwed slip joint connections sealed with silicone sealant are acceptable. Other duct material may be used, with prior approval.

5.3.1.3 ADDED Fans in Series
   Series exhaust fans shall not be installed.

5.3.1.4 ADDED Velocities
   Transport duct velocities shall be 1000-2000 FPM for gases and 3500-4500 FPM for particulates, depending on the particle size and specific gravity.

5.3.1.5 ADDED Dampers
   Install a single blade volume control damper with locking quadrant in the hood duct between the hood and venturi damper for all laboratory ventilation system systems.

5.3.1.6 ADDED Elbows
   Use long radius elbows to reduce resistance. Three piece stainless steel elbows are acceptable.

5.3.1.7 ADDED Flex Duct
   Flex duct shall not be used on laboratory ventilation systems systems.

5.3.2.9 CLARIFICATION Fire Dampers
   The accidental activation of a fire damper will shut off airflow from one or more laboratory chemical hoods and may cause worker injury or exposure.

   The activation of a fire damper caused by a fire in a laboratory chemical hood will shut off airflow from that hood making it impossible to remove the combustion products from the hood and forcing the hood to become positively pressurized. This condition makes it likely the fire will escape the fire resistant hood into the laboratory.

   With the exhaust flow from one or more hoods shut off, the laboratory may become positively pressurized with respect to the corridor, encouraging the spread of the combustion products, and perhaps the fire, from the laboratory to adjoining spaces.

5.3.2.12 CHANGED Constant Suction, Redundancy, Emergency Power
   - Manifold Exhaust, New Construction
     Manifold exhaust and makeup air systems shall be connected to an emergency power supply to ensure hood performance during power outages.
• Manifold Exhaust, Remodel or Renovation
  Emergency power is not required.
• Individual Exhaust Systems (single-hood/single-fan)
  Emergency power is not required.

5.3.3.1 ADDED Exhaust Fan Components
• Shaft Seals
  The case penetration at the shaft is to be sealed with a corrosion resistant flexible seal.
• Motors
  The motor may be non-explosion proof if it is located out of the air stream and sealed off from any possible exposure to the fumes being handled by the fan. If it is located in an enclosed room, the room must be adequately ventilated.
• Coatings
  Non-stainless steel fans, sheet-metal, flexible connectors, dampers, etc., in contact with the air stream are to be Eisenheiss or Heresite coated, or prior approved equal.
• Back draft Dampers
  Stainless steel or coated gravity back draft dampers are to be provided on fan discharges.
• Vibration Isolators
  On smaller fans, rubber-in-shear vibration isolators are to be provided. These are inherently seismic rated and need nothing further. Larger fans may require spring type isolators with seismic snubbers.
• Fan Casing Drains
  Where the fan discharge is vertical and open to the weather, a drain half coupling should be provided on the bottom of the fan housing. If the fan is located indoors, a trapped drain line is to be run to the outside to avoid blowing hazardous fumes into the building due to the pressurized housing.
• Duct Pressure
  Exhaust duct pressure shall be negative with respect to all interior building spaces.
Design Requirements – 3.8 HVAC – University of Utah Supplement

5.3.3.2 ADDED Labeling and Identification

- Laboratory ventilation systems
  All laboratory ventilation systems shall be clearly identified and labeled to indicate which fan or ventilation system they are connected to.

- Exhaust Fans
  All exhaust fans shall be clearly identified and labeled to show which hood(s) and/or ventilation systems they are serving. Exhaust fan labels shall indicate current and future design airflows and shall be updated whenever changes are made to the systems they are serving.

- Corrosive and Flammable Cabinets
  All corrosive cabinets shall be labeled “Corrosive” and all flammable cabinets shall be labeled “Flammable”.

5.3.5.1 ADDED Termination Devices

Horizontal fan discharges, fixed caps, mushroom caps and rotating cap outlets prevent exhausted materials from being freely projected upward into the air stream for removal and are not to be used.

5.3.5.2 ADDED Bird Screens

Bird Screens shall not be installed.

5.3.5.3 ADDED Corrosive Condensate

Refer to ASHRAE 2003 Handbook – HVAC Applications, Chapter 44 recommends a stack velocity of 1000 fpm when corrosive condensate droplets are present and an exit cone to increase the discharge velocity to 3000 fpm to prevent plume downwash.

5.3.6.1 CHANGED General Room Exhaust

Air from the general laboratory containing chemical laboratory ventilation systems (as distinguished from laboratory chemical hoods) shall not be returned back to a central air handling unit where the air is re-circulated to other areas of the building.

8.10.3.1 CLARIFICATION Automatic Fire Dampers

In 2001 at the University of California a fire resulted in an injury and caused approximately $3.5 million in damage. Based on the investigation, it was concluded that not having the fire dampers on the exhaust duct of the ventilation system at the shaft wall appears to have been beneficial in this fire scenario. The investigation observed that the exhaust system was effective at removing significant quantities of combustion products from the building during the fire, thereby reducing the amount of combustion products spreading to other areas of the building. The shutting down of the supply air by fire dampers did not
significantly hinder the exhaust system since fresh air was provided through a broken window. However, if the window had not failed, the team concluded that the exhaust system probably would not have performed as well.

If protection of the openings is desired, one method is to use a subject assembly. Where a branch duct connects to an enclosed exhaust riser located inside a shaft, which has a required fire resistance rating of 1 hour or more and in which the airflow moves upward, protection of the opening into the fire resistance-rated enclosure should be made with a steel subduct turned upward a minimum of 0.06 m (22 in.) in length and a minimum thickness of 22 gauge [0.76 mm (.030)]. The steel subduct should be carried up inside the riser from each inlet duct penetration. This riser should be appropriately sized to accommodate the flow restriction created by the subduct.

c. Comparison Table

<table>
<thead>
<tr>
<th>COMPARISON TABLE</th>
<th>ALTERNATE DESIGN</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ICODE:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>IBC Tables 307.7(1) &amp; 307.7(2)</strong></td>
<td>No change to Code requirements.</td>
</tr>
<tr>
<td>Hazardous materials in quantities less than Tables 307.7(1 &amp; 2) per Control Area to be classified as Group B occupancy. All others to be a Group H occupancy.</td>
<td></td>
</tr>
<tr>
<td><strong>IBC Section 707.3.1</strong></td>
<td>No change to Code requirements.</td>
</tr>
<tr>
<td>Fire resistive rated shaft enclosures at openings between stories for more than 2 stories.</td>
<td></td>
</tr>
<tr>
<td><strong>IBC Section 714.3.1</strong></td>
<td>No change to Code requirements.</td>
</tr>
<tr>
<td>Unprotected openings for penetrations less than 6” in diameter are permitted at shafts.</td>
<td></td>
</tr>
<tr>
<td><strong>IBC Section 717</strong></td>
<td>Fire and smoke dampers are not allowed as they would interrupt supply and exhaust air for laboratory ventilation systems. Provides continuous supply air and exhaust for products of combustion and hazardous materials regardless of quantities.</td>
</tr>
<tr>
<td>Penetrations by ducts and air transfer openings of fire resistive rated shaft enclosures are to be protected with approved fire and smoke dampers.</td>
<td></td>
</tr>
<tr>
<td><strong>IMC:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>IMC Section 501.4</strong></td>
<td>No change to Code requirements.</td>
</tr>
<tr>
<td>Exhaust system must maintain negative pressure and make-up air.</td>
<td></td>
</tr>
<tr>
<td><strong>IMC Section 502.1</strong></td>
<td>No change to Code requirements.</td>
</tr>
<tr>
<td>Exhaust system required for laboratories using hazardous materials.</td>
<td></td>
</tr>
<tr>
<td><strong>IMC Section 502.8.2</strong></td>
<td>No change to Code requirements.</td>
</tr>
</tbody>
</table>

Design Requirements – 3.8 HVAC – University of Utah Supplement 115
| Hazardous materials in any quantity to be in a negatively exhausted environment. | IMC Section 502.9.5  
Flammable and combustible liquids in any quantity shall be provided with an exhaust system. | No change to Code requirements. |
| IMC Section 510.2  
A hazardous exhaust system shall be required wherever operations involving the handling or processing of hazardous materials, in the absence of such exhaust systems and under normal operating conditions, have the potential to create: 1. A flammable vapor, gas, fume, mist or dust is present in concentrations exceeding 25% of the lower flammability limit of the substance for the expected room temperature; 2. A vapor, gas, fume, mist or dust with a health-hazard rating of 4 is present in any concentration; 3. A vapor, gas, fume, mist, or dust with a health-hazard rating of 1, 2 or 3 is present in concentrations exceeding 1% of the median lethal concentration of the substance for acute inhalation toxicity. | No change to Code requirements. The design professionals will need to demonstrate that for the given project, chemical inventory quantities and list and the anticipated processes, that this provision is not a concern. Otherwise, a hazardous exhaust system will be required. |

**HH. High Temperature Hot Water System**

1. **Purpose**

   This supplement provides basic design requirements for new heating systems connected to the University of Utah's high temperature water (HTW) distribution piping system.

2. **Construction Documents**

   a. Construction drawings and specifications are to provide sufficient detail to fully describe the extent and arrangement of the work expected.

   1) **Underground Piping**

   Drawings are to include plan and profile drawings showing existing and new pipeline elevations; existing piping along the route; existing and new boxes, manholes, anchors, expansion guides, etc.; and, manhole identification numbers, details and elevations of manholes, connections, and pipe routing.

   2) **Mechanical Room Piping**

   Provide lay-out drawings, elevations, and details showing all necessary dimensions
required to arrange the pipe, specialties, and equipment within the building.

3) Tanks

Include specifications and drawings for all tanks designed for HTW primary and secondary heating systems.

4) Controls

Include specifications and drawings completely describing the control system to be used on the project.

(3) Design Requirements

a. HTW System Availability

The consultant must coordinate with the University Project Manager to determine if HTW is the best application for the heating system, including availability of HTW before design.

b. Steam Generation Using HTW

Steam generation requires prior approval before design. Steam generation from HTW may overburden the distribution system.

c. Consultant Experience

The campus high temperature water system requires a unique expertise. The University reserves the right to limit the selection of consultants to those experienced in high pressure/high temperature piping design with associated maintenance and safety design capabilities, and require evidence of such experience.

d. System Testing

Unless directed otherwise, specify system tests which conform to applicable sections of the codes, ordinances, and industry standards referenced in 2.0 Codes, Laws, Rules and Regulations, University of Utah Supplement.

e. Design Parameters for System Calculations

1) System Operating Pressure = 460 psig for both “upper” and “lower” zones.

2) System Operating Temperature, “Upper Zone” = 390°F.

3) System Operating Temperature, “Lower Zone” = 435°F.

4) Minimum Approach Temperature:
APPROACH TEMPERATURE = (HTW RETURN TEMP °F) - (SECONDARY SUPPLY TEMP °F)

a) HTW steam generators:

(i) 10° F (for 45 psig to 100 psig steam operating pressures)

(ii) 15° F (for 44 psig and lower steam operating pressures)

b) HTW water-to-water converters and water heaters, 15° F

5) Maximum Pressure Drop.

The maximum allowable pressure drop from the HTW building entry through each mechanical room including piping, equipment, and controls shall be 20 PSIG.

f. Equipment Ratings

Pressure/temperature ratings required for equipment, valves and piping are described in (4) "Guide Specifications – High Temperature Hot Water System" below.

g. Blowdown Heat Recovery on Humidifier Steam Generators

Steam generators used for humidification shall be designed with heat recovery on the blowdown line. The recovered heat shall temper the makeup water to the steam generator to avoid shocking the generator.

h. Piping System Design

1) Use Fanning or other equally acceptable formulae to calculate flow, velocity, and resistance of the water piping.

2) The maximum allowable pressure drop in branch lines from the main to building equipment and returning to the main shall be 2 PSI/100 FEET OF PIPE, with a maximum water velocity of 7 FEET/SECOND.

3) Minimum pipe size shall be 1/2" for HTW lines above ground and 2-1/2" for underground branch lines.

4) The minimum bury depth to the insulation wrap shall be no less than 5 feet between the top of the insulation and the ground level for plain pipe. Thermacor Process L.P. Duo Therm “505” pre-insulated pipe requires a minimum bury depth of 24”. If conditions require a shallower depth, the minimum bury can be 12” for Thermacor “505” pipe if under a concrete slab on grade. The minimum insulation depth to the top of the pipe shall be 6” (and varies to 10” - see detail).

5) Buried pipe crossing over or under high temperature water lines:

   a) Routing of new HTW piping may require revisions to existing underground
utilities. New buried utility piping will require special considerations for crossing HTW piping.

b) To prevent damage to pipe and / or contents from the elevated temperatures expected at crossing high temperature water lines, the following requirements apply (with the exception of Thermacor Process L.P. Duo Therm “505” piping):

(i) Buried piping systems which must cross over or under HTW lines shall be metal pipe (no plastic) for at least 5 feet either side of the cross point of the HTW pipe line.

(ii) A buried water, sewer, or storm sewer pipe which crosses HTW piping shall be constructed of a 20 foot section(s) of ductile iron pipe, with the middle of the ductile pipe section centered over or under the crossing HTW pipe(s). The angle of crossing shall not be less than 60º. Any storm drain entry box, or piping joints within five feet lateral clearance of a crossing point over or under high temperature water piping must have an epoxy concrete envelope around the storm drain joints.

(iii) Buried pipe which crosses HTW piping must have adequate vertical clearance; a minimum of two feet (2') is allowed without a copper guard. If the clearance between the crossing pipes must be closer than two feet, design a 4' wide, ¼” copper plate(s) midway between the crossing piping and the HTW piping. The copper plate(s) shall extend a minimum of 3 feet either side of the HTW piping.

(iv) Buried electrical and telecommunications ductbanks which cross HTW piping must have adequate vertical clearance; a minimum of one foot (1') is allowed without a copper guard. If the clearance between the ductbanks must be closer than one foot, design a 4' wide, 1/4” copper plate(s) between the ductbanks and the HTW piping. See Detail HTW-18.

6) If new Thermacor Process L.P. Duo Therm “505” pipe system is to be installed, and a connection to an existing Gilsulate insulating fill system or a Z-Crete cast-in-place insulation system is required, design an engineered transition which may include a vault, foundation, or doghouse. Direct connections between the differing pipe/insulation systems shall not be permitted.

7) Minimum size for drains and vents shall be 3/4” DRAINS and 1/2” VENTS. Refer to drawing details provided herein. Gate valves shall be used on all HTW drains and vents.

8) Due to the high potential for high pressure water to flood adjacent areas, rooms shall be designed to contain water and quickly drain it away. All instrument air tubing in the HTW equipment rooms shall be copper.

9) HTW Vent Lines
Vent valves are to be installed at the highest point of the HTW system inside the building. Vent valves are also to be installed at the high point of each high temperature water converter (HTW side of each water and steam converter/generator) in both the supply and return piping.

10) Design to Minimize Shock

If the length of HTW piping between the control valve and the converter/generator exceeds 20 feet, include a bypass line near the converter/generator to allow HTW circulation which will serve to keep the idle HTW consistently hot and thereby prevent start-up shock.

11) When selecting heavy wall pipe (i.e. schedule 80), the consultant must account for the smaller inside pipe diameter in design calculations.

12) Submit detailed calculations to Facilities Management through the University Project Manager for review. The calculations used in the design of all HTW extensions shall be approved by Facilities Management prior to construction.

13) Piping insulation thickness shall be shown in table form on the drawings or in the specifications.

i. Domestic Hot Water Design Using HTW

Domestic hot water systems are to be designed with multiple storage tanks to allow maintenance on one tank while the system remains in service.

j. Avoid Pad Support Under Heat Exchangers

Do not specify a housekeeping pad under HTW heat exchangers. Hydraulic lifts are used to remove heat exchanger heads and a minimum of 3 feet clearance is required at the floor behind the heads for proper access.

k. HTW Equipment Rooms

See 3.4 Structural / B. University of Utah Requirements / (2) Design Criteria / f. High Temperature Water Equipment Rooms for special design requirements.

l. Emergency Shut-Off Control Valve at Building Supply

1) Include an emergency shut-off control valve at new buildings and new installations of a high temperature water system. Manual remote operation of the valve is to be located outside of the HTW equipment room near the door. The purpose of the emergency shut-off control valve is to protect the equipment room from destruction after a tube rupture or head gasket failure. The HTW emergency shut-off control valve shall have the following characteristics:

a) The control valve shall be installed inside the building on the HTW supply line and shall be full line size with a full port.
b) Cast steel valve body conforming to ANSI 600 LB specifications. Flange surface shall match 600 LB ANSI flanges.

c) The seat leakage shall be limited to the requirements of ANSI B16.104, Class IV. Control valve shall close against a 500 psi pressure difference and shall be suitable for 450°F.

d) The control valve shall be specified normally closed, failing to the closed position on loss of control air. The valve shall be a rotary ball design with a side mount actuator that can be right or left of the pipe. Actuator shall be air operated with spring return. The maximum air to operate the valve shall be 60 psig. The maximum allowable air to actuator to be 125 psig.

e) Control valve shall have remote control for opening and closing through the campus automation system.

m. Blowdown Heat Recovery on Steam Generators

Steam generators shall be designed with heat recovery on the blowdown line. The recovered heat shall temper the makeup water to the steam generator to avoid shocking the generator.

n. System Review by Facilities Management

In all cases, piping design, equipment selections, and controls are to be reviewed with Facilities Management through the University Project Manager at each stage of design development.

(4) Guide Specifications – High Temperature Hot Water System

General Design Requirements

a. The information provided in this section should be used in coordination with other related sections of the University of Utah supplement. Information regarding pipe identification, insulation, seismic supports, etc., found in other sections of the University supplement may pertain to the work being designed.

b. This section is not intended to encompass all the needs of a complete project. The consultant will be expected to provide appropriate additional information for the contract specifications to adequately cover the requirements of the work.

c. Contract Documents are to include EQUIPMENT SCHEDULES for all HTW generators and converters. Include sufficient design data to allow manufacturers to calculate their own selection routines for their equipment. Such design data should include, as a minimum, OPERATING TEMPERATURES and PRESSURES, FLOW REQUIREMENTS for both primary and secondary systems, TUBE SIDE SURFACE AREA, MAXIMUM PRESSURE DROP for each system, FOULING FACTOR limits, and confirming BTU/HR REQUIREMENTS.

d. Contract Documents are to include CONTROL SCHEMATIC DRAWINGS for all HTW
equipment requiring system controls. Include sufficient design data to allow manufacturers to calculate their own selection requirements for valves, operators, and system logic.

e. Installation

1) BTU meters will require a minimum length of straight piping to allow the manufacturer to guarantee performance. The meter installation shall be designed for 20 pipe diameters upstream and 10 pipe diameters downstream of straight piping only. If these conditions cannot be met, some reduction allowance will be approved, but no less than 10 pipe diameters upstream and 5 diameters downstream of the meter. Contract documents shall clearly indicate the required length of unobstructed flow to the piping contractor.

2) High Temperature Water Meters

a. Building meters shall meter high temperature hot water consumption in British Thermal Units (BTUs) delivered to the building by Campus central plant facilities.

b. Meters shall provide instantaneous information via on-screen local displays as well as integrate into the University’s Energy Information System.

c. Meters shall have the ability to provide instantaneous energy consumption in Btu/h.

d. If piping arrangements prohibit this installation protocol, HHW BTU meters may be installed on the building side of the converters. All converters shall be metered for complete hot water usage monitoring.

e. All HTHW meters shall guarantee the following performance levels at all operating (pressure and temperature) scenarios:

1) Accuracy: ±1 percent

2) Repeatability: ±0.5 percent.

3) Pressure drop: As indicated on project drawings

4) Flow sensor turndown: No less than 10 to 1.

f. Flow rate shall be measured in gallons per minutes (gpm).

g. Metering components and BTU computers shall be capable of operating in ambient temperatures of at least 150 °F.
h. All data sheets and informational literature shall be submitted for review prior to implementation
   1) Transmitters
   2) Sensors
   3) Flow elements
   4) Totalizers
i. Calibration for all flow metering distribution meters and transmitters shall be provided.
j. Meter and BTU computer shall be capable of communicating with the University’s building automation system and Energy Information System. The following data shall be provided:
   1) Fluid temperatures
   2) BTU
   3) Btu/h
   4) Flow (GPM)
k. Flow element shall be a variable-area, differential pressure flow element.
l. RTDs shall be provided to measure supply and return temperature at building interface piping or at building heat exchangers. 1) RTDs shall be 316 stainless steel.
m. Flow sensor size shall match installed pipe size.
n. Temperature Sensors and Transmitters
   1) Spring-loaded dual element 100 ohm platinum resistance temperature detector (RTD) temperature sensor.
   2) RTD accuracy: ±0.5 percent at 32 °F.
      a) Temperature range: 20 °F to 800 °F.
   3) Install RTDs with 316 stainless steel thermo-well.
   4) Straight-run distance shall not be less than 4 times the diameter (4xD).
f. Specifications shall mandate all new materials.

g. For a planned shut-down of the high temperature water system, direct the Contractor to add additional lead time to that shown in the Supplemental General Conditions for University of Utah Projects; and, coordinate the request well in advance of the needed shut down date to allow preparation time for the affected University services.

h. Before the Contractor begins any work which will affect the University’s high temperature water system, direct the Contractor to prepare a ‘hazard control plan’ in accordance with OSHA; and, require the Contractor to submit the plan in advance of the work to the A/E for initial review and comment. The A/E shall forward the plan with comments to the University Project Manager who will review the plan with Facilities Management. Work on the University’s HTW system shall not commence without an approved hazard control plan.

15060 Pipe and Pipe Fittings

15061 HTW Piping - General

a. All HTW piping installed in building mechanical rooms shall be exposed and not concealed within the structure.

b. Design the anchors and supports for all HTW piping with allowance for free expansion and movement without damage to piping, valves, structures or connected equipment.

c. Piping expansion shall be provided by expansion loops only. No mechanical expansion joints will be allowed on the HTW System.

d. Eccentric reducers shall be used on horizontal piping. Specify / detail the reducers with the straight side on top of the piping.

e. Do not allow the Contractor to hang pipe from other piping.

f. Isolate each branch line and each equipment item with valves and flanged unions. Provide flanged or welded connections only. Refer to drawing details provided herein.

g. Threaded unions are not allowed on HTW connections.

h. Specify only long radius elbows for piping turns.

i. Neither bushings, short nipples, cast iron fittings, nor flanges shall be allowed in HTW Piping. The entire assembly shall be all welded construction.

j. Require the Contractor to identify pipe and fittings at the work site with labels. See paint and label requirements in 3.8 HVAC. The University reserves the right to reject items not readily identified as meeting the requirements of this supplement.
k. Vents and drains - high points of piping must be properly vented. Careful consideration must be given to pipe routes and elevations, especially for underground piping. Costly manholes must be provided for vents if a means cannot be found to avoid high points. Drains at low points in underground piping are usually impractical, so low points should be avoided.

l. Tie-ins between Thermacor Process L.P. Duo Therm “505” pipe and pipe by other manufacturers are not recommended. Design shall include a vault, doghouse, or foundation as solution for transition.

15062 Piping and Fittings Below Grade

a. Unless otherwise approved, all new below ground direct bury HTW piping shall be Thermacor Process, L.P. Duo Therm “505” or prior approved equal pre-insulated pipe, including extra strong schedule 80 carrier pipe. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid. Follow ALL of the manufacturer’s installation details and processes.

1) When approved for direct bury, specify extra strong schedule 80 piping, ASTM A106 Grade B, plain end seamless black steel pipe.
   a) Insulate all plain (non-pre-insulated) direct buried HTW piping with insulation specified in section 15256.

b. All service piping, supply and return, shall meet the above specifications, including piping installed in service boxes, underground conduit, and appurtenance piping connected thereto including sensing, vent, drain, etc. piping. Piping shall be all welded construction for all sizes.

c. Fittings 2" and smaller shall be socket weld forged black steel, conforming to ASTM A105, Grade II, and ANSI B16.11, 3000 pounds. Specify only United States (domestic) manufactured pipe and fittings. Acceptable manufacturers are Grinnell, Ladish, and Vogt.

d. Fittings 2-1/2" and larger shall be butt weld seamless black steel, long radius, conforming to ASTM A234, ANSI B16.9, ASA B10, Grade B Extra Strong Schedule 80, and physically/chemically equal to the piping to which connected. Specify only United States (domestic) manufactured pipe and fittings. Acceptable manufacturers are Grinnell, Ladish, Tube-Turn, and Tube Forgings.

15063 Piping and Fittings in Mechanical Rooms and Tunnels

a. All exposed insulated piping in mechanical rooms and tunnels shall be Extra Strong Schedule 80 for 4" and smaller, ASTM A106 Grade B, plain end seamless black steel pipe. Specify only United States (domestic) manufactured pipe and fittings.

b. Piping 5” and larger shall be Schedule 40 ASTM A106 Grade B, plain end seamless black steel pipe.
c. Fittings 2" and smaller shall be socket weld forged black steel, conforming to ASTM A105, Grade II, and ANSI B16.11, 3000 pounds. Specify only United States (domestic) manufactured pipe and fittings. Acceptable manufacturers are Grinnell, Ladish, and Vogt.

d. Fittings 2-1/2" and larger shall be butt weld seamless black steel, long radius, conforming to ASTM A234, ANSI B16.9, ASA B10, Grade B Schedule 40, and physically/chemically equal to the piping to which connected. Specify only United States (domestic) manufactured pipe and fittings.

15064 Joints
a. Pipe joints 2" and smaller shall be socket weld as specified above.
b. Pipe joints 2-1/2" and larger shall be butt-weld as specified above.
c. Adapter fittings between Schedule 40 and Schedule 80 pipe shall be prepared according to the latest edition of ASME B31.3.

15065 Flanges and Accessories
a. Flanges 2" and smaller shall be forged black steel, conforming to ASTM A105, Grade II, and ASA 16.5, Class 600 LB, with serrated raised face and socket weld connections.
b. Flanges 2-1/2" and larger shall be forged black steel, conforming to ASTM A234 and ASA B16.5, Class 600 LB, with serrated raised face, welding neck, or slip-on welding flanges.
c. Gaskets shall be Flexitallic. No other gasket will be approved.
d. Bolts are not to be used in HTW pipe assembly.
e. Studs and nuts shall conform to the following ANSI and ASTM Standards: ANSI Class 300 LB, 400 LB and 600 LB standards; and, ASTM A193 Grade B7 and ASTM A194 Grade 2H requirements.
f. Nuts shall not exceed 2" in size.
g. Provide flanged connections where shown on plans for convenient dismantling and reassembling piping, for branch line and equipment connections, and for convenient dismantling and reassembling of bypass assemblies.

15066 Welding Certification
a. Each welder shall have passed a qualification test within the past 6 months.
b. The test shall be in accordance with the ASME Boiler and Pressure Vessel Code, Section IX, "Welding Qualifications", ASME Section VIII, and ANSI 313.
c. The test report shall certify that the welder is qualified to weld the material to be used at the job site.

d. The Contractor shall submit three copies of each welder's qualification test report to the A/E / University Project Manager for approval prior to commencing the work. No welder shall be used on the project until so certified and approved by the University Project Manager.

**15067 Welding**

a. Electric metallic arc process shall be specified for all welding. End preparations shall conform to ANSI and ASTM Standards.

b. Specify only one welder for each joint.

c. Weld slip-on flanges on both front and back sides.

d. Thermometer wells and test wells shall be back welded.

e. Require the Contractor to maintain a log and map of all pipe welds showing a weld number, location, and welder information. The log is to be turned over to the University Project Manager at the completion of the work.

**15068 Piping Tests**

a. Prior notification of at least 10 days will be required for an intent to perform hydrostatic testing. The Contractor's notice shall be reviewed and approved by the University Project Manager and Facility Operations prior to commencement of the required testing.

b. Specify piping tests performed in accordance with the applicable ANSI Code for Pressure Piping. Insert the applicable code reference for use by the Contractor.

c. Piping tests shall be completed prior to painting, insulating, or covering the pipe.

d. The University will retain the services of an ASME Authorized Inspector. The inspector’s duties will include on-site verification of all piping tests from commencement to test completion. The inspector will provide written certification of completed tests. Three copies of the certification report for each test will be submitted to the University Project Manager for approval.

e. Each test shall comply with the requirements of industry standards and prior notification as specified above. Piping shall be hydrostatically tested. 100% of all welds will be visually and x-ray inspected by the University’s ASME inspector whether above or below grade. If a socket weld fitting needs to be tested, then specify hydro testing.

**15069 Internal Cleaning**

a. All HTW piping shall be internally cleaned prior to system start-up and after
successful testing. The cleaning of the piping system shall be accomplished by the approved water treatment supplier, W.E.S.T., Water and Energy Systems Technology. Other suppliers must be prior approved with University field tests before bidding.

b. Specify prior notification of the time for boil-out to the University Project Manager, who shall witness the process.

c. Require the Contractor to furnish a boiler (or other suitable heat source), circulating pump(s), valves, etc. and all required materials and labor to complete the internal cleaning.

d. Specify that all internal surfaces shall be cleaned using a "boil-out" process with solutions specified. Repetitive flushing shall remove all traces of grease, oil, dirt, loose scale, metal particles, welding slag, etc. Include the following in the specifications:

1) Step One - Flush

Flush piping with clean water to remove loose material, then discharge the water in a location away from service boxes, where no damage will occur.

2) Step Two - Boil Out

Thoroughly dissolve West B 802 Caustic High pH Boil-Out Cleaner using 25 pounds for each 1000 gallons of system water in the piping and equipment. Fill the system piping/equipment with clean water and the cleaning solution. Circulate the system water at a minimum velocity of 0.5 FT/SEC, and heat until the solution in the entire system is between 160 and 180 degrees F. Maintain the temperature level between these limits and continue circulation at no less than 0.5 FT/SEC for a minimum of 24 hours.

3) Step Three – Drain

Thoroughly drain the system including all equipment.

4) Step Four – Flush

Fill the system piping and equipment with clean water and flush, then thoroughly drain, and repeat until the pH of drained flush water is below eight.

5) Step Five - Final Fill

Completely fill the system with clean, zeolite softened water in cooperation with the University Project Manager and HTW Plant Personnel. The Contractor shall furnish interconnections and the services of an approved water supplier for filling. Water hardness measured at the University wells is approximately 27 GPG total hardness as CaCO₃.
15070  **System Start-Up**

a. No valve between existing and new HTW piping shall be opened until after all tests are approved, and internal cleaning operations are complete; then, system valves may be opened only with authorization and on-site-assistance from Campus Utility Services, the HTW Plant, and the University Project Manager.

b. Require the Contractor to assist University personnel in system start-up. The HTW Plant personnel will provide on-site management of the start-up process and direct the Contractor in valve positioning. The Contractor shall not activate any valve during start-up until directed to do so by the University.

c. Require the Contractor to check all parts of the system for leaks, and repack valve stem glands that indicate a need for additional packing.

15083  **Strainers**

a. Show strainers on the inlet side of all control valves on contract drawings. Strainers are to be full pipe size, and where pipe size reductions occur, the strainer shall be the same size as the large end of the reducer.

1) Strainers 2-1/2” and Smaller: Strainers shall be Y-type with socket weld ends and drain conforming to ANSI Class 600 LB, with body material of carbon steel, type 1030 WCB. They are to have a bolted retainer plate; a socket welded drain connection; studs conforming to ASTM A193, Grade B7; nuts conforming to ASTM A194, grade 7H; and, stainless steel screens. The blow down line shall be welded (only). No threads are allowed on the blow down line until after two valves.

2) Strainers 3” and Larger: Strainers shall be Y-type with butt weld ends and drain conforming to ANSI Class 600 LB, with body material of carbon steel, type 1030 WCB. They are to have a bolted retainer plate; a socket welded drain connection; studs conforming to ASTM A193, Grade B7; nuts conforming to ASTM A194, grade 7H; and, stainless steel screens. The blow down line shall be welded (only). No threads are allowed on the blow down line until after two valves.

15090  **Pipe Hangers, Supports and Anchors**

a. Pipe hangers, supports and anchors are to be designed as a complete support system for HTW piping. Approved manufacturers are Blaw Knox, Fee & Mason, and Grinnell.

b. The shop drawing submittal shall include system calculations for zero reaction on all equipment, and shall include necessary seismic restraints.

c. Require the Contractor to install all connections, supports, hangers, anchors, guides, and accessories necessary to provide pipe support, restraint, and allowance for predicted movement.
d. Require the Contractor to provide and install auxiliary structural steel supports as necessary to support, anchor, and/or restrain the pipe and accessories.

e. Within Manholes

Design structural steel anchors, hangers, and pipe supports in manholes. Require the Contractor to cut anchor steel to accurately fit the pipe, and bend the support to allow a continuous weld to the pipe. Prepare for the weld so as not to reduce pipe wall thickness or impair strength. Specify gusset or filler plates between structural members and pipe as required. Change the slope of pipe only at anchors. See the detail drawings included in these supplement.

f. Wall Entry

Specify and show packed gland seals and end seals at service box walls and building walls as shown on the detail drawings.

g. Cathodic Protection at Wall Entry

Pipe anchors which will be set in concrete shall have an epoxy coating to act as a dielectric for the anchor and adjoining pipe. The area to be coated shall be cleaned to remove mill scale, grease, dirt, etc. Brush apply a full coverage prime coat of O'Brien Mira-Plate, or Westglas 920 with hardener added. Follow with a brushed coat of O'Brien Mira-Plate Hi Luster or Westglas No. 930. Finish using necessary catalysts or hardeners, and repair damaged areas prior to pouring concrete around the anchor. The finish must be continuous without blemish at the time of pour. Wall rebar must not contact the anchor or pipe.

15100 Valves

a. Secondary Side, Low Pressure Valves

Valves installed on the low pressure side of converter systems shall be as specified in 3.8 HVAC.

b. Acceptable Manufacturers for HTW valves are Crane, Velan, Vogt, RP&C.

1) Require the Contractor to identify valves at the work site with labels. The University reserves the right to reject items not readily identified as meeting the requirements of this University of Utah supplement.

c. High Temperature Water - Gate and Globe Valves, 2” and Smaller

Valves shall be specified forged steel, outside screw and yoke rising stem (OS&Y), conforming to ANSI Class 800 LB, with the valve body conforming to ASTM 105 Grade 2, and ANSI B16.11. Provide socket weld ends, a bolted bonnet, full bore, stud bolts conforming to ASTM A193 Grade B7, and nuts conforming to ASTM A194 Grade H. Provide stainless steel internals and trim (ASTM A182, Grade F-6-1961T) with hard-faced seats.
1) Gate valves shall have a solid wedge and shall be full ported.

2) Globe valves shall have a solid disc.

d. High Temperature Water - Gate and Globe Valves, 2-1/2" and Larger

Valves shall be specified "full flow", cast steel body, OS&Y, conforming to ANSI Class 600 LB standards. The valve body shall conform to ASTM A216 Grade WCB, stud bolts shall meet ASTM A193 Grade B7 requirements, and nuts shall conform to ASTM A194 Grade 2H. The internals and trim shall be alloy steel with hard faced seats.

e. Valves shall be rated for 800 degrees F (transient) and 445 degrees F continuous operating temperature, both at 500 PSIG.

f. Specify butt-weld ends.

g. Specify a bolted, flanged yoke-bonnet with a tight shut-off back seat arrangement inside the bonnet to allow packing the valve while in operation.

h. Each valve shall be factory tested to ANSI B16.34 or API 598 standards for hydrostatic shell and seat testing, and shall be certified for tight shut-off prior to shipping. Factory test results and certification shall be submitted (three copies) to the University Project Manager prior to installation.

i. Each valve shall have a nameplate to match the requirements of 3.8 HVAC. Additionally include the manufacturer, the size, and the ANSI pressure-temperature service rating.

j. Specify that the machined end bore of each valve shall match the bore of the connecting pipe.

k. By-Pass

Valves 5" and larger shall be furnished with a single valved by-pass (3/4" for valves 5", 6", and 8") (1" for valves 10" and larger). The by-pass shall have welded joints and a welded globe valve meeting the specifications listed above.

l. Special Operators

Valves 8" and larger shall be furnished with concealed bevel gear type operators. Approved manufacturer is Crane Converto-Gear Type N, and P.

m. Optional Factory Service Requirement

Some projects may require a follow-up check-out of the valves. The following sample specification may apply:

"THE VALVE SUPPLIER SHALL INCLUDE IN HIS BID THE COSTS FOR A POST-START-UP ADJUSTMENT SERVICE TO BE PERFORMED BY A FACTORY AUTHORIZED SERVICE"
"AFTER THE VALVES HAVE EXPERIENCED OPERATING PRESSURES AND TEMPERATURES FOR A MINIMUM OF TWO WEEKS, THE FACTORY AUTHORIZED SERVICE TECHNICIAN SHALL FIELD INSPECT AND ADJUST EACH VALVE SUPPLIED TO CORRECT LEAKS OR DEFECTS. THIS SERVICE MUST BE PERFORMED WITH UNIVERSITY PERSONNEL FROM THE HTW PLANT. THE TECHNICIAN SHALL TIGHTEN BOLTS AND PACKING GLANDS, AND PROVIDE ADDITIONAL PACKING OR REPLACE PACKING WHERE REQUIRED. THIS SERVICE SHALL PROVIDE A LEAK PROOF PACKED SEAL AT THE MOVABLE STEM AND BONNET OF EACH VALVE."

n. Strainer Drain Valves

1) All strainers are to have two valves welded in the drain piping.

2) Show one globe valve in the drain line near the strainer, full line size, ANSI Class 800 LB as specified above.

3) Downstream of the first valve, specify a second valve rated for 1500 PSIG at 1050 degrees F. The second valve shall be a self-aligning disc type valve, straightway pattern, with a forged steel body and socket weld ends. The valve shall have a stellite faced seat, a non-distorting thermal compensated seat groove, and a 321 SS stem. All working parts must be removable through yoke.

o. Blowoff Valves at HTW Steam Generators:

Show two valves in tandem (in series). Each shall be seatless lubricated type valves rated for 250 PSIG. The valves shall have iron body construction with flange connections.

15130 Manholes

a. General

Branch line connections to the underground high temperature water mains shall be in underground concrete manholes. Connections to the mains shall include gate valves in the manholes. Vents and drains shall be double valued with a 6" long threaded nipple outlet. Vent and drain lines are to be as short as possible and not tied together, nor routed to a wall. A 90 degree elbow between the first and second valve will be acceptable if required for clearance.

b. HTW manholes (vaults) shall be poured-in-place reinforced concrete, constructed in accordance with 3.2 Civil, with University specified protected rebar. The manholes shall be square or rectangular in shape with reinforced concrete footings, walls, and top. The bottom shall be open for drainage and shall have a four foot deep gravel sump.
c. Two entry lids shall be provided in the top of each manhole. The entry lids shall be located at opposite corners of the manhole. Install the entry lids and manhole rings at ground level, with round reinforced concrete extensions down to the manhole ceiling.

d. Grade the ground surface/concrete surrounding the manhole lids to provide sloped drainage away from the lids with a gradual grading which will not interfere with snow removal blade operation. Note: Manhole rings, extensions, and connections to the vault shall be waterproofed to prevent ground water and surface water from entering the vault.

e. Specify / show a stainless steel ladder extending from 12” above the floor to entry point. The ladder shall be 14”W, with 3/4” knurled risers at 12” on center, and shall have 1-1/2” x 1/2” runners. The ladder shall be bolted to the structure at the top and bottom of the ladder and with 4’ minimum vertical spacing. Arrange piping to provide a clear landing below each ladder, and a clear egress path for emergency escape.

f. The manhole lids will be used for regular maintenance and shall have a minimum diameter of 24” and a maximum diameter of 30” with exceptions noted below.

1) For valve removal one of the manhole lids must be large enough to remove the largest valve.

2) If the 30” diameter entry is too small for valve removal, specify / show a dual manhole lid instead. A dual lid shall be a 36” diameter or a 42” diameter lid (sized determined by valve removal needs) with a 24” diameter lid in the center of the larger lid. The 24” lid will be used for regular maintenance and the 36” or 42” lid will be used to removed and replace a large valve.

g. Specify that high temperature water manhole lids shall be provided with vent holes.

h. High temperature water manhole entry lids shall be specified cast iron or steel with "HTW" stamped or welded on the lid.

11250 Insulation

11254 Pipe Insulation - Above Ground

a. General

1) Require the Contractor to Insulate all HTW piping and equipment. The term "piping" as used herein includes piping, fittings, valves, controls, specialties, accessories, etc.

2) "Above ground" includes HTW piping in buildings, tunnels, crawl spaces, etc. "Above ground" refers to every location except direct bury pipe.

3) Insulation shall be delivered to the job site in original, unopened manufacturer's containers.
b. Installation

1) Approved manufacturers for "above ground" HTW insulation are Johns-Manville, Carey, Eagle-Pitcher, Owens-Corning, Pabco, and Pittsburgh-Corning.

2) Installation shall be neat and professionally trim.

3) Insulating cement shall have temperature-resisting qualities equivalent to those of the insulation used.

4) Finishing cement shall provide a smooth hard finish over pipe, fittings, and block insulation.

5) Glass fabric shall be heavy duty "GLAS-FAB."

6) Adhesives shall be either Arabol, Sealfas, or Swifts.

7) Provide an aluminum or white PVC jacket with color code stripe in accordance with the section describing color code identifiers in 3.8 HVAC. If yellow PVC jacket is used it will not be necessary to have color code stripe. PVC jackets shall not be used for lines which run in supply air or return air plenums.

8) Where a waterproof vapor barrier is required, install a short fibrous "cut-back" material equal to "Insulseal".

c. Piping Insulation

1) Insulation for HTW piping "above ground" shall be heavy density one-piece or sectional pipe insulation suitable for temperatures up to 1200 degrees F. The jacket may be either "all-purpose" pre-manufactured, or field prepared. Approved manufacturer is Johns-Manville, or prior approved equal. No plastic, nor aluminum will allowed.

2) Calcium silicate precision molded pipe covering will be used, provided the installed thickness produces specified insulating value. Refer to required insulation thickness specifications herein or on the drawings.

3) Foamglass expanded glass may be specified, provided the installed thickness produces specified insulating value. Refer to required insulation thickness specifications herein or on the drawings.

4) Fiberglass insulation may be specified, provided the installed thickness produces specified insulating value. Refer to required insulation thickness specifications herein or on the drawings.

d. Equipment Insulation

HTW equipment (tanks, heat exchangers, etc.) shall be insulated with calcium silicate
precision molded block, consisting of expanded silica combined with a binder and inorganic fiber. The completed system shall be water-resistant and suitable for temperatures of at least 1200 degrees F.

e. Required Thickness

Piping insulation "above ground" shall conform to the following:

<table>
<thead>
<tr>
<th>NOMINAL PIPE SIZE</th>
<th>MINIMUM THICKNESS*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&quot; and Under</td>
<td>1-1/2&quot;</td>
</tr>
<tr>
<td>1-1/2&quot; to 2&quot;</td>
<td>2-1/2&quot;</td>
</tr>
<tr>
<td>2-1/2&quot; to 4&quot;</td>
<td>3&quot;</td>
</tr>
<tr>
<td>5&quot; to 6&quot;</td>
<td>3-1/2&quot;</td>
</tr>
<tr>
<td>8&quot; and Larger</td>
<td>3-1/2&quot;</td>
</tr>
</tbody>
</table>

* Calcium silicate insulation only (thickness of cement, cover, etc. not included)

f. Application of Materials (HTW EQUIPMENT) "Above Ground"

1) Require the Contractor to install insulation over steam generators and converters to completely cover all surfaces, except heads and flanges.

2) Require the application of calcium silicate block and monolithic type insulation, 2-1/2" (minimum, not including thickness of insulating cement and canvas cover) over all surfaces of equipment.

3) Secure the block insulation to the surface of the equipment with 10 gauge black annealed iron wire (or clips, nuts, etc.) welded to the metal surface.

4) Fill depressions or cavities in the surface of the equipment with block and insulating cement to provide a smooth base for the application of the block insulation. Finish curved surfaces with close fitting curved blocks.

5) Reinforce the insulation at openings and corners with metal beading securely wired in place.

6) Require the Contractor to cover the entire area of block insulation with 1" poultry netting, then apply a 1/4" coat of insulating cement and a fabric cover.

7) Allow adequate maintenance space for accessibility to all fittings and name plates. Taper the insulation to these items for such access.

g. Application of Materials (HTW EQUIPMENT HEADS and FLANGES)
1) A special insulation is required for HTW HEAT EXCHANGER HEAD SECTIONS, CONNECTING FLANGES, and ORIFICE FLANGES.

2) Removal blankets shall be installed. These shall consist of felt mineral insulation, glass fabric, and "velcro" or buckle type enclosures. Wire type closures will not be approved. The density and thickness of the felt shall be uniform to assure full insulating value.

3) The blankets shall be rated for 850 degrees F.

4) Approved manufacturer is Johns-Manville Turbine Blanket.

h. Application of Materials (PIPING) "Above Ground"

1) All required piping tests shall be completed before insulation is applied to the pipe.

2) Flanged joints shall not be insulated until after start-up when the piping system is at final operating temperature, and the flange bolts have been fully tightened.

3) Require the Contractor to insulate valve bodies and accessories with coverings equal in temperature resistance and thickness to that of the connecting piping.

4) Require the Contractor to install a short piece of pipe covering next to flanges on both sides of the joint. This will allow removal of a short piece of pipe insulation, providing access to bolts in the flange.

5) All flanges shall have blanket covers as specified above.

6) Require the Contractor to apply pipe insulation in sectional form. Fit all segments to conform to the curved surfaces to which applied. Carefully point all joints with cement and apply a thin finishing coat of insulation cement to present a smooth, even surface.

7) Fasten calcium silicate insulation securely with annealed iron wire* 6” on centers. Use the following wire gauges for the appropriate pipe size:

<table>
<thead>
<tr>
<th>PIPE SIZE</th>
<th>WIRE GAUGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>4” and Smaller</td>
<td>No. 18</td>
</tr>
<tr>
<td>5” and Larger</td>
<td>No. 16</td>
</tr>
</tbody>
</table>

* Fasten each layer of insulation independently of other layers. Secure the wires and allow no projections to be visible through the canvas jacket. Fill all indentations with insulating cement for an even surface.
8) Provide expansion joints per the manufacturer’s instructions for expansion control of the finished insulation system.

9) Vertical Piping

Tack weld studs or clips to vertical sections of pipe when the rise is more than 5'-0" vertically to support the insulation and prevent displacement by slipping or contraction. Welds must conform to the welding specifications above.

10) Insulation on fittings shall be standard pipe insulation or blocks molded into sections to form a smooth exterior. Coat the exterior of the insulation with insulating cement to form neatly rounded curves. Finish in the same manner as the adjoining pipe.

11) Apply calcium silicate block insulation on valve bodies, leaving the packing nuts exposed, then securely tie the insulation with wire.

12) Where exposed metal surfaces will exceed 200 degrees F (i.e. at the edge of the insulation) rather than use a canvas covering on the insulation, apply a 6" wide strip of glass cloth over the insulation at the edge of the exposed surface. Paste the glass cloth over the affected area with suitable adhesive.

13) All piping in mechanical rooms, chases, and manholes must be labeled in accordance with the specifications provided in 3.8 HVAC.

i. Work Site Operations

1) Require the Contractor to clean the worksite at the end of each work period. Protect the equipment and building with drop cloths and procedures which minimize the migration of work materials into adjacent spaces.

2) Store materials in locations which will not interfere with the work of others.

3) Remove spatters and other defacements from structures, equipment and the work of others.

4) Leave the premises clean and free from insulation debris.

15256 Piping Insulation - Below Ground Direct Bury

a. Unless otherwise approved, all new below ground direct bury HTW piping shall be Thermacor Process, L.P. Duo Therm “505” or prior approved equal pre-insulated pipe, including extra strong schedule 80 carrier pipe. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid. Follow ALL of the manufacturer’s installation details and processes.

b. When approved for direct bury, specify the insulation of all plain (non-pre-insulated) pipe with inorganic granular insulation as follows:
1) Provide engineered inorganic non-toxic, non-flammable, sodium potassium aluminum silicate insulation with calcium carbonate filler.

2) Insulation shall be chemically treated to render it hydrophobic.

3) Insulation shall be free of asbestos.

4) Provide insulation with the following properties for below grade installations on piping systems with operating temperatures at or above 400 Degrees F:
   a) Density: 40 to 42 lb/cu ft consolidated use density.
   b) Load Bearing: 12,000 psf at consolidated density.
   c) Thermal Conductivity: $K = 0.60 \text{ BTU/hr/sq ft/degrees F/inch}$ at consolidated density and at mean temperature of 176 degrees F.
   d) $K = 0.65 \text{ BTU/hr/sq ft/degrees F/inch}$ at 300 degrees F.
   e) Temperature Range: 35 degrees F to 800 degrees F.
   f) Electrical Resistivity: Greater than 10 to the 12th Ohm-cm.
   g) Approved Product: GILSULATE 500 or prior approved equal. All other manufacturers / products must be reviewed and approved by University Facilities Management prior to bid.

5) Provide insulation with the following properties for below grade installations on piping systems with operating temperatures below 400 degrees F.
   a) Thermal Conductivity: (ASTM C 177) $K = 0.58$ to $0.68 \text{ btu/hr/ft}^2 \text{ °F}$. 
   b) Minimum Temperature Range of 0°F to 400°F (250°C).
   c) Bulk Density: 40 to 62 lbs per cubic feet (CF) installed.
   d) Load Bearing: Up to 12,000 lbs per square feet.
   e) Electrical Resistivity Range: From $R = 10$ to the 12th to $R = 10$ to the 14th OHMS-CM.
   f) Dielectric Constant: 2.7
   g) Friction Coefficient: 0.35 ± 0.04
   h) Water/Moisture Resistance: Withstands 10 ft hydrostatic head of water for a minimum of 14 days with moisture gain less than 0.02%.
6) Completely Non-Toxic and Environmentally Safe.

7) Approved Products: Gilsulate or Dri Therm or prior approved equal. All other manufacturers must be reviewed and approved by University Facilities Management prior to bid.

8) Installation of granular insulation as required by the granular insulation manufacturer/supplier:
   a) Installation of expansion cushions as required by the manufacturer/supplier:
      (i) Wrap mineral fiber cushions around pipe elbows on expansion elbows and expansion loops as indicated on manufacturer’s drawings and as specified herein.
      (ii) Ensure there is sufficient space or flexibility between cushions to allow insulation to pour and be consolidated under piping.
      (iii) Secure cushion to pipe with strapping.
   b) Installation of Forms
      (i) Provide gypsum board forms with support posts as indicated in manufacturer’s design and installation manual.
      (ii) Posts must be located on the outside of the forms and spaced to prevent bowing of the gypsum board.
      (iii) After forms are in place, partially backfill outside of form to height of pipe.
   c) Testing of Pipe
      (i) Prior to installing insulation, x-ray test, number and log all pipe welds as required by other sections of the specifications.
      (ii) Clean pipe of dirt, scale and foreign materials.
   d) Insulation Coverage for Piping Systems
      Provide insulation coverage for piping systems in accordance with granular insulation manufacturer’s/supplier’s instructions.
   e) Pouring of Insulation
      (i) Pour insulation in short sections along the pipe axis.
(ii) Apply bitumastic to structural steel surfaces and fill trench to center line of pipe as required by the manufacturer/supplier.

(iii) Consolidate insulation using a rod-type concrete vibrator pulled along the sides and between the pipes if required by the manufacturer/supplier.

(iv) Pour and consolidate additional layers of insulation until the design coverage has been achieved.

(v) Backfill first 6 inches of soil (no stones) by hand.

(vi) Complete backfilling and mechanically compact in layers to grade levels as required by the manufacturer/supplier.

c. Interfacing New Granular Insulation to Existing Z-CRETE

1) Contractors must be made aware that most existing insulation used for the HTW system is Z-CRETE. This product was installed with a bubble wrap, surrounded by an insulating mud compound, and then wrapped inside a rubber membrane. This was then covered by sand and then back-filled with regular soil.

2) The University Project Manager shall be notified prior to any work on HTW lines.

3) Tar shall be placed at each connection point to the existing Z-CRETE membrane envelope. Tar coverage shall be 100%, extending at least 12" beyond the cut (or damaged) Z-CRETE membrane.

4) A sheetrock form shall be built and new insulation properly installed surrounding the pipe.

5) Stored insulation must be protected from moisture.

6) Under no circumstance shall any of this work be buried without notification and approval of the High Temperature Water Plant Supervisor (following inspection).

d. Repairs to Existing Z-CRETE. (See c. Interfacing New Granular Insulation to…)

1) Require the Contractor to notify the University Project Manager immediately if the Z-Crete membrane is ruptured.

2) The HTW Plant Supervisor shall determine who will make the repair and what type of repair to make. No work on this damage, nor covering of this damage shall occur without authorization.

3) Before insulation repair can be made, the membrane must be exposed by...
removing dirt to a point at least 12” beyond any part of the fractured membrane.

4) If severe damage occurs, the membrane and insulation shall be removed completely from the pipe. It shall then be treated as an interface (see c. above).

5) Under no circumstance shall any of this work be buried without notification and approval of the High Temperature Water Plant Supervisor (following inspection).

e. Guarantee

The Contractor shall guarantee the installation of the insulating system for a period of one (1) year from date of acceptance by the University against deterioration of insulating value, compaction, or water leakage under normal operating conditions.

15732 HTW Steam Generators and Hot Water Heat Exchangers

a. General

HTW generators and heat exchangers shall be manufactured by Howard’s Engineering of Pico Rivera, California. The terms “converter” and “heat exchanger” are interchangeable when used in this supplement. Approval for other manufacturers will be considered after suitable field testing by the University. Prior to fabrication, submit shop drawings detailing the material, coatings, connections, appurtenances, dimensions, and arrangement of the heat exchanger.

b. All HTW heat exchangers shall operate with HTW in the tubes and secondary water or steam in the shell.

c. Show an overhead rail over each heat exchanger, complete with block and tackle, to allow head and tube removal and tube/shell cleaning. Design the heat exchanger with adequate tube removal space.

d. Locate each heat exchanger with adequate clearance for emergency egress. Valves and controls are to be located near the head, fully accessible from a standing position (without ladder and without kneeling), and maintainable from a clear access zone which will not trap a maintenance man if any part of the system fails to hold the hot media.

e. Each unit shall be factory tested prior to shipment. The factory hydrostatic test pressure for heat exchanger shall be 1.5 times the design pressure, correcting for temperature. This test shall be provided for both tube and shell sides of each unit. Provide ASME Code and National Board inspection and stamping for both the tube side and the shell side; and, furnish shop inspection certificates.

f. Design all appurtenances with allowance for expansion and contraction of all parts. Arrange the pipe and fittings to prevent rubbing and abrasion as the system parts move during temperature changes.
g. Each heat exchanger shall have factory installed supporting steel saddles (cradles) with drilled holes for anchors.

h. Prior to shipping, require the manufacturer to thoroughly clean all surfaces and apply an exterior coating suitable for the expected operating temperature specified. The coating shall include saddles and supports.

i. See the HTW equipment drawing details in this supplement for head construction and additional requirements.

j. General Construction

Provide for convenient removal and replacement of tube bundles through flanged shell openings. All connections shall be tight and free of leaks at test and operating pressures. Provide a minimum of 1/8" corrosion allowance for all carbon steel pressure parts.

k. Tube bundles shall be U-tube type, 5/8" or 3/4" O.D. seamless 18 BWG Cupro-Nickel.

1) Provide double wall U-tube bundles with passive tube leak detection for domestic water converters. Provide single wall U-tube bundles and not double wall U-tube bundles on industrial water converters.

2) Tube bends shall be stress relieved after bending.

3) The bundle shall be designed to allow free expansion and contraction.

4) The tubes shall be designed for a minimum operating pressure of 535 PSIG at 450 degrees F. They shall pass a factory hydrostatic test of 800 PSIG prior to shipment.

5) The maximum pressure drop through the tubes shall be 8 FT W.C.. The maximum water velocity shall be 7 feet per second.

6) Fouling factors for the shell shall be 0.001 for steam generators, 0.0005 for space heating heat exchangers, 0.003 for domestic water heating, and 0.003 for industrial water heating heat exchangers.

7) Tube arrangement shall be square pitch with not less than 3/16" cleaning space between tubes.

8) Tube sheets for steam generators and space heating heat exchangers shall be constructed of carbon steel plate. Tube sheets for domestic water heating and industrial water heating heat exchangers shall be constructed of 304 stainless steel plate. The surface of each sheet shall be machined for bolt clearance to allow male and female gasket seating of the flange and multiple pass partitions. See the drawing details provided in this supplement.
9) In addition to flange bolts, attach the tube sheet to the shell flange with four recessed shoulder bolts allowing the HTW head bonnet to be removed and replaced without disturbing the gasket between tube the sheet and shell flange.

10) Do not exceed 2” nut size for flange studs.

11) The tube sheet shall have two "slip-through" holes in its face for insertion of pulling eyes. Holes which are not threaded shall be protected by removable plugs.

12) Tube supports, sheets, and baffles shall be Teflon coated steel plate, adequately braced and spaced to prevent tube rattle or sag during operation.

13) Supports, sheets, and baffles shall be fabricated and arranged to prevent abrasion and wear on the tubes during expansion, contraction, or service.

   The unit construction shall allow convenient removal and replacement of the tube bundle from shell.

1. HTW heads shall be constructed of flange steel ASTM A285, grade C, rated for 600 PSIG design pressure and 900 PSIG test pressure at 450 degrees F.

   1) HTW heads shall be stationary bonnet type with bonnet flange rated at 600 LB TEMA class "C", with a confined gasket joint.

   2) Provide radial flange side inlets and outlets as shown on the details provided herein.

   3) High and low points on tube side not vented or drained by nozzles are to be provided with 1/2” (minimum) connections for venting and 3/4” (minimum) connections for draining the tube bundle. All fittings must be socket weld; no screwed fittings are allowed on the primary HTW system.

   4) Heads are to be provided with lifting eyes or lugs.

   5) Air Vent.

      Provide 2 welded valves as shown in details with threaded nipple, 3” long, open to atmosphere.

   6) HTW connection piping shall conform to ANSI Class 600 LB with the bonnet head flange rated at 600 LB TEMA Class C.

m. All heat exchanger shells shall be constructed to operate at a design pressure of 150 PSIG and a test pressure of 225 PSIG. The shells shall be factory tested prior to shipment.

   1) HTW/steam generator shells and hot water heating converter shells shall be weldment fabricated using flange steel plate ASTM A285 Grade C.
HTW/domestic water converter and industrial water shells shall be fabricated with 304 stainless steel.

2) Each shell shall be x-rayed and stress relieved during fabrication at the factory.

3) High and low points of shell shall be provided with 3/4" vent (minimum) and 1-1/2" (minimum) drain connections.

4) Each shell shall be provide with an adequately sized relief valve, drip pan ell, and threaded fitting to allow the attachment of relief piping to the outside. Each safety relief valve shall be sized in accordance with ASME Code requirements.

5) Provide an aluminum or white PVC jacket with color code stripe in accordance with the section describing color code identifiers in 3.8 HVAC. If yellow PVC jacket is used, it will not be necessary to have color code stripe.

n. Steam generator shells shall be sized to provide a steam space of 55% (minimum) of the total shell volume. See the drawing details included in this supplement.

1) Steam generators shall include a steam separator and a baffle arrangement at the top of the shell to limit the passage of solids to 5 PPM with a design loading of 2500 PPM total solids in the water located in the shell, while the steam generator operates between 10% and 110% of the rated capacity.

2) The unit shall be fabricated with attachment ports for blowdown piping, feedwater piping, and chemical feed piping per the details included herein.

3) The interior of the shell shall be sandblasted to bare metal, then two coat of "Apexior No. 1" shall be applied.

4) The shell shall have an automatic surface blow down and conductivity meter factory installed and tested.

o. HTW space heating heat exchanger shells shall be sized to limit the overall shell length (including the thickness of the shell flange) to a maximum of 5 times the shell diameter. See the drawing details contained in this supplement.

1) The interior of the shell shall be sandblasted to bare metal, and at least two applications of a corrosion resistant material (suitable for the service intended) shall be applied to the internal surfaces.

2) The shell shall be inspected prior to assembly and any damage to the interior coating shall be repaired and cured prior to shipment.

p. Shell connections for all heat exchangers shall be factory installed as detailed herein. Shell connections shall be internally and externally welded to the shell. Reinforcing steel plates shall be installed where required by code.
1) All flanges shall conform to ANSI B16.5 and ASTM A181-11. They shall have a serrated raised face and can be butt welded or slip-on. Slip-on flanges shall be welded inside and outside.

2) Couplings and half couplings shall be socket weld type to conform to ASTM A105 Grade 2 for 3,000 lb.

3) Piping butt weld connections shall conform to ASTM A106 or A53 Grade B pipe. Pipe 3” and smaller shall be Schedule 80, and 4” and larger shall be Schedule 40.

4) The secondary (shell side) piping shall conform to ANSI Class 150 lb.

5) All openings shall be securely covered prior to shipping.

q. Make-up water to steam generators and space heating heat exchangers shall be soft water.

15900 Controls and Instrumentation

15901 General

a. Controls and instruments shall be provided for all HTW heat exchangers. All controls shall be wired through the emergency power system. Control power shall be 120 volts or 240 volts, field selectable.

b. Mechanical rooms where HTW equipment will operate shall be provided with:

1) Temperature gauges and metering
2) Pressure gauges and metering
3) HTW flow recorder/meter
4) HTW temperature difference recorder/meter
5) BTU meter
6) BTU totalizer meter
7) Connections to the campus central control system (as described in 3.8 HVAC, Section 15900)

15902 Control Panel Cabinet

a. Specify the installation of a control panel cabinet to house the meters, recorders, and all controllers for HTW heat exchangers. The controls, instruments, meters, etc., shall be flush mounted on the panel door. Submit shop drawings to the University prior to fabrication for approval of the panel arrangement. The minimum mounting height is
3'-0" from the floor to the cabinet bottom.

b. The panel cabinet shall be free standing or wall mounted, totally enclosed with a hinged access door(s) allowing access to the entire back of the panel. Panel doors shall close tightly.

c. Specify the panel fabricated with cold rolled steel plate and a supporting frame of sufficient for the mounting of the controls, meters, recorders, and accessory equipment.

d. Show the cabinet mounted with bolts and secured to a 4" concrete housekeeping base. Seismically brace the cabinet to withstand a 1 G horizontal impact.

e. Coat the cabinet with an undercoat rust-resistant primer, then three coats of filler, two coats of a sanding surface coat sanded smooth, and finally, two coats of sprayed lacquer.

f. Require the Contractor to provide name plates for all items mounted on the panel. These shall be black Norplex-Micarta or Bakelite with white engraved block style lettering 3/16" high.

g. Install all controls, relays, accessories, etc. inside the panel, except those items that must be remote mounted. Panel wiring and piping shall be the work of the instrument contractor.

h. The cabinet shall include a mounted wiring diagram, fuse blocks, terminal blocks for outgoing leads, and labeled wires and tubes.

i. Water piping and tubing within the cabinet shall have isolation valves between the controls and instruments and the system. Terminate outgoing piping and tubing connections at bulkhead unions.

j. Air piping and tubing shall be installed with one control air supply connection to a manifold. Provide a shut-off valve at each pipe inlet and outlet to/from the header.

15903 Heat Exchanger and Generator Controls

a. HTW heat exchanger and steam generator control valves shall be specified as manufactured by Fisher. Other proposed valves must be reviewed and approved by the University prior to bid. Downstream steam or hot water valves are specified in 3.8 HVAC. The HTW heat exchanger control valves shall have the following characteristics:

1) Normally closed, failing to the closed position on control failure, and must close against a 500 PSI “delta-P”.

2) Single seat with equal percentage flow-to-travel operation. Seat leakage shall be limited to the requirements of ANSI B16.104, Class V.
3) Cast steel valve body conforming to ANSI 600 LB specifications.

4) Fast operating pneumatic operator with repeatable accuracy.

5) Pneumatic valve positioner, factory installed (“I” to “P”), including an actual "%" position indicator.

b. HTW heat exchanger controls serving the HTW valves shall be Powers 535 or prior approved equal by the University. Other proposed controls must be reviewed and approved by the University prior to bid. Label Each Controller by specific function (SHC - SPACE HEATING HEAT EXCHANGER, DHWC - DOMESTIC HOT WATER HEAT EXCHANGER, ABSC - ABSORBER HEAT EXCHANGER, SG - STEAM GENERATOR). The heat exchanger controls shall have the following characteristics:

1) Controls shall be reverse acting, PID, with a consistent, repeatable accuracy of plus or minus 0.5% of full scale (including hysteresis). The controls shall use a 100 OHM RTD, 3 wire DIN curve; or, a 4-20 MA signal. The controls shall have two alarm function input signals.

2) Provide "auto/manual" control with bumpless transfer.

3) The control shall provide a direct reading indication of SETPOINT, PERCENT OUTPUT, VALVE POSITION (% open), and include an IDENTIFIER SIGN describing the controlled process.

4) A loss of control air, power, or loss of a control signal shall cause a loss of control to the HTW valve, allowing the valve to fail to the closed position. Such a condition shall allow the use of the local manual override using a security pass code.

   a) Include optional 3rd and 4th outputs for additional relays to provide an output signal to the central control system informing the HTW Plant that the controller has failed (refer to the "manufacturer's order option" for the Powers 535 Controller).

5) The controller shall have a slow ramp to setpoint (adjustable), for all conditions including start-up and set-point change.

6) The controller shall accept a remote set-point adjustment from the campus central computer, and shall have the ability to toggle between remote and local operation. For initial programming, unless specifically required by the HTW Plant, program the controller to operate without the remote setpoint function.

c. Make-up water controls for HTW steam generators shall include:

1) Controls to regulate the supply make-up water from the water softener to the make-up/condensate receiver tank, including all necessary operators and valves.
2) Provide feedwater controls including a float activated electric switch mounted on the HTW generator shell. The device shall be Mc Donnell Miller Number 150S, or approved equal by Mercoid or Magnetrol. The unit shall have 1" pipe tappings on the float cage and shall be fabricated with packless construction. The controller shall cycle the feedwater pumps to maintain a safe water level in the shell.

3) Provide a low water cut-out and alarm and high water level cut-out and alarm to stop the feedwater pumps, close the HTW control valve, and activate a central control alarm indicating a low water or high water level in tank. Separate indications are required at the central control monitor. This device is to be separate from the feedwater controller. Provide a McDonnell Miller Number 150 or approved equal by Mercoid or Magnetrol. The controller shall operate an electric-pneumatic relay to close the HTW control valve at either the high or low level condition in the shell. Note that the low water cut-out must be manually reset.

d. Blowdown Tank Controls for HTW Steam Generators shall include:

1) Temperature Controls to limit the temperature of the water leaving the blowdown tank to a 120 degrees F. (maximum) by mixing blowdown water in the tank with cold soft water.

2) Control valves shall be self-operated and controlled by a remote temperature bulb. Construction shall include a double seated bronze body, screwed ends, and stainless steel seats and disc. Provide with separable socket, removable liquid filled bronze bulb, bronze welds, and copper tubing with spiral weld metal cover over the capillary tubing. Each valve shall have a fully adjustable temperature setting with the temperature scale and indicator in the valve frame. Approved manufacturers are American Temperature Regulator and Trerice.

15904 Gauges and Level Indicators

a. Temperature gauges and sockets serving the HTW system shall conform to the following:

1) Sockets and wells shall be 3/4" stainless steel Type 316, socket welding type, rated for a design pressure of 1,000 PSIG at 1,000 degrees F, and tapered or machined to provide maximum contact with the stem or bulb. The stem length shall allow for the required insulation (2-1/2" extension length). Approved manufacturers are Trerice and Palmer.

2) Socket connections shall be separable union type.

3) Thermometers shall be glass tube, red reading mercury type, straight or angle as required for convenient reading from ground level. Thermometers shall be industrial grade. Approved manufacturers are Trerice, Palmer, and Weksler.

4) Thermometer case shall be 9", black finish, cast aluminum or extruded brass,
with magnifying lens, stainless steel bulb chamber, and separable socket (union type).

5) The thermometer scale shall be black on white or silvered background. The scale range shall be 100 degrees to 550 degrees F with 5 degree graduations.

b. Pressure Gauges serving the HTW system shall be wall mounted on a panel or bracket. Approved manufacturers are Helicoid, Crosby, and Trerice. The gauges shall conform to the following:

1) Pressure gauges shall be industrial quality bourdon tube type (stress relieved) constructed of stainless steel movement with welded joints, socket, and tip.

2) The case shall be flush or surface panel mounting type constructed of cast aluminum with a black finish. Mount rigidly on brackets securely fastened to the building.

3) Flanges shall be cast aluminum or iron with a black finish. Provide a screwed bezel ring to retain the glass cover. The required range for HTW service is 0 to 800 PSI.

4) The dial face shall be black figures set in a laminated plastic surface, with micrometer adjustable points. Provide a 6” dial.

5) Accessories shall include a stainless steel pressure snubber and needle valve. The needle valve shall be constructed of forged or bar stock stainless steel with stainless steel trim and a pressure rating 600 PSIG at 750 degrees F.

c. ISE-Magtech water column level indicators shall be installed on HTW steam generators, condensate receivers, and make-up tanks. The units shall be rated for 250 PSIG and shall include water gauge valves. The units shall use a magnetized indicator or series of metallic flags with the indicator magnetically coupled to the float.

1) Indicators shall provide full visibility of the water level from 2” below the low water cut-off to 2” from the top of the tank or shell. In all cases, the high level alarm position shall be visible.

2) Gauge valve holders shall be Reliance Number 403 RS with a 250 PSIG rated blowdown cock.

15905 High Temperature Water BTU Meters

a. The University requires metering of high temperature water service to its buildings. Review the proposed HTW system and estimate the total building load and capacity, then install a Fluxus ADM 7407 Liquid Ultrasonic Digital Flowmeter or preapproved equal. When system is designed for high temp and chilled water, a dual channel meter shall be selected. Provide load calculations and product specifications to the University Project Manager for each project. Copies of computer programming, wiring diagrams, manuals, and certifications will be physically provided to the HTW Plant and the University Utility Analyst.
b. High temp water BTU meters shall be a wall mounted fixed installation consisting of a BTU computer, BTU totalizer, and display device capable of measuring and reporting.

1) The BTU computer shall be a microprocessor unit and shall calculate, store and display the following properties:
   a) HTW flow rate
   b) Supply and return temperatures and the difference between.
   c) Instantaneous MBH
   d) Password protected MBtu totalizer that uses an even multiplier of 10,000 Btu, 100,000 Btu or 1,000,000 Btu.

2) The meter must be capable of transmitting calculated flow rate, energy flow rate, supply and return temperatures and an energy totalizer to the campus central computer using Modbus Rtu protocol.

3) Loss of main power or battery back-up must not erase Btu total.

4) Locate meter display in adjacent mechanical room and not in HTW mechanical room because of high ambient temperature and humidity.

5) Capable of water temperature range 0-500°F Fahrenheit.

c. Specify that Contractor is responsible for parts not specified but required for installation and wire terminations.

d. The HTW flow sensor element shall be installed in the return line in a location approved by flow meter manufacturer to guarantee performance. The flow sensor should be clamped on rather than welded. Sensors requiring silicone grease resulting in scheduled maintenance are not acceptable. Piping contractor must provide upstream/downstream straight piping distances as specified by piping specifications. unless specifically stated accuracy of flow transmitter should be +/- 0.8% of reading with +/- 0.2% repeatability of flow rate.  *Pilot tube or orifice plate technology is not acceptable.*

e. A minimum of 2 temperature sensors shall be furnished and installed in heavy duty stainless steel wells which are back welded in locations approved by the meter manufacturer.

1) Temperature sensors shall be resistance type, 100 ohm RTD. Signals should be transmitted to Btu computer via separate wiring with system accuracy of +/- 0.1%.  *Temperature measurements using gas or mercury filled bulbs are not allowed for Btu Calculations.*
2) Supply and return RTD’s shall be matched pair and connected directly to flow computer following the meter manufacturers specifications in reference to the number of wires transmitting the signal from the RTD to the calculator.

f. Specify a requirement for a trained instrument service engineer and special documentation. Trained service engineer shall determine flow meter and temperature element location in field prior to installation of piping; and, shall calibrate all instruments and certify accuracy of installation. Record this information along with a copy of the Btu computer’s programming, wiring diagrams, manuals and certifications and include in O&M manual with any web-based information provided by having the address clearly marked. Specify 2 extra copies of this information should be bound separately and routed to the HTW Plant, the University of Utah’s Utility Analyst, and placed in the O&M manual with the building number designated on the covers. Wire termination at the field instrument location and panel location and system start-up shall be done by instrument supplier/contractor.

End of 3.8 HVAC