23 21 13 - Hydronic Piping

1. Introduction

   A. This Design Guideline covers piping systems for building mechanical systems, including, but not limited to:

      1. Hot-water heating piping.
      2. Chilled-water piping.
      3. Condenser-water piping.
      4. Glycol cooling-water piping.
      5. Makeup-water piping.
      6. Condensate-drain piping.
      7. Blowdown-drain piping.
      8. Air-vent piping.
      9. Safety-valve-inlet and -outlet piping.

   B. Designers should coordinate with Duke FMD to coordinate selection and execution requirements for piping systems.

2. References

   A. NC State Mechanical Code, 2009

   B. Duke University Design Guidelines, Section 230716 Mechanical Systems Insulation

   C. Duke University Design Guidelines, Section 336300 Underground Steam and Condensate System

   D. Duke University Design Guidelines, Section 336100 Chilled Water Distribution

3. Performance Requirements

   A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:

      1. Hot-Water Heating Piping: 150 psig at 250 deg F

      2. Chilled-Water Piping: 200 psig at 75 deg F

      3. Condenser-Water Piping: 150 psig at 100 deg F

      4. Glycol Cooling-Water Piping: 100 psig at 150 deg F

      5. Makeup-Water Piping: 80 psig at 75 deg F

      6. AHU Condensate-Drain Piping: 75 deg F

7. Blowdown-Drain Piping (Non Steam): 225 deg F
8. Air-Vent Piping: 200 deg F
9. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

4. Design Standards

A. The following table illustrates desired piping standards for different mechanical systems:

Service	Size	Fitting Connection	Pipe Connection	Material
Chilled Water Condenser Water Heating Hot Water Process Water	2" and smaller	Steel - Threaded (NPT), Copper – Propress, PP-R - Fusion	Steel - Threaded (NPT), Copper – Propress, PP-R -Fusion	SCH 80, A53 Gr. B Carbon Steel, ERW or Type L copper hard drawn or Polypropylene (PP-R)
	2-1/2" and larger	Steel - Class 125/150 Flange, copper – Brazed or Propress (up to 4”), PP-R - Fusion	Steel - Butt Weld, copper – Brazed or Propress (up to 4”), PP-R - Fusion	SCH 40, A 53 Gr. B Carbon Steel, ERW or Type L copper hard drawn, Polypropylene (PP-R)
Domestic/Potable/ Non Potable Water (Hot & Cold)	Up to 1-1/2”	Solder (95/5) or Propress	Solder (95/5) or Propress	Type L copper, hard drawn
	2" to 4”	Brazed or Propress, excetion for Valves, Flanges, Unions may be Solder (95/5)	Brazed or Propress	Type L copper, hard drawn
	6” and larger	Class 125 Flanged, or Brazed	Brazed	Type L copper, hard drawn
Reclaim/re-use/gray water	2" and smaller	Threaded (NPT), PP-R - Fusion	Threaded, PP-R - Fusion	SCH 40, A53 Gr B Carbon Steel, Seamless or Polypropylene (PP-R)
	2-1/2" and larger	Class 150 Flange, PP-R - Fusion	Butt Weld, PP-R - Fusion	SCH 40, A 53 Gr B Carbon Steel, Seamless or Polypropylene (PP-R)

Service	Size	Fitting Connection	Pipe Connection	Material
Equipment Drain	2" and smaller	Threaded (NPT) or Propress, PP-R - Fusion	Threaded or Propress, PP-R - Fusion	SCH 40, A53 Gr B Carbon Steel, Seamless or Type L copper hard drawn or Polypropylene (PP-R)
	2-1/2" and larger	Class 150 Flange, PP-R - Fusion	Butt Weld, PP-R - Fusion	SCH 40, A 53 Gr B Carbon Steel, Seamless or Polypropylene (PP-R)
Natural Gas	2" and smaller	Threaded (NPT)	Threaded	SCH 40, A53 Gr B Carbon Steel, Seamless
	2-1/2" and larger	Class 150 Flange	Butt Weld	SCH 40, A 53 Gr B Carbon Steel, Seamless

1. Valves shall be installed in compliance with Duke University Design Guidelines 23 05 23 – General Duty Valves for Piping.
2. Piping shall be insulated in accordance with Duke University Design Guidelines 23 07 16 – Mechanical Systems Insulation
3. Piping shall be supported in accordance with the North Carolina Mechanical Code. Piping supports for thermal systems requiring expansion shall not restrict growth or movement of piping.
    a. Pipe supports mounted to floor shall be grouted in place with non-shrink grout a minimum of 1” prevent rusting from flooding or standing water on floor.
    b. Wall supports shall be installed in a manner with a minimum of 1” gap between support and floor to prevent rusting from flooding or standing water on floor.
    c. Each hanger/support shall be individually supported from above. Hangers may not be supported from other hangers unless it is designed as such and approved by Duke Utilities and Engineering Services.
4. Where possible, piping shall be grouped and stacked vertically and racked together on a structural support rather than spacing horizontally. When stacking piping vertically, the largest pipe diameter is on top, the smallest diameter is on bottom. **This should be noted on the construction drawings for contractors to coordinate.**
5. T-Drill is not an acceptable form of fitting in any hydronic piping application.
6. Material use should be consistent throughout piping segment. Piping should not transition from one material to another unless previously approved by DUES. The

use of dielectric fittings is not acceptable. Where dissimilar metals are joined, the use of a bronze/brass ball valve or fitting is preferred.

7. Brass nipples shall the material used for CHW drains 1” and smaller. The intent of using a brass nipple is for any piping segment, which is considered static (water not flowing regularly, such as a drain connection).
8. Valves to be located at all branch lines off risers. Drains shall be installed downstream of valve.
9. Vents shall be install at top of all risers to aid in air removal. If an automatic air vent is used, an isolation valve must be between the vent and piping.
10. All sensors and gauges shall be equipped with an isolation valve at the main to facilitate replacement without a system shut down.

5. <u>Testing</u>

A. Chilled water and heating water system welds shall be tested 10% or a minimum of 5, whichever is more by means of radiograph by an approved third party testing agency. Welds shall be inspected in accordance with ASME B31.9 Building Service Piping code requirements. Each system shall be tested independently.

1. If any welds are found to be defective, the weld must be cut out and re-welded. Repair of defective welds by adding weld material over the defect, or by peening shall not be permitted. Welders responsible for the defective welds shall be re-qualified before performing additional welding on the job. Any failed weld shall be retested by radiograph at the contractor’s expense.

   a. For any welding failures, 10% of remaining welds must be tested and pass. Additional testing will be at the contractor’s expense.

      (1) Example: Chilled water system has 50 welds, which 5 welds would be tested. One weld fails testing. The failed weld would be reworked and retested. The remaining 45 welds would be tested at 10%. An additional 5 welds would need to be tested and pass before the testing procedure would be complete. If another weld failed, the process repeats until 10% of remaining welds pass.

2. Hydrostatic testing is required on all interior carbon steel piping systems at 1-1/2 times working pressure for 2 hours.
3. Chilled water and heating water systems shall be flushed and chemically treated with cleansers and inhibiters. Refer to flushing procedures outlined in Section 6 below.

4. Refer to *401000 - Building Steam & Condensate Systems* design guidelines for testing and flushing procedures for steam and condensate piping.

5. Refer to *336300 - Underground Steam and Condensate System* design guidelines for testing and flushing procedures for direct buried steam and condensate piping.

6. <u>Flushing</u>

B. Chilled Water

1. Prior to connecting any piping to the Campus Chilled Water Loop at Duke University, a flushing plan must be approved by FMD. The following steps must be followed.

2. Specifications shall require the contractor to provide a flushing plan prior to starting work. The preferred method of flushing is as follows:

   a. Terminal devices need to be equipped with flushing bypass loop during construction. Terminal devices are to be disconnected and isolated from flushing procedure (providing a bridge bypass and isolating equipment with valves is not acceptable). After flushing is complete, bypass loop shall be removed and terminal device connected to permanent piping system. Any deviation from this must be approved prior by FMD and outlined on the flushing plan.

3. System shall be cleaned using chemical cleaner appropriate for metallurgies in system. System must be circulated for sufficient time to allow complete cleaning to occur.

4. System shall be flushed until virtually all the cleaner has been removed from the system.

5. To determine if flushing has been sufficient, the system should be field tested and compared to a city water sample collected as close to the system make up source as possible. System water must meet all of the following criteria to move on to Step 6. If it does not, flushing must continue until it does.

   a. Conductivity within 20 micromhos of city water conductivity.
   b. pH within 0.3 of city water pH
   c. Visibly show no signs of cleaner or contaminants.

6. System shall be tested by ChemTreat prior to proceeding with chemical treatment.

7. Prior to connecting to the campus chilled loop, the following chemistry dosages must be added to the system and circulated for 48 hours to ensure proper passivation and mixing in the new piping.

   a. Benzotriazole > 25 PPM
   b. Silicate (as SiO_2) > 40 PPM
   c. Sodium Erythorbate to deliver an ORP of -200 mV or less

d. Blue dye at a sufficient concentration to match or exceed level of blue tint in campus chilled loop

8. Following 48 hours of circulation of all chemicals listed above, a sample must be taken sent to an ISO certified analytical lab. Lab report should include at least:

   a. Conductivity
   b. BZT
   c. Silicate (as SiO2)
   d. Soluble Iron
   e. Total Iron
   f. Copper

9. Lab analysis should be provided to DUES/. Once received, DUES will arrange a time to conduct final the field test of system water with ChemTreat. If the system water passes the field tests, ChemTreat will notify DUES the system is approved to be tied in to the Campus Chilled Loop.

10. Upon receipt of the approval email, the contractor shall issue an email to all parties copied on the ChemTreat email detailing the contractor's plan to tie in the new piping including date(s).

11. DUES will then issue the final approval to allow the tie in to commence.

C. Heating Water

1. Prior to connecting any piping to the Campus Hot Water Loop at Duke University (or Building Hot Water System), a flushing plan must be approved by FMD. The following steps must be followed.

2. Terminal devices need to be equipped with flushing bypass loop during construction. Terminal devices are to be disconnected and isolated from flushing procedure (providing a bridge bypass and isolating equipment with valves is not acceptable). After flushing is complete, bypass loop shall be removed and terminal device connected to permanent piping system. Any deviation from this must be approved prior by FMD.

3. System must be leak tested. Any leaks must be fixed before advancing to Step 4.

4. System must be cleaned using chemical cleaner appropriate for metallurgies in system. System must be circulated for sufficient time to allow complete cleaning to occur.

5. System must be flushed until virtually all the cleaner has been removed from the system.

6. To determine if flushing has been sufficient, the system should be field tested and compared to a city water sample collected as close to the system make up source as

possible. System water must meet all of the following criteria to move on to Step 7. If it does not, flushing must continue until it does.

a. Conductivity within 20 micromhos of city water conductivity.

b. pH within 0.3 of city water pH

c. Visibly show no signs of cleaner or contaminants.

7. System shall be tested by ChemTreat prior to proceeding with chemical treatment.

8. Prior to putting the loop into service or connecting to an existing hot water loop, the following chemistry dosages must be added to the system and circulated for 48 hours to ensure proper passivation and mixing in the new piping.

    a. Benzotriazole > 20 PPM
    b. Sodium Nitrite > 600 PPM

9. Following 48 hours of circulation of all chemicals listed above, a sample must be taken sent to an ISO certified analytical lab. Lab report should include at least:

    a. Conductivity
    b. BZT
    c. Sodium Nitrite
    d. Soluble Iron
    e. Total Iron
    f. Copper

10. Lab analysis should be provided to DUES/. Once received, DUES will arrange a time to conduct final the field test of system water with ChemTreat. If the system water passes the field tests, ChemTreat will notify DUES the system is approved to be tied in to the Heating Water system.

11. Upon receipt of the approval email, the contractor shall issue an email to all parties copied on the ChemTreat email detailing the contractor's plan to tie in and/or start up the new piping system including date(s).

12. DUES will then issue the final approval to allow the tie in to commence.

7. <u>Installation and Performance Requirements</u>

A. Documents shall include an existing conditions drawing. Existing conditions shall include piping size, location, capacity, etc.

B. Confirm installation responsibilities at out-set of project. Installation services will be provided in-house or contracted out.

C. Coordinate all required tie-in points with Duke Utilities and Engineering Services.

D. Coordinate all commissioning efforts with Duke Utilities and Engineering Services.

E. Documents shall include riser diagram as part of drawing set.