UCONN
UNIVERSITY OF CONNECTICUT

STEAM AND CONDENSATE DISTRIBUTION PIPING
Utility Standards

Office of University Planning, Design and Construction,
Facilities Operations and Waldren Engineering

Established Date: September 2025

SECTION 40 1001
STEAM AND CONDENSATE
DISTRIBUTION PIPING

PART 1 GENERAL

1.1 Introduction

This document and any attachments are general guides and not intended, nor should it be used as a substitute from what is expected from the Designer to design.

This specification governs requirements for all Piping, Valves, Specialties, and piping components used in the steam and condensate distribution systems at the University of Connecticut, Storrs and Avery Point campuses.

On the Storrs campus, steam is generated at the CUP and is distributed throughout the Storrs campus through a piping distribution system. And condensate return water is brought back to the CUP. The pressure is reduced for the steam distribution to 65 psig and a design temperature of 350°F. Condensate is returned to the power plant using gravity or pumped condensate return piping systems at temperatures ranging from 125ºF – 180º F.

Where it is economical, it is preferred that all chilled water, condensate and steam piping be installed in either a central utility tunnel or a dedicated steam tunnel. All tunnels shall have a mechanical ventilation system to allow non-permit confined space entry, LED lighting along the full length, and 120-volt convenience outlets at no greater than fifty (50) foot intervals.

When a tunnel is not feasible, field insulated piping shall be used. Insulated piping systems are used for steam, pumped condensate, and high-pressure condensate (trap) lines and include all pipe, fittings, anchors, transitions, expansion loops, field joints, etc., to a point designated on the drawings inside a building, tunnel, or manhole wall

Wherever possible, design straight sections of forty (40) foot lengths to minimize the number of field welds. All fittings, anchors, and accessories shall be designed and prefabricated to job dimensions to minimize the number of field welds. All field joints shall have a heat shrink sleeve applied. Include 50% of the welds (40% field and 10% factory) be x-rayed by an independent qualified testing agency hired by the Owner's Representative at a cost to the trade contractor. Such test locations shall be identified with the testing agency in the field by the Designer.
It is the responsibility of the Designer to ensure that specified piping application and their submittals include the Certified Mill Test Reports for the steel used in the piping prior to delivery for installation to ensure quality assurance and controls are being performed by the fabricator.

All chilled water, steam and condensate piping shall have a seventy-five (75) year service life.

1.2 Definitions

A. High Pressure Steam: Steam generated at the campus utility plants, this system normally operates at 125 psig saturated conditions. The piping interconnecting the Central Utility Plant (CUP) and the Supplemental Utility Plant (SUP) operate at the high-pressure steam conditions while the remaining steam distribution typically operates at the medium pressure steam conditions.

B. Medium Pressure Steam: Steam generated at the campus utility plants and reduced in pressure in the utility plants for distribution throughout campus. This system normally operates at 65 psig saturated conditions.

C. High Pressure Condensate: Condensate from the high-pressure steam system up to and including the sparge tube, flash receiver, or other device which reduces this condensate to a lower pressure.

D. Medium Pressure Condensate: Condensate from the medium pressure steam system up to and including the sparge tube, flash receiver, or other device which reduces this condensate to a lower pressure.

E. High Pressure Chilled Water: Chilled water generated at the Storrs Campus utility plants, is supplied at a temperature of 45 degrees F with a pressure range from 50 psig to 100 psig.

F. Pumped Condensate: condensate which was at atmospheric pressure and has been pressurized by a condensate return pump (may be electric centrifugal, pressure powered or another type). This system comprises the majority of the condensate distribution piping.

1.3 Codes and Standards

A. The equipment covered by this specification, and the materials of the construction, shall be supplied and installed by the Contractor based on criteria and specifications included herein unless otherwise specified by the Owner, and shall be designed, fabricated, inspected and tested in accordance with, but not limited to, the following listed codes, standards, specifications and guidelines, including all addenda in effect at the time of contract execution unless otherwise stated in this specification:

1. ASME - American Society of Mechanical Engineers
    a. B31.1 Power Piping
    b. Boiler and Pressure Vessel Code (BPVC) Sect. I, Sect. VIII, Sect. XI
2. ASTM - American Society for Testing and Materials
3. ANSI - American National Standards Institute

4. ASNT - American Society for Non-Destructive Testing
5. ACI - American Concrete Institute
6. AWS - American Welding Society
7. Connecticut State Building Code
8. EJMA - Expansion Joint Manufacturers Association
9. ICC - International Code Council (with State of CT amendments)
10. MSS - Manufacturers Standardization Society
11. OSHA - Occupational Safety & Health Administration
12. PFI - Piping Fabricators Institute
13. Any other applicable Codes or Standards

1.4 Design Conditions

A. Engineer of Record shall be responsible for verification and determining applicability of the following system design conditions:

1. High Pressure Steam
    a. Design Pressure: 180 psig
    b. Design Temperature: 390 deg F
2. High Pressure Condensate
    a. Design Pressure: 180 psig
    b. Design Temperature: 390 deg F
3. High Pressure Chilled Water
    a.
4. Medium Pressure Steam
    a. Design Pressure: 180 psig
    b. Design Temperature: 390 deg F
5. Medium Pressure Condensate
    a. Design Pressure: 180 psig
    b. Design Temperature: 390 deg F
6. Medium Pressure Chilled Water
    a.

7. Pumped Condensate
    a. Design Pressure: 185 psig
    b. Design Temperature: 200 deg F
8. Pumped Chilled Water
    a.

1.5 Scope of Work

A. Work Included: The Work of this Section includes, but is not limited to the following:
    1. Piping system materials of construction
    2. Piping system joints, fittings and components.
    3. Piping system ancillaries and specialties

1.6 Submittals

A. The Engineer of Record (EOR) shall include the some or all of the following as deliverable and shall not delegate them to the contractor or the contractor's engineer. Any documents from the scope that are not applicable may be removed subject to Owner's approval and contractual requirements.

B. The Engineer of Record Minimum Design Deliverable Requirements:
    1. Engineering Documents
        a. Code Assessment
        b. Basis of Design
        c. Pipe Sizing Calculations
        d. Equipment and Component Sizing Calculations
        e. Pipe Stress Modeling, Support Loading and Nozzle Loading Calculations
        f. Pipe Support Calculations
        g. Hydraulic Calculations
        h. Steam Regulator Sizing
        i. Safety Relief Valve Sizing
        j. Safety Relief Valve Discharge Vent Blowback Analysis (Open Systems)
        k. Safety Relief Valve Discharge Vent Backpressure Calculations (Closed Systems)
    2. Construction Documents
        a. Process and Instrumentation Diagrams (P&IDs)

b. Equipment Location Plans

c. Pipe Routing Plans and Elevations

d. Engineered Pipe Support Detail Drawings

e. Mechanical Installation Detail Drawings

f. Equipment Specifications and Datasheets

g. Construction Specifications

h. Testing and Commissioning Plans

C. The installing Contractor shall submit the following for approval:

1. Welding Procedures Specifications (WPS'S)
2. Welding Procedure Qualification Records (PQR's)
3. Welding Performance Qualification (WPQ's)
4. Bolted Flange Assembly Procedures and Bolt Patterns
5. Piping, Fittings, and Valves:
   a. Manufacturer Standard Cutsheets
   b. Valve Actuators and Gear Operators
   c. Pressure/Temperature Ratings
   d. Materials of Construction with specification, class or type, and schedule
   e. Mill Test/Certification Reports
6. Miscellaneous piping specialties and appurtenances data-sheets, installation guidelines, and O&M manuals. Including but not limited to the following:
   a. Strainers
   b. Steam Traps
   c. Steam Regulators
   d. Pressure Relief Valves
   e. Flash Arrestors (Sparge Tubes)
7. Expansion joints:
   a. Manufacturer Standard Datasheets
   b. Shop Drawings
   c. Installation Guidelines
   d. Shop Testing Reports

e. Laser Alignment Reports

8. Pipe Supports:
   a. Structural Steel Datasheets and Mill Test/Certification Reports
   b. Structural Steel Material Finishes
   c. Chemical Adhesive Anchor Datasheets and Installation Guidelines
9. Insulation and Jacketing:
   a. Insulating Materials
   b. Jacketing Materials
   c. Insulation Blanket Materials and Construction
   d. Mastic, Insulating Cement, and Sealants
   e. Written installation procedures for all products used.
10. Instrumentation
   a. Instrument Datasheets
   b. Installation Requirements
   c. Calibration Certificates
   d. O&M Manuals
11. Pressure Testing and NDE
   a. System Pressure Test Procedures (prior to testing), including:
      (1) Pressure boundaries
      (2) Test Gauge locations and datasheets
      (3) Test pump connections.
      (4) Identification of any blank or blind flanges required to create pressure boundary.
      (5) Fill connections.
      (6) High point vents/low point drains
      (7) Water Source and Quality
      (8) Test medium disposal plan
      (9) Temporary support locations and details
   b. System Pressure Test Report/Results
   c. Weld maps (prior to commencing NDE testing)

d. Visual NDE (VT) weld inspection procedure.

e. Certification of NDE Testing Company qualifications.

f. Radiograph (RT), magnetic particle (MT), dye penetrant (PT), and ultrasonic testing (UT) NDE test procedures and acceptance criteria as required per ASME B31.1.

g. NDE test reports and results.

h. Initial Service testing procedures per ASME B31.1

12. Flushing and Cleaning

    a. Flushing Procedures

    b. MSDS of all chemicals used , if any, including description and proper disposal method for any waste.

    c. Diagrams and/or Drawings showing all temporary facilities required for flushing and cleaning.

    d. Bill of Materials for temporary facilities

    e. Flushing and Cleaning Report/Results

    f. List of Required Utilities

13. Steam Blow Cleaning

    a. Target Steam Blow Procedures

    b. Non-Target Steam Blow Procedures

    c. Diagrams and/or Drawings showing all temporary facilities required for flushing and cleaning.

    d. Bill of Materials for temporary facilities

    e. Stress analysis of temporary piping

    f. Cleaning Force Ratio Calculations

    g. Acceptance Criteria for each blow (per NEMA standards)

    h. Expected Noise Levels during process

    i. Flushing and Cleaning Report/Results

    j. List of Required Utilities

14. Other piping specialties identified on project drawings.

15. Personnel Protection Systems for uninsulated piping.

PART 2 PRODUCTS

2.1 General

A. Materials

1. All materials and products shall be new, undamaged and unused. Products that have been discontinued are not acceptable.

2. All materials supplied for use in Boiler External Piping (BEP) shall be furnished in accordance with the requirements of the ASME BPVC Section I- i.e. ASME SA-106 material in lieu of ASTM A-106 material.

B. Material Finishes

1. Un-insulated carbon steel piping systems, including those that are insulated only for personnel protection shall have a finish coat of paint applied. Stainless Steel, galvanized steel and non-ferrous metal alloys shall not be painted.

2. Valves and specialties shall be furnished with manufacturer's standard finish unless otherwise noted in Specification sheet or piping drawing.

2.2 Piping Materials

A. Country of Origin

1. All piping materials, valves and specialties subject to this specification ust be made in North America. Deviation from this requirement requires Owner approval.

B. Steam and Condensate System Piping | General

1. Applicable systems

a. High Pressure Steam

b. Medium Pressure Steam

c. High Pressure Condensate

d. Medium Pressure Condensate

e. High Pressure Chilled Water

f. Medium Pressure Water

g. Pumped Condensate

h. Pumped Chilled Water

2. Piping Material: Seamless Carbon Steel ASTM A106 gr. B

3. Piping Schedule

a. Steam Piping

(1) 2” & Smaller: 80

(2) 2-1/2” & Larger: STD

b. Condensate Piping

(1) 2” & Smaller: 80

(2) 2-1/2” & Larger: 80

c. Chilled Water

(1) 2” & Smaller: 80

(2) 2-1/2” & Larger: STD

4. Fittings

a. 2” & Smaller: Class 3000 Forged Steel Socket Welded fittings, ASTM A105, ASTM B16.11

b. 2-1/2” & Larger: Wrought Butt Welding Steel Fittings, ASTM A234 Gr. WPB, SCH to Match Pipe

5. Branch Connections

a. 2” & Smaller: Full Size Tees, Reducing Tees, Sockolets Per MSS-SP-97

b. 2-1/2” & Larger: Full Size Tees, Reducing Tees, Weldolets per MSS-SP-97

6. Flanges

a. 2” & Smaller: ASME B16.5 Raised Face Flanges, Socket Welded, Class 150, ASTM A105

b. 2-1/2” & Larger: ASME B16.5 Raised Face Flanges, Welding Neck, Class 150, ASTM A105

c. 2-1/2" to 4" Alternate: ASME B16.5 Raised Face Flanges, Slip-On, Class 150, ASTM A105. Slip-on flanges shall be attached by double fillet welds.

7. Gaskets

a. ASME B16.20 Spiral Wound Gaskets. 304 Stainless Steel Winding, Flexible Graphite Filler, 1/8” thick

8. Bolting

a. ASTM A193 Gr. B7 Studs with ASTM A194 Gr. 2H Heavy Hex Nuts

9. Unions

a. Not Permitted. Flanges shall be used in lieu of unions.

10. Nipples

a. Match material and schedule of applicable pipe size.

11. Joints
    a. 2” & Smaller: Socket Welding GTAW or SMAW.
    b. 2-1/2” & Larger: Butt Welding GTAW or SMAW.
12. Weld Preheat: 50°F minimum
13. Post Weld Heat Treat: None Required
14. Welding Examination
    a. Fillet, Socket, Seal, Attachment Welds: 100% MT or PT
    b. Butt Welds: 100% RT
15. Direct Buried Piping
    a. Direct buried piping shall be insulated in a pre-formed, cellular glass, rigid insulation system with a heat sealable bituminous jacketing. Refer to following sections for additional information on insulation materials and installation.
16. Notes
    a. The design, materials, fabrication, installation, testing, and examination shall comply with the requirements of ASME B31.1 Power Piping or the requirements of this section, whichever are more stringent.

C. Stainless Steel Instrumentation Tubing

1. Piping Material: ASTM A269 304/304L Seamless Stainless-Steel Tubing
    a. Tubing system components including but not limited to tees, needle valves, check valves, and stainless-steel tubing shall be manufactured be the same vendor.
    b. Manufacturers
        (1) Swagelok, or approved equal
2. Wall Thickness
    a. 1/4”,3/8”,1/2” Diameters: 0.035”
3. Fittings
    a. All Sizes: Double Ferrule Type, Stainless Steel Construction, Compression Fittings. Fittings shall be used for branch connections. Fittings must be compatible with tubing system and manufactured by the same vendor as tubing system. Tube bending shall be used for direction changes to the greatest extent possible.

4. Branch Connections

a. All Sizes: Tees

2.3 Manual Valves & Specialties

A. Steam, Condensate and Chilled Water Systems

1. Gate Valves

a. Small Bore

(1) Size Range: 2" & Under

(2) Pressure Class: ASME Class 800

(3) Design Codes: ASME B16.34, ASME B16.11,

(4) End Connections: Socket Welded

(5) Valve Body: ASTM A 105 Forged Carbon Steel

(6) Description: Solid Wedge, Bolted Bonnet, OS&Y, Integral Backseat, Spiral Wound Bonnet Gasket, Two-piece packing gland, Full port, Open Spoke Steel Handwheel, Bonnet hardware ASTM A193 Gr. B7 with ASTM A194 Gr. 2H nuts.

(7) Manufacturers: Velan, Bonney Forge

b. Large Bore

(1) Size Range: 2-1/2" & Larger

(2) Pressure Class: ASME Class 150

(3) Design Codes: ASME B16.34, ASME B16.5

(4) End Connections: Flanged

(5) Valve Body: ASTM A216 Gr. WCB Body and Bonnet

(6) Description: Flexible Wedge, Bolted Bonnet, OS&Y, Integral Backseat, Spiral Wound Bonnet Gasket, Graphite Packing, Two-piece packing gland, Open Spoke Iron or Steel Handwheel, Bonnet hardware ASTM A193 Gr. B7 with ASTM A194 Gr. 2H nuts, Hardfaced Seat and Disk.

(7) Manufacturers: Crane, Milwaukee, Velan, Bonney Forge

2. Butterfly Valves

a. Large Bore

(1) Size Range: 2-1/2" & Larger

(2) Pressure Class: ASME Class 150

(3) Design Codes: ASME B16.5

(4) End Connections: Flanged or Lugged

(5) Valve Body: Cast Steel, ASTM A216 Gr. WCB.

(6) Description: Triple or Quadruple offset, High Performance metal seated butterfly valve, One piece Body, ASTM A216 Gr. WCB Disc, Stainless Steel Stem, Hardfaced Seat, Graphite Packing.

(7) Notes: Butterfly valves 6" and larger shall be equipped with bevel gear operator and handwheel.

(8) Manufacturers: DeZurik, Flow Seal, Bray, Jamesbury, Keystone

3. Check Valves

a. Small Bore

(1) Size Range: 2" & Under

(2) Pressure Class: ASME Class 800

(3) Design Codes: ASME B16.34, ASME B16.11

(4) End Connections: Socket Welded

(5) Valve Body: ASTM A105 Forged Carbon Steel

(6) Description: Spring Loaded Piston Check, Stainless Spring and Piston, Tapered Seat, Bolted Bonnet, Full Port, T-Pattern, Integral Hard Faced Seat Ring, Spiral Wound Bonnet Gasket, Bonnet hardware ASTM A193 Gr. B7 with ASTM A194 Gr. 2H nuts.

(7) Manufacturers: Powell, Velan, Bonney Forge

b. Large Bore

(1) Size Range: 2-1/2" & Larger

(2) Pressure Class: ASME Class 150

(3) Design Codes: ASME B16.34, ASME B16.5

(4) End Connections: Flanged

(5) Valve Body: ASTM A216 Gr. WCB Body and Cover

(6) Description: Bolted Cover, Swing Check, One piece disk with anti-rotation lugs, Spiral Wound Bonnet Gasket, Bonnet hardware ASTM A193 Gr. B7 with ASTM A194 Gr. 2H nuts, Hardfaced Seat and Disk, Internally mounted disk and hanger with no body penetrations, all parts accessible from top for maintenance.

(7) Manufacturers: Crane, Milwaukee, Powell, Walworth, Velan, Bonney Forge

4. Globe Valves

a. Small Bore

(1) Size Range: 2” & Under

(2) Pressure Class: ASME Class 800

(3) Design Codes: ASME B16.34, ASME B16.11,

(4) End Connections: Socket Welded

(5) Valve Body: ASTM A 105 Forged Carbon Steel

(6) Description: T-Pattern, Forged Steel Disk, Tapered Seat, Bolted Bonnet, OS&Y, Integral Backseat, Spiral Wound Bonnet Gasket, Two-piece packing gland, Open Spoke Steel Handwheel, Bonnet hardware ASTM A193 Gr. B7 with ASTM A194 Gr. 2H nuts.

(7) Manufacturers: Powell, Velan, Bonney Forge

b. Large Bore

(1) Size Range: 2-1/2” & Larger

(2) Pressure Class: ASME Class 150

(3) Design Codes: ASME B16.34, ASME B16.5

(4) End Connections: Flanged

(5) Valve Body: ASTM A216 Gr. WCB Body and Bonnet

(6) Description: Body Guided Disk, tapered seat, Bolted Bonnet, OS&Y, Integral Backseat, Spiral Wound Bonnet Gasket, Graphite Packing, Two- piece packing gland, Open Spoke Iron or Steel Handwheel, Hammer Handwheel on Valves NPS 10 and larger, Bonnet hardware ASTM A193 Gr. B7 with ASTM A194 Gr. 2H nuts. Hardfaced Seat and Disk.

(7) Manufacturers: Crane, Milwaukee, Powell, Velan, Bonney Forge

5. Strainers

a. Small Bore

(1) Size Range: 2” & Under

(2) Pressure Class: ASME Class 800

(3) Design Codes: ASME B16.5, ASME B16.11, ASME B1.20.1

(4) End Connections: Socket Welded

(5) Body: ASTM A216 Gr. WCB Cast Carbon Steel

(6) Description: Wye pattern strainer, Straight thread screen retainer, spiral wound screen retainer gasket, provide plug for blowdown port, 304 Stainless Screen with 0.045in perforations.

(7) Manufacturers: Mueller, Keckley, Spirax Sarco, Titan, Yarway

b. Large Bore

(1) Size Range: 2-1/2" & Larger

(2) Pressure Class: ASME Class 150

(3) Design Codes: ASME B16.5

(4) End Connections: Flanged

(5) Body: ASTM A216 Gr. WCB Cast Carbon Steel

(6) Description: Wye pattern strainer, Bolter Cover, Spiral Wound or compressed fiber cover gasket, 304 Stainless Steel Screen, ASTM A193 Gr. B7 with ASTM A194 Gr. 2H cover hardware.

(7) Notes: All large bore strainers shall be provided with a valved and capped blowoff outlet. Blowoff valves and piping shall match the size of the blowoff connection and shall conform to the root valve specification below. The outlet shall be terminated in a safe location. All Large Bore strainers shall be provided with a fine mesh startup basket or liner. Strainers in liquid service shall have the following perforation sizes: 4" & Smaller 0.062", 6" & larger 0.125". Strainers in steam service shall have the following perforation sizes: 4" & Smaller 0.045", 6" and Larger 0.062".

(8) Manufacturers: Keckley, Spirax Sarco, Titan

6. Root Valves (for instrumentation)

a. Small Bore

(1) Size Range: ½" unless otherwise noted

(2) Pressure Class: ASME Class 800

(3) Design Codes: ASME B16.34, ASME B16.11,

(4) End Connections: Socket Welded

(5) Valve Body: ASTM A 105 Forged Carbon Steel

(6) Description: Root valves shall be provided for isolation of pressure instrumentation.

(7) Notes: Root valves for steam and condensate shall be small bore gate valves conforming to the specification above.

(8) Manufacturers: Velan, Bonney Forge

2.4 Pressure Regulating Valves

A. Pilot operated, pressure regulating valves shall be diaphragm type with external sensing line as required and pilot with adjustable setting.

B. Materials of Construction:

1. Body: Cast Carbon Steel

2. Trim: Stainless Steel

C. End Connections:

1. ANSI CL 150 Raised Faced Flange

D. External sensing lines shall be constructed form stainless steel tubing and shall include a needle valve.

E. Minimum Design Ratings for Regulator and Components:

1. Pressure: 180 psig

2. Temperature: 390 deg F

F. Normal Regulator Operating Conditions:

1. Inlet (High Pressure Steam):

a. Pressure: 125 psig

b. Temperature: 353 deg F

2. Outlet (Medium Pressure Steam):

a. Pressure: 65 psig

b. Temperature: 312 deg F

G. Manufacturers: Armstrong, Spirax Sarco, Spence, Watson McDaniel, Leslie

2.5 Pressure Relief Valves

A. Pressure relief valves shall be ASME BPVC compliant and bear a code stamp.

B. Valves shall be direct acting unless otherwise noted.

C. Materials of Construction:

1. Body: Cast Carbon Steel

2. Trim: Stainless Steel

D. End Connections:

1. ANSI CL 150 Raised Faced Flange

E. Relief valves shall be provided with vent piping discharging to safe locations agreed upon with Owner. Engineer must determine based on routing if an open or closed discharge is acceptable and identify on project drawings. Where open discharge vent pipes are used, a drip pan elbow on the pressure relief valve shall be provided.

F. Manufacturers: Kunkle, Farris Engineering, Crosby

2.6 Steam Traps

A. Steam traps for steam main drainage shall be the thermodynamic disk type.

B. Size: 3/4" THD NPT

END OF APPENDIX XIII

C. Steam Trap Design Rating:

1. Pressure: 600 psig
2. Temperature: 750 deg F

D. Body Material: Stainless Steel

E. Disc and Seat Material: Stainless Steel

F. Capacity: Minimum 800 lbs/hr at a 100 psi differential

G. Integral hardfaced seat and hardfaced disk

H. Manufacturers: Armstrong, Spirax Sarco, Watson McDaniel

2.7 Flash Arrestors (Sparge Tube)

A. Flash Arrestors shall be a premanufactured connections from trap discharges to pumped condensate mains that include a perforated inlet pipe inserted into an oversized piping segment shell with eccentric reducers.

B. Materials of Construction:

1. Perforated Inlet Pipe: Stainless Steel, SCH. 80
2. Shell: Carbon Steel

C. End Connections:

1. Perforated Inlet Pipe: NPT
2. Shell: Butt Weld

D. Manufacturers: Watson McDaniel, Envirosep

2.8 Expansions Joints

A. General

1. Expansion Joints used in steam and condensate systems must be externally pressurized metal bellows type.
2. Expansion joints must be designed and fabricated in accordance with EJMA standards.
3. Joints for Steam service shall be designed for a total of 8" of axial compression. As standard joints shall be shipped in a "pre-compressed" state, able to accept 6" of additional compression and 2" of extension.

4. Joints for condensate service shall be designed for a total of 6" of axial compression. As standard joints shall be shipped in a "pre-compressed" state, able to accept 4" of additional compression and 2" of extension.
5. The expansion joint manufacturer must provide a cross sectional thrust area and a bellows spring rate which must be considered in the piping design.
6. Manufacturers: U.S. Bellows, Metraflex, Senior Flexonics, Hyspan

B. Construction

1. For steam service the inner pipe and the outer casing of the expansion joint must be fabricated from SCH STD ASTM A106 Gr. B Seamless Pipe.
2. For condensate service the inner pipe and the outer casing of the expansion joint must be fabricated from SCH 80 ASTM A106 Gr. B Seamless Pipe.
3. End connections must be ASME CL150 Raised Face flanges.
4. Bellows shall be single ply Inconel (Alloy 625).
5. Expansion joint outer casing must be provided with 3/4" half coupling high point vent and low point drain. Vent and drain connections must come from the factory equipped with threaded plugs.

2.9 Insulation and Jacketing

A. General requirements

1. ASTM C552 Performed closed cell foam glass insulation primary for direct buried and manhole applications. ASTM C547 Fiberglass insulation primary for indoor applications. ASTM C1728 Aerogel insulation may be used as an alternative.
2. Insulation thicknesses shall be as determined by the current edition of the CT State Building Code as modified by IECC. Manhole and direct buried thicknesses as stated herein.

B. Piping Insulation and Jacketing

1. Piping Insulation | Primary Direct Buried & Manholes
   a. ASTM C552 Pre-formed Closed Cell Cellular Glass Insulating Material
      (1) Closed cell cellular glass insulation systems shall be rated for 900 °F and have a maximum thermal conductivity of (k) = 0.42 Btu-in/hr-ft2-°F at a mean rating temperature of 250 °F

(2) Closed-cell foam glass insulation shall be jacketed with a 70 mil thick, heat-sealable bituminous jacketing membrane designed for specifically for direct buried installation. The jacketing shall be equipped with a 1 mil alluminum top film.

(3) Insulation: Owens Corning FOAMGLAS.

(4) Jacketing: Owens Corning PITTWRAP SS.

(5) Note: Acceptable for direct buried and manhole applications.

2. Piping Insulation | Primary Indoors

a. ASTM C547 Preformed Fiberglass Insulation for Piping

(1) Fiberglass pipe coverings shall be rated for a minimum temperature of 850°F and have a maximum thermal conductivity (k) = 0.32 Btu-in/hr-ft2-°F at a mean rating temperature of 250°F.

(2) Fiberglass insulation shall be jacketed with polyvinyl chloride (PVC) jacketing.

(3) Note: Not acceptable for direct buried and manhole applications.

3. Piping Insulation | Alternative

a. ASTM C1728 Aerogel - Type III, Gr. IA insulation as standard.

(1) Aerogel insulation systems shall be rated for 1200°F and have a maximum thermal conductivity (k) = 0.17 Btu-in/hr-ft2-°F at a mean rating temperature of 250°F.

(2) Aerogel insulation to be installed in 5, 10, or 20 mm layers. The final/top layer shall be installed with factory applied foil jacket to minimize dust release once installed.

(3) Aerogel insulation shall be jacketed with polyvinyl chloride (PVC) jacketing.

4. Insulation Thickness Requirements

Service	Insulation & Installation Type	Minimum Required Insulation Thickness by Pipe Size				
		<1”	1”	1-1/2” to 3”	4” to 6”	8” and larger
High	ASTM C552 Cellular Glass	5.0 "	6.0 "	5.0"	5.0"	5.0 "

Pressure Steam	Direct Buried & Manholes					
	ASTM C547 Fiber Glass Indoors	4.5"	5.0"	5.0"	5.0"	5.0"
High Pressure Condensate	ASTM C552 Cellular Glass Direct Buried & Manholes	5.0"	6.0"	5.0"	5.0"	5.0"
	ASTM C547 Fiber Glass Indoors	4.5"	5.0"	5.0"	5.0"	5.0"
Medium Pressure Steam	ASTM C552 Cellular Glass Direct Buried & Manholes	2.5"	4.0"	4.0"	4.0"	4.0"
	ASTM C547 Fiber Glass Indoors	3.0"	4.0"	4.5"	4.5"	4.5"
Medium Pressure Condensate	ASTM C552 Cellular Glass Direct Buried & Manholes	2.5"	4.0"	4.0"	4.0"	4.0"
	ASTM C547 Fiber Glass Indoors	3.0"	4.0"	4.5"	4.5"	4.5"
Pumped Condensate	ASTM C552 Cellular Glass Direct Buried & Manholes	1.5"	1.5"	1.5"	1.5"	1.5"
	ASTM C547 Fiber Glass Indoors	1.5"	1.5"	2.0"	2.0"	2.0"

For insulation materials other than C547 fiberglass and C552 cellular glass which differ in conductivity stated for the materials specified above, the minimum thickness of the material shall be determined per the provisions stated in the current edition of the CT Building Code and the IECC.

C. Valve Insulation and Jacketing

1. Trap station piping shall be covered with applicable steam system insulation thickness and material on steam side (high-pressure side) of

trap station and with applicable condensate system insulation thickness and material on condensate side (low-pressure side) as standard. Steam traps shall not be covered.

2. Small bore valves (2" and smaller) shall be insulated with oversized insulation of the same type and thickness as the rest of the system.

3. Large bore valves (2-1/2" and larger), strainers, expansion joints and other large piping components shall be insulated with removable blankets of the following construction.

   a. Fabric Jacketing

      (1) Silicone impregnated glass fabric rated for 1200°F.

      (2) Minimum weight of 18.5 oz per square yard

      (3) Fabric shall have a minimum thickness of 0.028"

      (4) Material shall be General Insulation Company GLT 2025 or engineer approved equal.

      (5) All factory seams to be sewn with teflon coated fiberglass thread and shall be a minimum of double stitched.

      (6) Edges of material shall be folded over and stitched for a neat finish and to prevent fraying.

      (7) Field joints in jacketing material shall be made using by sewing with teflon coated fiberglass thread. One of the following alternative methods may be used when approved by Owner and Engineer:

         (a) In addition to the field joints method above, stainless steel banding shall be provided. Banding shall be 1/2" thickness with a maximum spacing of 16".

   b. Insulating Material: Mineral fiber, flexible batt insulation with a minimum rated temperature of 1200°F. Owens Corning. Insulation material shall be of the same thickness as the surrounding insulation.

   c. Insulation blankets shall be secured with adjustable buckles.

   d. Expansion Joints shall not have the moving section of the joint insulated.

D. Personnel Protection

1. High temperature piping which does not require thermal insulation for energy conservation or process reasons may be identified as requiring insulation for personnel protection if the surface temperature is expected

to be above 140 deg F and the piping is accessible from the floor, a ladder, a platform or other access surface.

a. Accessible is defined as within eight feet above or three feet laterally distant from the access surfaces described above.

2. For piping which requires personnel protection insulation and is accessible, the insulation shall match the system which the piping is serving.

a. Alternative: personnel protection shields can be used in lieu of insulation where identified on the project drawings. These shall generally be prefabricated from pipe clamps, bar, and welded or woven wire mesh. They shall be configured to be removable. Maximum opening size on wire mesh used for personnel protection is 3/8".

2.10 Pipe Supports

A. Components

1. All supports, parts and components thereof and installation practices shall conform to the latest requirements of MSS Standard Practice SP-58, SP-69, SP-89 and SP-90 except as supplemented or modified by the requirements of this specification.

2. All supports and parts shall conform to the latest requirements of the governing code for the piping system on which they are intended to be used.

3. Wherever possible pipe supports shall be designed not to be in contact with the floor of a manhole. Preference shall be given to attaching supports to the manhole walls.

4. Where pipe supports must be in contact with the floor of the manhole, they must be designed to include a 12" high concrete pier or a 12" high section of stainless steel. Carbon steel, uncoated or galvanized, must not be installed within 12" of the floor elevation due to the high risk of corrosion from standing water.

5. Threaded rod shall not be used in compression.

B. Spring Cans

1. Spring cans, where required, will be shown on Engineer's Design Drawings. Spring constants, deflections, applied loads, hot and cold settings, presets and support types will be specified accordingly.

2. Spring supports shall be MSS SP-58 type 51,52 or 53 Variable Spring

Hanger supports and shall include load scales and travel indicators. Type 48 and 49 Spring Cushion Supports or similar supports that do not include load scales or travel indicators are prohibited.

3. Structural spring can elements shall be of carbon steel construction. Springs shall be made of hard-drawn high carbon steel.

4. Spring cans shall be painted with semi-gloss primer. Spring cans installed outdoors shall be galvanized and springs shall be neoprene coated.

5. Spring cans shall be supplied with travel stops to maintain the factory pre-set load condition.

6. Threaded parts shall be thoroughly coated with copper-based anti-seize compound.

C. Materials

   a. In general, and unless otherwise noted, pipe supports and accessories in direct contact with the piping shall be of the same material as the piping system on which they will be used (e.g. stainless-steel components with stainless steel piping; etc.).

2. Pipe supports and components made of special materials shall be used as follows:

   a. Stainless steel components shall be provided where noted on project drawings to meet special corrosion resistance criteria.

D. Material Finishes

1. Unless otherwise noted, all carbon steel pipe supports, and associated components installed outdoors or in manholes shall be hot-dipped galvanized in accordance with ASTM A123 to a thickness of 50 µm.

2. Unless otherwise noted, all carbon steel pipe supports, and associated components installed indoors shall be unfinished.

3. Unless otherwise noted, all supplemental steel installed outdoors or in manholes shall be hot dipped galvanized in accordance with ASTM A123 to a thickness of 50 µm.

4. Welds on galvanized components shall be coated with two coats of cold galvanizing after acceptance of NDE results.

5. Unless otherwise noted, all supplemental steel installed indoors shall be finished to match the structural steel. All welds shall be touched up

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accordingly.

6. Every effort shall be made to prevent field welding to hot dipped galvanized components. Bolted joints shall be used to the greatest extent possible. Field welds to hot dipped galvanized components require engineer approval.

7. Finish painting shall be required only where specifically called out on the project drawings.

8. Stainless steel, copper and aluminum components shall remain unfinished unless specifically noted otherwise.

9. Sliding surfaces on pipe supports shall remain unfinished unless specifically noted otherwise. Steel-to-steel sliding surfaces in piping systems not equipped with PTFE or graphite slide plates shall be lubricated during assembly with an industrial lubricating compound rated for the design temperature of the system, Never-Seez® Regular Grade.

E. Grout

1. Grout used under pipe support baseplates must be cementitious with a minimum compressive strength of 6000 psi.

2. Grout used under pipe support baseplates must be formed and poured. Dry-packing of grout is prohibited.

2.11 Local Instrumentation

A. General

1. All instruments shall be in accordance with the requirements listed below.

B. Instrument Stands

1. O'Brien Saddlepak Primary Mount KM, I-Beam Spring Clip Mount

2. O'Brien Saddlepak Secondary Mount WP16M, WE16M, 2" Pipe Mount

3. Rosemount B4 Inline Mounting Bracket

C. Pressure Indicators

1. HP or MP Steam and Condensate Service: ASHCROFT Model 1279 Duragage or WIKA 232 direct reading pressure indicator with reading range of 0-160 psig.

2. Pumped Condensate Service: ASHCROFT Model 1279 Duragage or WIKA 232 direct reading pressure indicator with reading range of 0-50 psig.

3. All pressure indicators shall meet the following requirements:
    a. Dial Size: 4-1/2" Dial
    b. Accuracy: ASME B.40.100 Grade 2A, +/- 0.5% of span
    c. Process Connection: 1/2" MNPT Lower or Rear
    d. Case: Phenolic Case, Dry, IP65 Rated, Safety Glass Window
    e. Wetted Parts: 316 SS Element Material and Socket Material
4. All pressure indicators shall include a 2-valve instrument manifold that meets the following requirements.
    a. Ashcroft V-01 2 Valve Manifold or Andersen Greenwood 2 Valve Manifold
    b. Valves: 1 Isolation Valve, 1 Bleed Valve
    c. Process Connection: 1/2"
    d. Gauge Connection: 1/2"
    e. Material: 316L Stainless Steel
5. Coil Siphon (Steam Service Only)
    a. It is intended that the impulse tubing provide a low leg to trap condensate and insulate the pressure gauge. However, if the specific installation geometry does not allow for this, provide a coil siphon between the gauge and the instrument manifold.
    b. Ashcroft 1098 Coil Siphon or Andersen Greenwood CT7 Gauge Siphon
    c. Process Connection: 1/2"
    d. Gauge Connection: 1/2"
    e. Material: 316L Stainless Steel

D. Temperature Indicators
1. Steam Service: ASHCROFT Model EI or WIKA Model 55 temperature indicator with a reading range of 50-550°F.
2. Pumped Condensate Service: ASHCROFT Model EI or WIKA Model 55 temperature indicator with a reading range of 0-250°F.
3. All temperature indicators shall meet the following requirements:
    a. 304 SS case and stem material
    b. 1/4" Stem Diameter with 1/2" NPT union process connection

c. Safety Lens

d. Adjustable Angle connection type

4. All temperature indicators shall meet the following requirements:

a. Dial Size: 5" Dial

b. Accuracy: ASME B.40.200 Grade A, +/- 1% of span

c. Process Connection: 1/2" NPT, ADJUSTABLE ANGLE

d. Case: 304 Stainless Steel, Dry, IP65 Rated, Safety Glass Window

e. Wetted Parts: 316 SS Element Material and Socket Material

f. Stem: 0.25" Diameter, sized to fit the thermowell (see below).

5. All temperature indicators shall be installed with a thermowell that meets the following requirements:

a. Ashcroft Threaded Thermowell or WIKA TW15 Threaded Thermowell

b. Process Connection: 3/4" NPT

c. Gauge Connection: 1/2" NPT

d. Insertion: ~1/3 Pipe Diameter, not less than 2-1/2"

e. Shank: Tapered

f. Material: 316L Stainless Steel

g. Bore Diameter: 0.260"

h. Lagging: Equal to pipe insulation thickness

PART 3 EXECUTION

3.1 Engineering and Design

A. Responsibilities of Engineer of Record (EOR)

1. The Engineer of Record must be responsible for development of all engineering and construction documentation. The EOR responsibilities include and are not limited to the following:

a. Code Compliance Assessment

b. Establishing Design Conditions

c. Review and Certify Engineering Calculations

d. Review and Certify Engineered Drawings and Details

e. Review and Certify Construction Specifications

2. The Engineer of Record must ensure all engineering documentation is complete and compliant with all applicable codes and meets the standard of quality and professional care typical to utility system engineering.

3. The Engineer of Record must be a professional engineer with an active license in the State of Connecticut.

B. Minimum Engineering and Design Deliverables

1. Refer to the submittals section in Part 1 of this document. Engineer of Record is responsible for developing and submitting all applicable engineering and construction deliverables for review and approval by Owner and applicable Authorities Having Jurisdiction (AHJs).

2. The Engineer of Record must not delegate the responsibilities of completing, reviewing, and certification of any engineering documentation to a third Party.

3.2 Installation, General

A. Materials

1. All materials and products shall be new, undamaged, and unused. Products that have been discontinued are not acceptable.

B. Valves

1. The preferred valve type for large bore steam and condensate isolation valves is a high performance, triple or quadruple offset, metal seated butterfly valve. Gate valves shall only be installed with owner approval.

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C. Extent of Work

1. This specification covers the supply, fabrication and installation of all piping, valves, fittings, supports and components, including the root valves on instrument connections.

2. The piping installation shall be complete such that all plant systems can be made operational.

D. Fabrication, Design, and Material Requirements

1. Welders and welding procedures shall be qualified and certified in accordance with all applicable state and local codes and ASME BPVC Section IX. For all welding, Contractor shall submit the following QA/QC

statements:

a. Welding Procedure Specifications

b. Certified Welder / Welding Performance Qualification (WPQ) for each welder. A WPQ shall be submitted for each welder for each process to be used.

c. Welding Records per Paragraph 127.6 of ASME B31.1 where the welding record provides the information requested in (a) or (b) above. Duplicate submittals are

not required.

d. NDE Personnel Qualifications Records, per paragraph 136.3.2 of ASME B31.1.

e. Appropriate welding procedures shall be used when joining dissimilar materials (i.e. Chrome Moly to Carbon Steel).

f. Appropriate end preparation shall be performed when joining materials of different thicknesses.

E. General Piping Fabrication Practices

1. Butt welded joints shall have full penetration and complete fusion throughout the weld. Reinforcement of butt welds shall be per ASME B31.1 Power Piping Code.

2. Cleaning: Prior to welding, all dirt, grease, oil and foreign matter shall be removed from the edges and surfaces of the parts to be joined to expose a bright metal surface. Cleaning may be done by filing, power grinding, or power brushing. During welding, each bead shall be thoroughly cleaned with a power wire brush to remove all scale, slag, etc. The weld deposit shall be completed and prepared around the entire circumference of the weld groove before the succeeding weld passes are deposited.

3. Weld end preparation shall be by machining or grinding. Use of burning or electric arc methods must be approved in writing by the Engineer.

4. Refer to piping specifications for specific material pre-heat and post weld heat treat requirements.

5. Backing rings or consumable insert rings shall not be used on steam piping without express written consent from the engineer.

6. All materials shall be kept dry and protected from wind and weather during welding operations.

7. The use of unions shall be allowed only where specifically shown on the project drawings.

8. Fabrication tolerances shall be per PFI ES-3.

9. All pressure instruments shall be provided with an isolation “root valve” that complies with the applicable pipe specification.

F. Specific Practices for Carbon Steel Piping

1. Refer to system piping material specification section above for joint welding requirements.

G. Specific Practices for Flanged Piping Connections

1. In general, welded connections are preferred over flanged connections.
2. Where project drawings call for flanged connections or when components are specified with flanged end connections the following are applicable.
    a. If a flange specification is not provided with the corresponding piping specification contractor shall notify engineer.
3. For all High Energy Piping Systems at a minimum, the Contractor shall develop and submit flange assembly procedures for approval by the Engineer which define the following minimum assembly parameters:
    a. Bolt/Stud Material
    b. Nut Material
    c. Washer Material
    d. Bolt/Stud Lubricant
    e. Gasket Properties- to include basic gasket design parameters as well as the minimum gasket seating stress, and the compression stress at which crushing of the gasket will occur.
    f. Target Torque Value for Assembly (by flange size). In general, the Contractor may submit and utilize the gasket manufacturer's recommended values. In cases where such recommendations are not available, the Engineer will work with the Contractor to establish suitable values.
    g. Identify the types of tools to be used in the assembly and tightening of the joints, and describe the means by which torque will be controlled. At a minimum the use of hand-operated or auxiliary-powered tools with torque measurement shall be utilized.
    h. Bolt Tightening Pattern and Pass Description (general)
    i. The Contractor may utilize the same procedure for multiple systems as applicable, provided the values for parameters (a) thru (e) above are the same for both systems.
    j. Procedures shall also be developed specifically, if required, for bolted flanged joints involving a raised face flange mating with a flat face flange.
4. Flanges, bolts or studs, nuts, and gaskets shall be provided as specified on the Piping Material Specification.

5. Washers shall be utilized on all bolted flange connections in High Energy Systems at minimum. All washers shall be through-hardened, and shall be Type 4 alloy steel washers consistent with the material, fabrication, and dimensional requirements of Appendix M of ASME PCC-1, 2010, "Guidelines for Pressure Boundary Bolted Flange Joint Assembly."
6. Steel flanges mating to cast iron valves or equipment shall have flat faces.
7. All bolt threads and nut faces shall be lubricated with high temperature anti-seize compound.
8. Bolts of flanged connections when tightened shall have a minimum of three threads exposed past the nut.
9. For instrument orifice plate flanged connections, remove weld spatter and grind the inside of the welds smooth. Instrument orifice weld neck flanges (ANSI B16.36) shall have the inside diameter of the flange taper bored to suit the ID of the matching pipe.
10. Mating flanges shall comply with Paragraphs 108, 110, and 112 of ASME B31.1 Power Piping Code.
11. Refer to piping Material Specifications for gasket requirements.
12. Re-use of gaskets for any reason is prohibited.

H. Flange Alignment Tolerances

1. The following alignment tolerances shall be checked prior to installation of the gasket. For additional information, refer to Appendix E of "Guidelines for Pressure Boundary Bolted Flange Joint Assembly", ASME PCC-1, 2010.
    a. The misalignment tolerance between two flanges, when extending a straight edge from the outside of one flange over to (and either above or hitting) the adjacent flange, shall not exceed 1/16". A minimum of four points per flange shall be checked.
    b. Adjacent flange faces should be parallel with one another. The maximum discrepancy, when a gap measurement is made at the closest and farthest two points around the circumference of the two flanges, shall not be greater than 1/32".
    c. The rotational misalignment shall be such that the misalignment of corresponding bolt hole centers does not exceed 1/8" in rotation.
    d. The gap between two flanges prior to bolt-up shall not exceed a value equal to twice the gasket thickness.

I. Flange nuts for High Energy Piping Systems shall be tightened in accordance with the Legacy Pattern defined in Figure F-1 of ASME PCC-1, 2010, with a minimum of four passes. Flange nuts for General Service Piping Systems may be tightened in the same manner or in accordance with Alternative Assembly Pattern #1 or #2, provided at least two pattern passes are performed before the final circular pass.

J. Specific Practices for Mechanical Connections:

1. Couplings, bolts or studs, nuts, and gaskets shall be provided as specified on the pipe class specification.

K. Pipe and Tube Bending

1. Pipe bending shall not be used unless approved by the Engineer.
2. Tube bending is acceptable and shall be used to the greatest extent possible to minimize tubing compression joints.

L. Installation

1. Piping shall be installed in accordance with the arrangement and dimensions shown on the drawings. Should any conflicts, interferences, structural difficulties or the work of others prevent the installation of the piping as shown, the deviations shall be brought to the attention of the Engineer.
2. Reducing fittings shall be used where any change in pipe size occurs. The use of bushings to change pipe size is prohibited.
    a. Reducers installed in horizontal pump suction piping shall be eccentric type, oriented flat on top.
3. Piping subject to expansion or contraction shall be anchored and otherwise supported by the project drawings.
    a. For field routed piping subject to expansion or contraction adequate means to compensate for expansion or contraction and to thereby relieve the associated stresses and strain shall be provided by the contractor.
    b. In general compensation for expansion and contraction shall be accomplished by designing the piping with inherent flexibility (bends, lateral runs).
    c. Expansion joints may be used when adequate flexibility cannot be achieved with other means. Installation of any expansion joints shall be submitted to and approved by the Engineer.

4. All pipe openings shall be capped or plugged as they are being installed to prevent the ingress of materials that would obstruct pipe flows. These caps shall be left in place until removal is necessary for completion of installation.
5. The Contractor shall provide ¾" vents and drains at all high and low points respectively in piping systems. All vents and drains shall be double valved and capped in accordance with the applicable Piping Specification.
6. Couplings for threaded pipes shall not be used except where required.
    a. That is, for pipe runs (between fittings) are shorter than a standard pipe length, a single piece of pipe without intervening joints shall be used.
7. Piping connections to existing stub-ups and terminations shall be made by removing blind flanges and caps just prior to making connections. New gaskets shall be installed.
8. Field fabrication and installed piping shall be routed in a neat, workmanlike manner acceptable to the Owner and the Engineer.
9. Manually operated Valves 2-1/2" and larger shall be located where shown on project drawings.
    a. Access platforms shall be provided at locations shown on project drawings.
    b. Valves not accessible from the operating floor or platforms (more than 7 ft above or 3 ft laterally away from same) shall be equipped with chain operators, extended handles, or similar to enable operation.
10. Manually operated valves 2" and smaller shall be installed in locations easily accessible from the operating floor or platforms.
11. All freeblow drains and/or vents shall be routed to a safe location.
12. All drain piping shall be routed to existing drain troughs, hubs, or floor drains in a manner which does not impede access or create tripping or reduced clearance hazards.
13. Under no conditions shall any pipe connection with any piece of equipment be forced into place except where cold springing is specifically approved by the Engineer. To make certain that no piece of equipment is under strain, joints and flanges between the equipment and pipe shall be left free until the line has been completely welded. The pipe

shall be checked by the Contractor prior to welding or making up the flange. At the time when pipe strains on equipment are being checked for acceptance, pipe hangers and supports must be in place.

14. Allowance for gasket thickness must be considered when fitting up flanged joints.

15. Cutting and patching of the construction work, and of existing walks, pavements and building as required for the proper installation of the work shall be performed by the Contractor. Patching shall be of the same materials, workmanship, and finish as the surrounding work, and shall accurately match the same.

3.3 Insulation and Jacketing Installation

A. General Installation Requirements

1. Apply insulation to clean, dry surfaces only.

2. Do not furnish, deliver to site or install material containing asbestos.

3. Follow Manufacturer's instructions explicitly for the application and installation of all insulating materials, mechanical fastening systems, sealants, cement, tape, pre-formed fittings, fitting covers and blanket materials.

4. For the application of sealants, mastics or cements, ensure that the proper surface preparation and drying times are permitted in accordance with all Manufacturer's Recommendations.

5. Do not insulate over equipment nameplates, ASME stamps, instrument gauges, view ports, etc. Flash neatly around these items with high temperature insulating cement.

6. Multiple layers of insulation shall be installed with both longitudinal and circumferential joints staggered.

7. Blanket insulation may be installed with butt or lap joints at the seams unless otherwise noted by the manufacturer.

8. Where removable blankets are installed, create a neat, clean termination of the piping insulation and jacketing. Create a smooth, radial seal from the jacketing down to the piping surface with high temperature insulating cement. Arrange blankets with major opening on bottom to shed water.

9. In general, insulation shall be installed with a snug fit and without air pockets.

10. Strictly comply with manufacturer's recommended temperature

limits. Apply adhesives, mastic and coatings at the manufacturer's recommended minimum coverage.

11. When insulating at expansion joint locations, insulation shall be installed to allow for 6" of thermal expansion at joints.

12. Trap station piping shall be covered with insulation on the steam side in accordance with steam side insulation specification and insulation on the condensate side in accordance with condensate side insulation specification. Steam traps shall not be covered.

B. Pre-formed Cellular Glass Insulation

1. Cellular glass insulation shall be pre-formed in the shop prior to field installation. Cellular glass shop formed and installed per manufacturer's installation instructions.

C. Aerogel Insulation

1. During installation of aerogel insulation systems, contractors shall be responsible for containment, ventilation, cleaning, and disposal of dust and debris accumulated during install of aerogel.

2. Aerogel insulation jacketing systems shall be inspected upon completion to verify workmanship and adequate aerogel dust containment.

3.4 Direct Buried Piping Insulation

A. Install the cellular glass insulation and appropriate jacketing materials on pipe and fittings in accordance with Manufacturer recommendations.

B. Direct buried systems shall have a minimum of 6" cover of compacted sand backfill and 12" cover of soil. Backfill materials may be placed and compacted in maximum 12" lifts.

1. Back fill materials shall be free of rocks, debris, and stones of greater than 1/4" in diameter.

C. Insulation shall be continuous along entire length of direct buried piping up to and including through wall penetration.

D. The piping process within the cellular glass insulation shall be installed along the same centerline as the cellular glass insulation. Piping shall be supported as detailed in project drawings and per cellular glass insulation Manufacturer recommendations.

E. The insulation dimensions shall be selected for use with standard steel pipe sizes, and shall be in accordance with ASTM C585, unless noted otherwise. Where over-size insulation is required or specified, insulation dimensions do

not need to strictly conform to ASTM C585.

F. The insulation shall be jacketed with PittWrap® SS jacketing. Jacketing shall be 70 mil thick self-sealing, modified bituminous membrane material reinforced with woven glass fabric, designed specifically for the protection of underground piping. The jacketing material shall be equipped with a 1 mil aluminum top film and release paper backing.

G. Sealant shall be Pittseal® 727.

H. Insulation shall be oversized to accommodate the thermal expansion of the piping where specified in the project drawing.

1. In oversized portions of insulation, the piping shall be internally supported with concrete support pads in accordance Owens Corning installation details for suggested concrete support pad installation details.

I. The insulation inner diameter shall be at least 1" larger in size than the outer diameter of the socket welding couplings and fittings of which the pipe is constructed.

J. The pipe shall be supported with concrete support pads in accordance Owens Corning installation details for suggested concrete support pad installation details.

3.5 Manhole Piping Insulation

A. Install the cellular glass insulation blanket materials on pipe and fittings in accordance with Manufacturer recommendations. Insulation layers shall be secured in place with wire or stainless-steel bands which should be tightened to eliminate gaps.

B. Insulation shall be continuous up to pipe supports and small-bore connections such as vents and drains. Neatly cut and fit piping insulation tightly around pipe supports and hangers. Make all necessary penetrations in the insulation and jacketing neat and clean, and seal all the way around with insulating cement or appropriate sealant as required.

C. Fill all gaps in the insulation with insulating cement or appropriate sealant material to ensure complete coverage. Pay particular attention to joints and seams around fittings, flanges and valves.

D. Where removable blankets are to be installed, create a neat, clean termination of the piping insulation and jacketing. Create a smooth, radial seal from the jacketing down to the piping surface with high temperature insulating cement. Arrange blankets with major openings on the bottom to shed water.

E. Flash around all pipe supports with insulating cement to create a neat finish without gaps.

F. Jacketing shall be installed in accordance with manufacturer recommendations.

3.6 Pressure Reducing Valves

A. Valves shall be installed in locations shown on the project drawings.

B. Valves shall be installed in straight runs with upstream and downstream diameters according to the manufacturer's instructions.

3.7 Pressure Relief Valves

A. Pressure Relief Valves (PSVs) shall be installed in locations shown on project drawings.

B. PSVs shall be installed in accordance with ASME BPVC and manufacturer instructions.

C. Drip pan elbow drains shall be piped to a floor drain or equipment drain.

D. Relief valve discharge pipes shall be routed outdoors to a specified safe location or as shown on the project drawings and shall be as short and straight as possible.

E. Discharge pipes shall be sized to limit backpressure and/pr blowback in accordance with ASME B31.1 Power Piping.

3.8 Expansion Joints

A. Each expansion joint drain port must be provided with double gate valves and a cap.

B. Joints shall be installed in "cold" piping, meaning the metal temperature of the entire piping system between the respective anchors shall be less than 140 degF when the final field weld(s) are made to install the joint. This ensures proper deflection capacity of the system.

C. Expansion joints shall be aligned to prevent lateral end loads and torsional loads.

D. When expansion joints are installed, a travel scale shall be permanently scribed onto the moving section of the expansion joint with a minimum of six reference marks on a one inch spacing, starting with zero at the face of the guide plate. Each reference mark shall be labeled with its dimension in inches from the face of the guide plate. This scale shall be usable to determine expansion joint displacement from the as-installed position.

3.9 Steam Traps

A. All steam traps must be installed with an upstream and downstream union.

B. Traps shall be installed to permit gravity flow to the trap.

3.10 Local Instrumentation

A. General

1. For remote mount gauges, provide dedicated instrument stands.

2. Instrument stands shall fasten to existing support and supplemental steel via spring clips.

3. Do not drill holes or weld to any existing support steel without explicit approval from the engineer.

4. If necessary, provide ground supported primary instrument stands where no support or supplemental steel exists.

B. Pressure Gauges

1. Furnish and install all impulse tubing in accordance with the specification above.

2. Threaded joints shall use suitable pipe joint compound. Teflon tape shall not be used.

3. If the installation of tubing is not suitable to provide a low leg condensate trap, provide and install a coil siphon with the pressure gauge.

C. Temperature Gauges

1. All temperature gauges shall be provided with a suitable thermowell.

2. Threaded joints shall use suitable pipe joint compound. Teflon tape shall not be used.

3. Adjust "anyangle" gauges to be visible from grade.

3.11 Pipe Supports

A. Piping anchors shall require rigid connection to the supporting structure.

B. Piping which for which the Engineer has designed supports shall be supported exactly as piping design drawings show. Supports shown on drawings shall be classified as engineered supports, and shall not be field modified without the approval of the Engineer.

C. See Rod Sizing Table below for maximum allowable carbon steel threaded rod

capacities.

D. See Pipe Support Spacing Table below for support spacing requirements.

E. All pre-fabricated pipe supports on insulated piping systems shall be galvanized for outdoor use. Proper preparation of the welded area shall be done prior to welding. (e.g., remove the galvanized finish in the weld area)

F. When installing piping and pipe supports in existing facilities, precautions shall be taken to identify and abate asbestos and lead paint as required to accomplish the scope of work. Procedures shall be in strict accordance with Owner's requirements.

G. In general, existing structural steel shall be used for attachment of all pipe support assemblies. Where no structural steel is available, supplemental steel shall be installed by Mechanical Contractor.

H. Where structural steel is not available (grating and handrails are not acceptable) and installation of supplemental steel is not practical, attachments to masonry construction shall be made with through bolts or all-thread rods. Backing plates, nuts and lock washers shall be installed on each side. Extreme care must be taken not to collapse hollow masonry structures. All attachments to brick or block construction shall be approved by the Engineer prior to installation.

    1. Where through bolting is not practical anchors may be used. In this case, only anchors designed and rated for the existing masonry structural system shall be used. Furthermore, installation shall be in strict accordance with Manufacturer's instructions. Installation of anchors in brick or block construction shall be approved by the Engineer prior to installation.

I. Connections to brick and block masonry construction shall not be used if impact or dynamic loading is anticipated.

J. In general, pipe support attachments to structural steel shall be installed such that load paths are through the strong axes of the structural members. Eccentric loading of structural members shall be minimized. For large bore piping, details of proposed eccentric attachments to existing structural steel shall be submitted to the Engineer for approval.

K. All structural welding required for pipe support or supplemental steel installation shall be in accordance with AWS D1.1, Structural Welding Code.

L. All welding to existing structural members shall include appropriate surface preparation. That is, any paint, primer or oxidation that is present shall be removed. The finished weld and members shall be coated as specified above.

M. Installation of rod hangers on high temperature piping systems shall be located and installed with consideration for the expected thermal expansion. Maximum rod deflections shall be limited to 4˚ as measured from the vertical plane. Contractor shall adjust or relocate rod hanger supports if operating deflections exceed 4˚.

N. Pipe supports shall be designed and located to facilitate access and maintenance of valves, piping components, instruments and equipment.

O. Concentrated loads such as valves, strainers, in-line instruments and flanges shall be given special consideration. Pipe supports shall be located as near as practically possible to all concentrated loads.

P. Changes in direction shall be given special consideration. Pipe supports shall be located as near as practically possible to all directional changes. Supports shall be installed on only one leg directional changes.

Q. Contractor is responsible for providing additional temporary support as necessary to support:

1. The weight of hydrostatic testing fluid
2. Reaction forces due to steam blows, gas blows or similar
3. The weight of any temporary facilities required for steam blows, gas blows, or similar

R. Pins and/or travel stops on spring cans shall not be removed until all hydrostatic testing has been completed.

S. In general, non-insulated lines shall rest directly on support members. Insulated lines shall rest on base supports, shields or pipe saddles.

T. Where field located, contractor designed, pipe supports create interferences or impede free and clear access to walkways, equipment, or valves in a manner which is unacceptable to the Owner or Engineer, they shall be relocated or replaced by the Contractor at his expense.

U. Supporting pipes from other pipes, ducts or conduits is prohibited.

V. Piping connections to equipment shall be supported to minimize vibration.

W. Piping connected to the equipment nozzles shall be supported such that all piping loads will be reacted out by pipe supports and hangers.

X. Steel-to-concrete sliding support is prohibited.

Y. In general, all piping 1-1/2” and larger shall be laterally braced to resist earthquake loads in accordance with the Connecticut State Building Code.

Lateral support locations shall be determined by the Mechanical Contractor and shall be submitted to and approved by the Engineer.

1. In general, standard weight MSS SP-69 U-bolts with heavy hex nuts shall be used for lateral support. Refer to Part 2 of this Specification for additional U-bolt specifications.
2. Other standard support rated for side loads may be used if approved by the Engineer.

Z. U-bolt guides shall not interfere with thermal expansion of pipelines. Double heavy hex nuts, one on each side of the structural member flange, shall be used to adjust U-bolts to allow axial movement.

AA. All piping and valves shall be supported so that flanged, union and other non-welded joints make and break freely with minimal misalignment. That is; cold springing of pipe is prohibited.

BB. Support elements in direct contact with stainless steel piping shall be stainless steel.

CC. Support elements in direct contact with hard-drawn copper tubing shall be copper or copper plated steel.

DD. After start-up, all piping systems shall be inspected at operating conditions by the Contractor and Engineer. Support modifications shall be made by the Contractor as necessary to eliminate excessive movements, forces, vibration or noise.

EE. Pipe supports shall not be affixed directly to equipment without the approval of the engineer of record.

FF. Rod Sizing Table

Nominal Pipe Size, (in)	Rod Diameter, (in)	Safe Load at 650˚F Rod Temperature, (lb)
1 and smaller	3/8	610
1-1/4 to 3	1/2	1130
4 and 5	5/8	1810
6	3/4	2710
8 to 12	7/8	3770
14 and 16	1	4960
18	1-1/8	6230
20	1-1/4	8000
24	1-3/8	9470
-	1-1/2	11630

-	1-3/4	15690
-	2	20690

GG. Notes

1. All threaded rod shall be ASTM A36 or ASTM A575 Gr 1020, black steel

HH. Pipe Support Spacing Table

Nominal Pipe Size, (in)	Maximum Span, (ft-in)			
	Non-Insulated		Insulated	
	Liquid	Steam, Gas, Air	Liquid	Steam, Air, Gas
1/2	6-6	6-10	5-4	5-6
3/4	7-4	7-10	6-4	6-8
1	8-2	8-10	6-8	7-0
1-1/2	9-10	11-0	8-1	9-0
2	10-0	12-5	9-3	10-4
3	12-0	15-0	12-0	15-0
4	14-0	17-0	14-0	17-0
6	17-0	21-0	17-0	21-0
8	19-0	24-0	19-0	24-0
12	23-0	30-0	23-0	30-0
16	27-0	35-0	27-0	35-0
20	30-0	39-0	30-0	39-0
24	32-0	42-0	32-0	42-0

II. Notes

1. This table shall be used as a guideline to determine maximum pipe support spacing for general service piping. “High Energy” piping shall be stress-analyzed by the Engineer and any special pipe support requirements shall be shown on the design drawings.
2. Supports must be placed as close as possible to concentrated loads including but not limited to valves, strainers, flow meters, etc.
3. Supports must be placed as close as possible to all changes in direction.

3.12 Meters

Utilities supplied by the University shall be metered and monitored utilizing the preferred electronic software compatible with what electronic monitoring already

exists in the building or within the vicinity of another building. The Designer is responsible for obtaining approval from the University Representative in conjunction with FS on the most appropriate monitoring software for the project application, prior to finalizing the Design Development Phase.

Please Refer to Appendix XII – Utility Services Sub-Metering Design Standards to obtain specifics on metering.

3.13 Pressure Testing

A. General

1. All pressure testing shall be in accordance with ASME B31.1.
2. New piping shall be pressure tested.
3. Test boundaries shall be established to isolate existing piping. Existing piping shall not be subjected to the hydrostatic test pressure.
4. Joints between existing and new piping shall be initial service tested in accordance with ASME B31.1.
5. Pneumatic testing is prohibited.

B. Preparation for Pressure Tests

1. All joints, including welds, shall be left uninsulated and exposed for examination during test (including initial service tests).
2. Identify locations on steam services where additional supports may be necessary to support the weight of test liquids.
3. Ensure expansion joints, if any, have been provided with temporary restraints or have been isolated for pressure test.
4. Ensure blind flanges, pancakes or valves have been installed to create pressure boundaries where required.
5. Verify that all flange nuts and cap screws have been tightened to the required torque.
6. Ensure all installed instruments have either been removed or isolated with instrument root valves.
7. If test medium is subject to thermal expansion, contractors shall take precautions to avoid excessive pressure in piping system. Contractor shall provide pressure relief devices, if necessary, in accordance with ASME B31.1 Power Piping Code.
8. Test Gauges

a. All pressure test gauges shall be calibrated. A calibration sticker shall be prominently located on each gauge, noting date of calibration.

b. Pressure test gauges used in pressure testing shall be indicating gauges and shall be connected directly to the component or piping system. The indicating gauges shall be readily visible to the operator controlling the pressure applied throughout the duration of the tests.

c. Indicating gauges used in testing shall have dials graduated over a range of approximately double the intended maximum test pressure, but in no case shall the range be less than 1.1x nor more than four (4) times the test pressure.

d. Permanent process gauges shall be isolated or removed for pressure testing and shall not be used for measurement of the test pressure.

C. Hydrostatic Pressure Testing

1. Hydrostatic test pressures shall be 1.5x piping design pressures. Testing procedures shall be in strict accordance with ASME B31.1.

2. Use high point vents in system to purge air pockets while system is filling. All air must be vented to obtain reasonable test results. Systems shall be filled from the lowest point in the system to aid in removal of air through high point vents.

3. Hydrostatic pressure tests shall use clean water as the test medium.

4. After test is complete, all carbon steel and stainless steel piping shall be thoroughly drained with high point vents open. The piping shall then be blown down using dry air or nitrogen until dry. The Contractor shall submit detailed blow-down plans with the pressure testing procedures.

5. Hydrostatic test pressure shall be held for a minimum of 10 minutes and may be reduced to design pressure following the initial 10 minutes to examine piping for leaks.

3.14 Non-Destructive Examination

A. In addition to any other inspections specified or required by Code, in process visual inspection of welding operations shall be performed by the Contractor's inspectors. In process examination shall include examination of groove details prior to welding, examination for surface holes, cracks, and other defects during welding and examination for undercuts or other surface defects and reinforcement dimensions after welding. The Contractor shall inform the Engineer and Owner of his intent to repair prior to making any repairs. The extent of any repairs shall be fully documented and recorded by the Contractor

and provided to the Engineer and Owner.

B. Examination requirements for piping welds are as indicated above. Contractor shall include this examination as part of the scope of work. The repair of any unacceptable defect disclosed by visual examination, radiographic examination, ultrasonic examination, magnetic particle examination or any other inspection means shall be made at the Contractor's expense by removing the material in the defective area until free of the defect, then re-welding and re-inspecting, observing all the requirements of this specification for each operation performed. Repairs shall be made without altering the schedule.

C. All non-destructive weld testing procedures and acceptance standards shall be in accordance with the requirements stated in the ASME Boiler and Pressure Vessel Code, including qualification to ASNT (American Society for Non-Destructive Testing). Welds are required to meet the acceptance criteria stated and/or referred to in the ASME/ANSI Code for Pressure Piping B31.1 - Power Piping (edition, including any addenda, in effect at the time of contract execution).

D. Notwithstanding any other provision of this specification, contract, or applicable Codes, non-compliant work, as it pertains to welding, shall be defined as work that does not meet acceptance criteria/standards listed in the ASME Code, as well as incomplete penetration or any indication detected by any method of examination, inspection, or testing.

3.15 Flushing and Cleaning

A. Before a new, modified or repaired piping system, or portion thereof, is placed into service, all piping affected shall be flushed to ensure system cleanliness before operation is permitted.

B. To prevent air entrapment in system piping, the contractor shall fill the system at the lowest point and vent air out of the highest piped system vent.

C. The Contractor shall be responsible for developing all flushing/cleaning procedures following guidelines in this Specification and in the Piping Specifications. The procedures shall clearly and specifically describe all means and methods.

D. Procedures shall address the need and location for all required temporary facilities. The flushing procedure shall be accompanied by system volume calculations. Procedures shall be provided to and approved by the Engineer.

E. All in-line instruments shall be removed prior to high velocity cleaning and flushing operations.

F. All piping system flush results shall be turned over to the Owner and Engineer.

G. For water systems piping, a "flush" consists of moving three times the volume of the system piping through the system at the flushing flow rate.

H. The flushing flow rate is 150% of the piping design flow or sufficient flow to achieve a minimum Reynolds Number of 4000, whichever is less.

I. At least two flushes will be required in all cases. Additional flushes are to be accomplished until the flushing strainer is found clean and the flushing water is clear. The system being flushed shall be completely filled with clean, corrosion inhibited, water or blown completely dry after flushing is complete.

J. Alternately, temporary piping connections to form a closed loop piping system may be installed and the system flushed by means of recirculation. This is neither required nor prohibited. All temporary cross connection and/or special fabrication of adapters required shall be provided by the contractor.

K. If flushing into tank trucks, the contractor shall supply any temporary manifolds and a sufficient number of single compartment tank trucks and hoses to allow the desired flow rate to be achieved in a safe manner.

L. If flushing into drums, the contractor shall supply temporary hoses and drums of a sufficient number to allow desired flow rate to be achieved in a safe manner.

M. Before flushing or cleaning, systems shall be walked down to ensure minimum piping support requirements are met. Identify points where extra piping supports may be needed. Add supports if necessary for vapor service piping systems.

N. The minimum flow for flushing water systems is the normal operating flow for the system. System pumps in place are to provide the minimum flow velocity provided by the contractor.

3.16 Steam Blow

A. The preferred steam blow method is a low-pressure continuous blow.

B. This steam blow specification applies to all new steam piping.

C. The steam blow must be implemented such that a Cleaning Force Ratio (CFR) > 1.0 is achieved. CFR > 1.1 is preferred.

1. The CFR shall be calculated in the following manner:

a. $CFR = m_b^2 * v_b / m_n^2 * v_n$

b. where:

(1) m_b = mass flow during blow

(2) v_b = specific volume during blow

(3) m_n = normal operating mass flow for the line(s) to be cleaned

(4) v_n = specific volume during operation

D. The Contractor or designated Specialty Contractor must develop a hydraulic calculation to confirm that the required CFR can be achieved in all pipe sections, and this must be submitted with his procedure.

E. Generally, a means for pressure reduction is required to perform low pressure continuous blows. This is expected to be an orifice, temporary/sacrificial valve, or similar and will be used to reduce pressure from the steam source to the required blow conditions. The sizing of the pressure reduction device must be determined by the contractor using the hydraulic calculations. The contractor is responsible for providing a suitable pressure reduction device and determining where to install it. Permanent valves or components must not be used as the pressure reduction device.

F. The Contractor or designated Specialty Contractor shall be responsible for development of all steam blow procedures. Procedures shall be in accordance with the requirements of this Specification, applicable piping specifications and steam turbine vendor procedures.

G. Multiple steam blows and multiple procedures may be required based upon system configuration.

H. Procedures shall address the need and location of temporary supports, restraints, piping and other equipment. System steam blow results shall be noted on system commissioning check sheets. Procedures are to be submitted to and approved by Engineer.

I. All permanent piping shall have passed hydrostatic testing prior to any steam blows.

J. All in-line instruments and devices shall be removed prior to steam blowing. Temporary spool pieces shall be installed if necessary. Isolation valves on steam header instrumentation such as pressure transmitters, gauge lines etc shall be closed. After completion of the blow, the Contractor shall reinstall all instruments and complete continuity and loop checks on those instruments.

K. Contractor shall remove all safety and relief valves and install blind flanges on inlet and outlet piping prior to steam blow. Re-install safety valves after steam blow is completed.

L. Contractor shall provide all necessary temporary piping, valves, silencers, etc needed to accomplish steam blow(s) safely and within the guidelines

of this specification.

M. The steam blow shall minimize stress to the system components caused by excessive temperature and/or pressure changes.

N. The arrangement of the temporary piping shall be designed in accordance with ASME B31.1 Power Ping Code. The piping arrangement and steam blow shall not cause stress levels in any permanent or temporary piping component to exceed allowable levels as listed in ASME B31.1.

O. The arrangement of the temporary piping shall be designed to maintain all equipment nozzle loads below manufacturer's limits.

P. Any low points created as a result of the temporary piping arrangement shall have manual drains installed for proper drainage during the blow. If drains are installed in permanent piping, they shall be installed in accordance with the applicable piping specifications and shall remain in system after steam blow is complete.

Q. The exhaust end of the line(s) being blown shall be silenced as required to maintain 85 dBA or less at a distance of 50 ft from the steam discharge point.

R. The exhaust system may include water quenching systems to reduce noise as determined by the contractor.

S. Vent line shall be free, clear and safely terminated prior to steam blow. Safety barriers shall be installed to prevent inadvertent access to the discharge area. Warning tape and signage shall clearly identify all safety hazards.

T. Steam discharge piping shall be routed such that any airborne particles do not impact people, vehicles or buildings, etc.

U. Prior to steam blow, walk down system and ensure minimum requirements for steam piping supports are met. Identify points where extra piping supports may be needed. Add supports if necessary.

V. Mirror finish steel test coupons or “targets” shall be installed transversely in all piping runs subject to steam blows. Targets will be mechanically inserted into the steam blow path.

1. Targets shall be 1” square, machined from stainless steel and polished to a mirror finish.

W. Plant operating personnel is responsible for all valve line-up associated with steam blows. Contractor will be responsible for all coordination with Plant Operations.

X. Prior to all steam blows, piping shall be slowly warmed up using piping bypass valves.

Y. A minimum of three full thermal cycles (from ambient to full steam blow temperature) of piping to be blown must be accomplished prior to inserting the first target. Additional thermal cycles may be required to achieve an acceptable target.

Z. After each targeted blow, target bar(s) shall be removed and visually examined for high velocity impact marks. additional thermal cycles and targeted blows shall continue until impact marks are within acceptable limits. Refer to NEMA standards for further requirements.

AA. Steam blows shall be witnessed by Engineer, Contractor and Owner. Final acceptance shall be by Owner.

BB. Contractor shall log all steam blow results. All target bars shall be individually numbered with permanent etchings and numbers shall be keyed to the entries on the log sheets.

CC. Upon completion, all log sheets and target bars shall be turned over to the Owner.

DD. If any modifications to permanent fixtures or systems within the plant were performed to accommodate steam blows, the Contractor shall be responsible for full restoration unless specifically relieved of such duty by the Owner.

EE. Contractor is responsible for any cleaning or repair activities to restore the site to the "as- found" condition at the conclusion of the steam blow. This may include but not be limited to the following.

1. Cleaning of adjacent structures or surfaces to remove stains or residues.

END OF APPENDIX XIII