TRANSMITTAL LETTER

F.E. MORAN
femoran.com

F.E. Moran - Northbrook
2265 Carlson Dr.
Northbrook, IL 60062

Transmittal #

Date: 06/23/2016
Phone: 847/498-4800
Fax: 847/498-9091

Project Name: 108655000 McCormick Event Center **Project #:** 108655000

To: Clark Construction
Attn: Chris Tapas, Archie Gallup
216 S. Jefferson Street
Suite 502
Chicago, IL. 60661

SUBJECT: 230593-001-0 Field Quality Control – Piping Test Plans

Phone: **Fax:**

Items listed are being sent
- [x] Enclosed
- [ ] Under Separate Cover
- [x] Via E-mail

We are transmitting the following to you:

- [x] Submittals: 230593-001-0 Piping Test Plans
- [ ] Product Data
- [ ] Samples
- [ ] Shop Drawings
- [ ] O & M Manuals
- [ ] Plans
- [ ] Architectural Drawings
- [ ] Letters
- [x] Specifications
- [ ] Prints
- [ ] Addenda
- [ ] Engineering Drawings
- [ ] Change Order Requests

Submittal: 230593-001-0 Piping Test Plans

Code/Spec	Copies	For	Product #	Summary Item
230593	1	Information & Record		Field Quality Control – Piping Test Plans

Remarks:

Included in this submittal for approval:

1.) This Transmittal

2.) Submittal Stamp Sheet

3.) Specifications 230593 – Testing, Adjusting, and Balancing for trades.

4.) F.E. Moran's Hydronic Piping Field Quality Control – Heating Water & Chilled Water (Refer to spec 232100).

5.) F.E. Moran's Hydronic Piping Field Quality Control – Natural Gas (Refer to spec 231123).

COPIES TO:

By: Rebecca Winter
Project Engineer

Received by: _____ Date: 06/23/2016

F.E. MORAN

femoran.com

Material Submittal Coversheet

Project	McCormick Place Event Center
Address:	200 East Cermak Road, Chicago, IL 60616
F.E. Moran Job No. 108655000	Submittal No. 230593-001-0
Architect:	Moody Nolan / Goettsch Partners
Prime Contractor:	Prairie District 3 (PD3) Partners
Contractor:	Clark / Bulley / OVC / Powers, A Joint Venture
HVAC Subcontractor:	F. E. Moran, Inc.
Supplier / Manufacturer:	F. E. Moran, Inc.
Full Description of Item / Data:	Field Quality Control- Piping Test Plans
Specification Items:	230593
Specified Codes and Standards:	As listed in specification

Notes:

1 In compliance with Article 17.b of the Terms and Conditions, deviations are clearly identified on submissions.

2 FE Moran submits the enclosed information in conformance with ESD's 6/4/2014 Issued for Proposal Bridging Specifications FOR INFORMATION ONLY.

REVIEWED BY:
Joe Leinss

REVIEWED BY:
F.E. Moran, Inc.
William Kuzan
Joe Leinss
Les Santeler

Date: 06/23/2016

REVIEWED BY:
Architect

Date:

REVIEWED BY:
Contractor

Date:

REVIEWED BY:
Other

Date:

SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Testing, adjusting, and balancing of air systems.
B. Testing, adjusting, and balancing of heating systems.
C. Testing, adjusting, and balancing of cooling systems.
D. Testing, adjusting, and balancing of plumbing systems.
E. Measurement of final operating condition of HVAC systems.

1.2 QUALITY ASSURANCE

A. Agency shall be a company specializing in the adjusting and balancing of systems specified in this section with minimum three years experience. Perform work under supervision of AABC Certified Test and Balance Engineer, NEBB Certified Testing, Balancing and Adjusting Supervisor, SMARTA Certified Air and Hydronic Balancer, or TABB Certified Supervisor.

B. Work shall be performed in accordance with the requirements of the references listed at the start of this section.

1.3 REFERENCES

A. AABC - National Standards for Total System Balance, 2002.

B. ADC – Test Code for Grilles, Registers, and Diffusers.

C. AMCA – Publication 203-90; Field Performance Measurement of Fan Systems.

D. ASHRAE - 2003 HVAC Applications Handbook; Chapter 37, Testing, Adjusting and Balancing.

E. ASHRAE/ANSI - Standard 111-1988; Practices for Measurement, Testing, Adjusting and Balancing of Building HVAC&R Systems.

F. NEBB - Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems, Sixth Edition, 1998.

G. SMACNA - HVAC Systems; Testing, Adjusting and Balancing, Third Edition, 2002.

H. TABB – International Standards for Environmental Systems Balance.

1.4 SUBMITTALS

A. Submit copies of report forms, balancing procedures, and the name and qualifications of testing and balancing agency for approval within 30 days after award of Contract.

B. Submit four (4) certified copies of test reports to the Architect/Engineer for approval in soft cover, 3-hole binder manuals, with cover identification. Include index page and indexing tabs.

1.5 REPORT FORMS

A. Submit reports on AABC, SMACNA or NEBB forms. Use custom forms approved by the Architect/Engineer when needed to supply specified information.

B. Include in the final report a schematic drawing showing each system component, including balancing devices, for each system. Each drawing shall be included with the test reports required for that system. The schematic drawings shall identify all testing points and cross-reference these points to the report forms and procedures.

C. Refer to PART 4 for required reports.

1.6 WARRANTY/GUARANTEE

A. The TAB Contractor shall include an extended warranty of 90 days after owner receipt of a completed balancing report, during which time the Owner may request a recheck of terminals, or resetting of any outlet, coil, or device listed in the test report. This warranty shall provide a minimum of 24 manhours of on site service time. If it is determined that the new test results are not within the design criteria, the balancer shall rebalance the system according to design criteria.

B. Warranty/Guarantee must meet one of the following programs: TABB International Quality Assurance Program, AABC National Project Performance Guarantee, NEBB's Conformance Certification.

1.7 SCHEDULING

A. Coordinate schedule with other trades. Provide a minimum of seven days notice to all trades and the Architect/Engineer prior to performing each test.

PART 2 - PRODUCTS

NOT APPLICABLE

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. All procedures must conform to a published standard listed in the References article of this section. All equipment shall be adjusted in accordance with the manufacturer's recommendations. Any system not listed in this specification but installed under the contract documents shall be balanced using a procedure from a published standard listed in the References article.

B. Recorded data shall represent actual measured or observed conditions.

C. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing is complete, close probe holes and patch insulation with new materials as specified. Restore vapor barrier and finish as specified.

D. Permanently mark setting of valves, dampers, and other adjustment devices allowing for settings to be restored. Set and lock memory stops.

E. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, plugging test holes, and restoring thermostats to specified settings.

F. The Balancing Contractor shall measure terminal air box air flow, and the TCC shall adjust DDC readout to match. Refer to Section 23 09 00 for additional information.

G. Installations with systems consisting of multiple components shall be balanced with all system components operating.

3.2 EXAMINATION

A. Before beginning work, verify that systems are complete and operable. Ensure the following:

1. General Equipment Requirements:

   a. Equipment is safe to operate and in normal condition.
   b. Equipment with moving parts is properly lubricated.
   c. Temperature control systems are complete and operable.
   d. Proper thermal overload protection is in place for electrical equipment.
   e. Direction of rotation of all fans and pumps is correct.
   f. Access doors are closed and end caps are in place.

2. Duct System Requirements:

   a. All filters are clean and in place. If required, install temporary media.
   b. Duct systems are clean and free of debris.
   c. Fire/smoke and manual volume dampers are in place, functional and open.
   d. Air outlets are installed and connected.
   e. Duct system leakage has been minimized.

3. Pipe System Requirements:

   a. Coil fins have been cleaned and combed.
   b. Hydronic systems have been cleaned, filled, and vented.
   c. Strainer screens are clean and in place.
   d. Shutoff, throttling and balancing valves are open.

B. Report any defects or deficiencies to Architect/Engineer.

C. Promptly report items that are abnormal or prevent proper balancing.

D. If, for design reasons, system cannot be properly balanced, report as soon as observed.

E. Beginning of work means acceptance of existing conditions.

3.3 PREPARATION

A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to the Architect/Engineer for spot checks during testing.

B. Instruments shall be calibrated within six months of testing performed for project, or more recently if recommended by the instrument manufacturer.

3.4 INSTALLATION TOLERANCES

A. ± 10% of scheduled values:

1. Adjust air inlets and outlets to ± 10% of scheduled values.

2. Adjust piping systems to ± 10% of design values.

B. Adjust supply, return, and exhaust air-handling systems to +10% / -5% of scheduled values.

3.5 ADJUSTING

A. After adjustment, take measurements to verify balance has not been disrupted or that disruption has been rectified.

B. Once balancing of systems is complete, at least one damper or valve must be 100% open.

C. After testing, adjusting and balancing are complete, operate each system and randomly check measurements to verify system is operating as reported in the report. Document any discrepancies.

D. Contractor responsible for each motor shall also be responsible for replacement sheaves. Coordinate with contractor.

E. Contractor responsible for pump shall trim impeller to final duty point as instructed by this contractor on all pumps not driven by a VFD. Coordinate with contractor.

PART 4 - SYSTEMS TO BE TESTED, ADJUSTED AND BALANCED

4.1 GENERAL REQUIREMENTS

A. Title Page:

1. Project name.
2. Project location.
3. Project Architect.
4. Project Engineer (KJWW Engineering Consultants).
5. Project General Contractor.
6. TAB Company name, address, phone number.
7. TAB Supervisor's name and certification number.
8. TAB Supervisor's signature and date.
9. Report date.

B. Report Index

C. General Information:

1. Test conditions.
2. Nomenclature used throughout report.
3. Notable system characteristics/discrepancies from design.
4. Test standards followed.
5. Any deficiencies noted.
6. Quality assurance statement.

D. Instrument List:

1. Instrument.
2. Manufacturer, model, and serial number.
3. Range.
4. Calibration date.

4.2 AIR SYSTEMS

A. Air Moving Equipment:

1. General Requirements:
   a. Drawing symbol.
   b. Location.
   c. Manufacturer, model, arrangement, class, discharge.
   d. Fan RPM.
   e. Multiple RPM fan curve with operating point marked. (Obtain from equipment supplier).
   f. Final frequency of motor at maximum flow rate (on fans driven by VFD).
2. Flow Rate:
   a. Supply flow rate (cfm): specified and actual.
   b. Return flow rate (cfm): specified and actual.
   c. Outside flow rate (cfm): specified and actual.
   d. Exhaust flow rate (cfm): specified and actual.
3. Pressure Drop and Pressure:
   a. Filter pressure drop: specified and actual.
   b. Total static pressure: specified and actual. (Indicate if across fan or external to unit).
   c. Inlet pressure.
   d. Discharge pressure.

B. Fan Data:

1. Drawing symbol.
2. Location.
3. Manufacturer and model.
4. Flow rate (cfm): specified and actual.
5. Total static pressure: specified and actual. (Indicate measurement locations).
6. Inlet pressure.
7. Discharge pressure.
8. Fan RPM.

C. Electric Motors:

1. Drawing symbol of equipment served.
2. Manufacturer, Model, Frame.
3. Nameplate: HP, phase, service factor, RPM, operating amps, efficiency.
4. Measured: Amps in each phase.

D. Air Terminal (Inlet or Outlet):

1. Drawing symbol.
2. Room number/location.
3. Terminal type and size.
4. Velocity: specified and actual.
5. Flow rate (cfm): specified and actual.
6. Percent of design flow rate.

E. Air Terminal Unit (Terminal Air Box) Data:

1. General Requirements:
    a. Drawing symbol.
    b. Location.
    c. Manufacturer and model.
    d. Size.
    e. Type: constant, variable, single, dual duct.
2. Flow Rate:
    a. Cooling maximum flow rate (cfm): specified and actual.
    b. Heating maximum flow rate (cfm): specified and actual.
    c. Minimum flow rate (cfm): specified and actual.
    d. Water flow rate (gpm): specified and actual.
3. Temperature:
    a. Entering air temperature: specified and actual.
    b. Leaving air temperature (in heating mode): specified and actual.
    c. Entering water temperature: specified and actual.
    d. Leaving water temperature: specified and actual.
4. Pressure Drop and Pressure:
    a. Inlet static pressure during testing (maximum and minimum).
    b. Coil air pressure drop: specified and actual.
    c. Water pressure drop: specified and actual.

F. Air Flow Measuring Station:

1. Drawing symbol.
2. Service.
3. Location.
4. Manufacturer and model.
5. Size.
6. Flow rate (cfm): specified and actual.
7. Pressure drop: specified and actual.

G. LEED Indoor Chemical and Pollution Exhaust Verification

1. In accordance with LEED EQp2 and EQc5, negative pressurization must be maintained in the following rooms:

    a. Garages
    b. Housekeeping Closets
    c. Laundry Rooms
    d. Copy Rooms
    e. Printing Rooms

2. Verify that each room operates at a negative pressure (compared to each adjacent area and adjacent vertical chase) of at least -0.004 in. w.c. and an average of -0.020 in. w.c. when the doors to the room are closed.

3. Performance of rooms' differential air pressures must be verified by conducting 15 minutes of measurements, with a minimum of 1 measurement every 10 seconds.

    a. This test must be conducted for each adjacent area and adjacent vertical chase with the doors of the room closed.

H. LEED Air Contaminant Flushout

1. In accordance with LEED EQc3.2 Option 1, the Contractor shall perform a building flushout of air contaminants. The flushout must follow either Path 1 or Path 2 as outlined below. The Contractor shall coordinate with all other trades, the Construction Manager, and the Owner to determine the time required and scheduling for the flushout. The Contractor shall keep records documenting the flushout process and submit them to the Architect and Engineer when the process is complete.

    a. Path 1 - Pre-Occupancy Flushout: After construction is complete and prior to occupancy and with all interior finishes installed, install new filtration media and perform a flushout by supplying a total air volume of 14,000 cubic feet. of outdoor air per square foot of floor area while maintaining an internal temperature of at least 60°F and relative humidity no higher than 60%.

    b. Path 2 - Occupied Flushout: The space may be occupied after delivering a minimum of 3,500 cubic feet. of outdoor air per square foot of floor area (in accordance with the requirements listed in Path 1). Once the space is occupied, it must be ventilated at a minimum rate of 0.30 CFM/SF of outdoor air or the scheduled design minimum outside airflow rate, whichever is greater. During each day of the flushout period, ventilation must begin a minimum of 3 hours prior to occupancy and continue during occupancy. These conditions must be maintained until a total of 14,000 cubic feet. per square foot of outside air has been delivered to the space.

4.3 HEATING SYSTEMS

A. Pump Data (Tertiary Heating Water Loop Pumps):

1. Existing drawing symbol or equipment TAG
2. Service.
3. Manufacturer, size, and model.
4. Impeller size: specified, actual, and final (if trimmed).
5. Flow Rate (gpm): specified and actual.
6. Pump Head: specified, operating and shutoff.
7. Suction Pressure: Operating and shutoff.
8. Discharge Pressure: Operating and shutoff.
9. Final frequency of motor at maximum flow rate (on pumps driven by VFD).

B. Electric Motors (Associated Heating Water Loop Pump Motors):

1. Drawing symbol of equipment served.
2. Manufacturer, Model, Frame.
3. Nameplate: HP, phase, service factor, RPM, operating amps, efficiency.
4. Measured: Amps in each phase.

C. Heating Coils:

1. General Requirements:
    a. Drawing symbol.
    b. Service.
    c. Location.
    d. Manufacturer and model.
    e. Size.

2. Flow Rate:
    a. Flow rate (cfm): specified and actual.
    b. Water flow rate: specified and actual.
3. Temperature:
    a. Entering air temperature: specified and actual.
    b. Leaving air temperature: specified and actual.
    c. Entering water temperature: specified and actual.
    d. Leaving water temperature: specified and actual.
4. Pressure Drop and Pressure:
    a. Air pressure drop: specified and actual.
    b. Steam pressure after valve: specified and actual.
    c. Water pressure drop: specified and actual.
5. Energy:
    a. Air Btuh (cfm x temp rise x 1.09).
    b. Water Btuh (gpm x temp drop x 500). Repeat tests if not within 10% of air Btuh.

D. Terminal Heat Transfer Units:

1. General Requirement:
    a. Drawing symbol.
    b. Location.
    c. Manufacturer and model.
    d. Include air data only for forced air units.
2. Flow Rate:
    a. Flow rate (cfm): specified and actual.
    b. Water flow rate (gpm): specified and actual.
3. Temperature:
    a. Entering air temperature: specified and actual.
    b. Leaving air temperature: specified and actual.
    c. Entering water temperature: specified and actual.
    d. Leaving water temperature: specified and actual.
4. Energy:
    a. Air Btuh (cfm x temperature rise x 1.09).
    b. Water Btuh (gpm x temperature drop x 500). Repeat tests if not within 10% of air Btuh.

4.4 COOLING SYSTEMS

A. Pump Data (Tertiary Chilled Water Loop Pumps):

1. General Requirements:
    a. Drawing symbol.
    b. Service.
    c. Manufacturer, size, and model.
    d. Impeller size: specified, actual, and final (if trimmed).
    e. Final frequency of motor at maximum flow rate. (On pumps driven by VFD.)
2. Flow Rate:
    a. Flow Rate (gpm): specified and actual.
3. Pressure Drop and Pressure:
    a. Pump Head: specified, operating and shutoff.
    b. Suction Pressure: Operating and shutoff.
    c. Discharge Pressure: Operating and shutoff.

B. Electric Motors:

1. Drawing symbol of equipment served.
2. Manufacturer, Model, Frame.
3. Nameplate: HP, phase, service factor, RPM, operating amps, efficiency.
4. Measured: Amps for each phase.

C. Cooling Coils:

1. General Requirements:
   a. Drawing symbol.
   b. Service.
   c. Location.
   d. Size.
   e. Manufacturer and model.
2. Temperature:
   a. Entering air DB temperature: specified and actual.
   b. Entering air WB temperature: specified and actual.
   c. Leaving air DB temperature: specified and actual.
   d. Leaving air WB temperature: specified and actual.
   e. Entering water temperature: specified and actual.
   f. Leaving water temperature: specified and actual.
3. Flow Rate:
   a. Flow rate (cfm): specified and actual.
   b. Water flow rate (gpm): specified and actual.
4. Pressure Drop and Pressure:
   a. Water pressure drop: specified and actual.
   b. Air pressure drop: specified and actual.
5. Energy:
   a. Air Btuh (cfm x enthalpy change x 4.5).
   b. Water Btuh (gpm x temperature drop x 500). Repeat tests if not within 10% of air Btuh.

D. Terminal Heat Transfer Units:

1. General Requirements:
   a. Drawing symbol.
   b. Location.
   c. Manufacturer and model.
   d. Include air data only for forced air units.
2. Temperature:
   a. Entering air DB temperature: specified and actual.
   b. Leaving air DB temperature: specified and actual.
   c. Entering water temperature: specified and actual.
   d. Leaving water temperature: specified and actual.
3. Flow rate:
   a. Flow rate (cfm): specified and actual.
   b. Water flow (gpm): specified and actual.
4. Energy:
   a. Air Btuh (cfm x temperature rise x 1.09).
   b. Water Btuh (gpm x temperature drop x 500). Repeat tests if not within 10% of air Btuh.

4.5 PLUMBING SYSTEMS

A. Booster Pump Data:

1. Drawing symbol.
2. Service.
3. Manufacturer, size, and model.
4. Impeller size: specified, actual, and final (if trimmed).
5. Flow Rate (gpm): specified and actual.
6. Pump Head: specified, operating and shutoff.
7. Suction Pressure: operating and shutoff.
8. Discharge Pressure: operating and shutoff.

B. Electric Motors:

1. Drawing symbol of equipment served.
2. Manufacturer, model, frame.
3. Nameplate: HP, phase, service factor, RPM, operating amps, efficiency.
4. Measured: Amps for each phase.

C. Balancing Valve:

1. Drawing symbol.
2. Service.
3. Location.
4. Size.
5. Manufacturer and model.
6. Flow rate (gpm): specified and actual.
7. Pressure drop: specified and actual.

D. Domestic Water to Water Heat Exchanger:

1. Drawing symbol.
2. Service.
3. Location.
4. Size.
5. Manufacturer and model.
6. Flow rate (gpm): specified and actual.
7. Pressure drop: specified and actual.
8. Entering heating water temperature.
9. Leaving heating water temperature.
10. Entering domestic water temperature.
11. Leaving domestic water temperature.
12. Flow rate (gpm): Hot side:
    a. Scheduled
    b. Actual
13. Flow rate (gpm): Cold side:
    a. Scheduled
    b. Actual

END OF SECTION

SECTION 23 21 00
HYDRONIC PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Pipe and Pipe Fittings.
B. Valves.
C. Heating Water Piping System.
D. Chilled Water Piping System.

1.2 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body. Remanufactured valves are not acceptable.

B. Welding Materials, Procedures, and Operators: Conform to ASME Section 9, ANSI/AWS D1.1, and applicable state labor regulations.

1.3 REFERENCES

A. ANSI/AWS D1.1 - Structural Welding Code.

B. ANSI/AWWA C110 - Ductile Iron and Gray Iron Fittings 3" through 48", for Water and Other Liquids.

C. ASME B16.3 - Malleable Iron Threaded Fittings Class 150 and 300.

D. ASME B16.5 - Pipe Flanges and Flanged Fittings.

E. ASME B16.9 - Factory-Made Wrought Steel Butt Welding Fittings.

F. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings

G. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

H. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings (DWV).

I. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.

J. ASME B18.2.1 - Square and Hex Bolts and Screws, Inch Series.

K. ASME B18.2.2 - Square and Hex Nuts, Inch Series.

L. ASME B31.9 - Building Services Piping.

M. ASME Section 9 - Welding and Brazing Qualifications.

N. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.

O. ASTM A181 - Forgings, Carbon Steel for General Purpose Piping.

P. ASTM A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

Q. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

R. ASTM A733 - Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples.

S. ASTM B32 - Standard Specification for Solder Metal.

T. ASTM B88 - Seamless Copper Water Tube.

U. ASTM B813 - Standard Specification for Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube.

V. ASTM E413-87 - Classification for Rating Sound Insulation

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store and protect piping to prevent entrance of foreign matter into pipe and to prevent exterior corrosion.

B. Deliver and store valves in shipping containers with labeling in place.

1.5 COORDINATION DRAWINGS

A. Reference Coordination Drawings article in Section 23 05 00 for required hydronic systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

PART 2 - PRODUCTS

2.1 HEATING WATER
CHILLED WATER

A. Design Pressure: 125 psig.
Maximum Design Temperature: 225ºF. (230ºF for mechanical couplings)

B. Piping - 2" and Under:

1. Tubing: Type L drawn temper seamless copper tube, ASTM B88.

2. Joints: Solder with Type 95-5 solder. 50-50 solder is not acceptable.

3. Fittings: Wrought copper solder joint, ASME B16.22.

*** * * * * OR * * * * ***

C. Piping - 2” and Under (Contractor’s Option):

1. Tubing: Type L hard drawn seamless copper tube, ASTM B88.

2. Joints: Mechanical press connection.

3. Fittings: Copper, ANSI B-16.22, with embedded EPDM o-ring, NSF-61.

4. Acceptable Manufacturers: Viega, NIBCO Press.

D. Piping - 2-1/2" and Over:

1. Pipe: Standard weight black steel, beveled ends, ASTM A53, Type E or S, Grade B.

2. Joints: Butt-welded or flanged.

3. Fittings: Standard weight wrought steel, butt-welding type, ASTM A234, ASME B16.9.

4. Flanges: Class 150 forged steel, welding neck or slip-on, ASTM A181 or A105, Class 60, ASME B16.5 up to 24" and B16.47 above 24". ASME B16.1 for flanges mating with flat face equipment flanges.

*** * * * * OR * * * * ***

E. Piping - 2-1/2" and Over:

1. Pipe: Standard weight black steel, grooved ends, ASTM A53, Type E or S, Grade B.

2. Joints: Grooved type, with Grade E EPDM molded pressure-responsive gaskets suited for 32°F to 230°F per ASTM D2000.

3. Fittings: ASTM A536 Grade 65-45-12 ductile or A47 malleable iron, grooved type.

4. Flanges: Grooved end, flanged adapter.

F. Shutoff Valves:

1. Gate Valves:

a. GA-1: 2" and under, 125 psi S @ 353ºF, 300 psi WOG @ 150ºF, screwed, bronze, rising stem, screwed bonnet. Crane #431, Hammond #IB641, Stockham #B122, Walworth #56, Milwaukee #1150, Watts #B-3210, NIBCO #T-131.

b. GA-2: 2-1/2" thru 12", 125 psi S @ 353°F, 200 psi WOG @ 150ºF, flanged, iron body, bronze mounted, OS&Y. Crane #465-1/2, Hammond, Stockham #G623, Walworth, Milwaukee #F2885, Watts #F-503, NIBCO F-617-O.

c. GA-5: 2" and under, 125 psi S @ 353ºF, 200 psi WOG @ 150ºF, solder bronze. Crane #1334, Stockham #B108, Walworth #4SJ, Watts #B-3101, NIBCO #S-111.

2. Ball Valves:

a. BA-1: 3" and under, 150 psi saturated steam, 600 psi WOG, full port, screwed or solder ends (acceptable only if rated for soldering in line with 470°F melting point of lead-free solder), bronze body of a copper alloy containing less than 15% zinc, stainless steel ball and stem, Teflon seats and seals. Apollo #77C-140, Stockham #S-206 BR1-R, Milwaukee #BA-400, Watts, Nibco #585-70-66, National Utilities Co., RUB.

NOTES:

1) Provide extended shaft with operating handle of non-thermal conductive material and protective sleeve that allows operation of valve, adjustment of the packing, and adjustment of the memory stop without breaking the vapor seal or disturbing the insulation for all valves in insulated piping.

2) Provide lock out trim for all valves opening to atmosphere installed in domestic water piping over 120°F, heating water piping over 120°F, steam, condensate, boiler feed water piping, compressed air piping and gasoline/kerosene piping, and as indicated on the drawings. Solid extended shaft is not required on valves with lock out trim.

b. BA-1A: 2-1/2" and 3", 150 psi saturated steam, 275 psi WOG ANSI Class, 150 psi standard port, carbon steel body stainless steel ball and trim, Teflon seats and seals. Apollo #88A-100, Nibco #F510-CS/66, Milwaukee #F90.

NOTES:

1) Provide extended shaft for all valves in insulated piping.

2) Provide lock out trim for all valves opening to atmosphere installed in domestic water piping over 120°F, heating water piping over 120°F, steam, condensate, boiler feed water piping, compressed air piping and gasoline/kerosene piping, and as indicated on the drawings. Solid extended shaft is not required on valves with lock out trim.

3. Butterfly Valves:

a. BF-1:

1) 2-1/2" thru 6", 175 psi WOG, elastomers rated for 20°F to 250°F at 125 psig, fully lugged end, ductile or cast iron body (not in contact with fluid); bronze, aluminum-bronze or EPDM coated ductile iron disc; EPDM seat, stainless steel stem, extended neck, 175 psi bubble-tight, bi-directional dead-end shutoff without backing flange or nuts and with cap screws extending to centerline of valve body (for pipe extension without draining system), 10 position locking operator up to 6" size. Cv of at least 1580 in 6" size. Center Line Series 200, Keystone #222, Watts #DBF-03-121-1P, Nibco N200 Series, Milwaukee CL series, Hammond 5200 series.

2) 8" thru 12", 175# WOG, elastomers for 20°F to 225°F at 130 psi, fully lugged end, ductile or cast iron body (not in contact with fluid), bronze, EPDM coated ductile iron or aluminum-bronze disc, EPDM seat, stainless steel stem, extended neck, 175 psi bubble-tight, bi-directional dead-end shutoff without backing flange or nuts and with cap screws extending to the centerline of the valve body (to permit pipe extension without draining system), weatherproof gear operator. Center Line Series 200, Keystone #222, Watts #DBF-03-121-1G, Nibco N200 Series, Milwaukee CL series, Hammond 5200 series.

3) Mechanically coupled grooved end valves are acceptable if they have the features listed above. Victaulic #608, Nibco GD4765.

b. BF-5:

1) 14" through 24", 150 psi WOG, elastomers rated for 20ºF to 250ºF at 125 psig, fully lugged or grooved end, ductile or cast iron body (not in contact with fluid); bronze, aluminum-bronze or nickel plated ductile iron disc; EPDM seat, stainless steel stem, extended neck, 150 psi bubble-tight, bi-directional dead-end shutoff without backing flange or nuts and with cap screws extending to centerline of valve body (for pipe extension without draining system). Weatherproof gear operator. Cv of at least 12,000 in 16" size. Victaulic #709, Center Line Series 200, Keystone #AR2, Watts DBF-03-121-1G, NIBCO LD2000 or N200 or GD 4765, Victaulic #W706, Milwaukee CL series, Hammond 5200 series.

G. Throttling Valves:

1. Globe Valves:

a. GL-1: 2" and under, 125 psi saturated steam, 300 psi WOG, screwed, bronze. Crane #7TF, Stockham #B22T, Walworth #95, Milwaukee #590, Hammond #IB413T, Watts #B-4010-T, NIBCO #T-235.

b. GL-2: 2-1/2" thru 10", 125 psi S @ 353ºF, 200 psi WOG @ 150ºF, flanged, iron body, bronze mounted. Crane #351, Hammond #IR116, Stockham #G-512, Walworth #906F, Milwaukee #F2981, Watts #F-501, NIBCO #F-718-B.

c. GL-5: 2" and under, 300 psi WOG, solder, bronze. Hammond #IB423, Stockham #B24T, Milwaukee #1590, Watts #B-4011-T, NIBCO #S-235.

2. Butterfly Valves:

a. BF-4:

1) 2-1/2" thru 6", 175 psi WOG, elastomers rated for 20ºF to 250ºF at 125 psig, fully lugged or grooved end, ductile or cast iron body (not in contact with fluid); bronze, aluminum-bronze or EPDM coated ductile iron disc; EPDM seat, stainless steel stem, extended neck, 175 psi bubble-tight, bi-directional dead-end shutoff without backing flange or nuts and with cap screws extending to centerline of valve body (for pipe extension without draining system), infinite position locking operator with memory stop up to 6" size. Cv of at least 1580 in 6" size. Victaulic #300,

Center Line Series 200, Keystone #222, Watts #DBF-03-121-1P, NIBCO #LD2000, Milwaukee CL series, Hammond 5200 series.

2) 8" thru 12", 175# WOG, elastomers for 20ºF to 225ºF at 130 psi, fully lugged end, ductile or cast iron body (not in contact with fluid), bronze, EPDM coated ductile iron or aluminum-bronze disc, EPDM seat, stainless steel stem, extended neck, 175 psi bubble-tight, bi-directional dead-end shutoff without backing flange or nuts and with cap screws extending to the centerline of the valve body (to permit pipe extension without draining system), weatherproof gear operator. Center Line Series 200, Keystone #222, Watts #DBF-03-121-1G, NIBCO #LD2000 or N200, Victaulic #300, Milwaukee CL series, Hammond 5200 series.

b. BF-5:

1) 14" through 24", 150 psi WOG, elastomers rated for 20ºF to 250ºF at 125 psig, fully lugged or grooved end, ductile or cast iron body (not in contact with fluid); bronze, aluminum-bronze or nickel plated ductile iron disc; EPDM seat, stainless steel stem, extended neck, 150 psi bubble-tight, bi-directional dead-end shutoff without backing flange or nuts and with cap screws extending to centerline of valve body (for pipe extension without draining system). Weatherproof gear operator. Cv of at least 12,000 in 16" size. Victaulic #709, Center Line Series 200, Keystone #AR2, Watts DBF-03-121-1G, NIBCO LD2000 or N200 or GD 4735, Victaulic #W706, Milwaukee CL series, Hammond 5200 series.

H. Check Valves:

1. CK-1: 2" and under, 125 psi S @ 353ºF, 200 psi WOG @ 150ºF, screwed, bronze, horizontal swing. Crane #37, Hammond #IB904, Stockham #B319, Walworth #406, Milwaukee #509, Watts #B-5000, or NIBCO #T-413.

2. CK-4: 2" and under, 200 psi WOG @ 150ºF, solder, bronze, horizontal swing. Crane #1342, Hammond #IB912, Stockham #B309, Walworth #406SJ, Milwaukee #1509, Watts #B-5001, or NIBCO #S-413.

3. CK-13: 2-1/2" thru 12", 200# WOG, double disc wafer type, iron body, bronze or aluminum-bronze discs, 316SS shaft and spring, Viton, EPDM or BUNA-N, Cv of at least 700 in 6" size. Mueller Steam Specialty Co. #71-AHB-6-H, Stockham #WG-961, NIBCO W-920-W, Crane, Victaulic #716.

I. Strainers:

1. ST-1: Bronze body, screwed ends, screwed cover, 150 psi S @ 350°F, 200 psi WOG @ 150°F. Armstrong #F4SC, Metraflex #TS, Mueller Steam Specialty Co. #351, Sarco #BT, Watts #777, NIBCO T-122.

2. ST-2: Cast iron body, 125 lb. flanged ends, bolted cover, 125 psi S @ 350°F, 175 psi WOG @ 150°F. Armstrong #A1FL, Metraflex #TF, Mueller Steam Specialty Co.#758, Sarco #CI-125, Watts #77F-D, Victaulic #732, NIBCO F-721-A.

2.2 EQUIPMENT DRAINS AND OVERFLOWS

A. Steel Pipe: ASTM A53, Schedule 40 galvanized.

1. Fittings: Galvanized cast iron screwed drainage type, ASME B16.12.

2. Joints: Screwed.

3. Service: Not allowed on boiler drains and overflow.

*** * * * * OR * * * * ***

B. Copper Tubing: DWV drawn temper seamless copper drainage tube, ASTM B306.

1. Fittings: ASME B16.23 cast brass, or ASME B16.29 solder wrought copper.

2. Joints: Solder with Type 95-5 solder. 50-50 solder is not acceptable.

C. Piping 4" and Under (Contractor's Option):

1. Tubing: DWV drawn temper seamless copper drainage tube, ASTM B306

2. Joints: Mechanical press connection.

3. Fittings: Copper, ANSI B-16.22, with embedded EPDM o-ring, NSF-61.

4. Acceptable Manufacturers: Viega.

D. Piping Under 1-1/4" Size:

1. In sizes where drainage type fittings are not available, tees with threaded caps to permit rodding are acceptable.

E. Shutoff Valves:

1. Ball Valves:

a. BA-1: 3" and under, 125 psi saturated steam, 600 psi WOG, full port, screwed or solder ends (acceptable only if rated for soldering in line with 470°F melting point of lead-free solder), bronze body of a copper alloy containing less than 15% zinc, stainless steel ball and trim, Teflon seats and seals. Apollo #77C-140, Stockham #S-206 BR1-R, Milwaukee #BA-400, Watts, Nibco #585-70-66, National Utilities Co., RUB.

NOTES:

1) Provide extended shaft for all valves in insulated piping.

2) Provide lock out trim for all valves opening to atmosphere installed in domestic water piping over 120°F, heating water piping over 120°F, steam, condensate, boiler feed water piping, compressed air piping and gasoline/kerosene piping, and as indicated on the drawings. Solid extended shaft is not required on valves with lock out trim.

b. BA-1A: 2-1/2" and 3", 150 psi saturated steam, 275 psi WOG ANSI Class, 150 psi standard port, carbon steel body stainless steel ball and

trim, Teflon seats and seals. Apollo #88A-100, Nibco #F510-CS/66, Milwaukee #F90.

NOTES:

1) Provide extended shaft for all valves in insulated piping.

2.3 AIR VENTS

A. At end of main and other points where large volume of air may be trapped - Use 1/4" globe valve, angle type, 125 psi, Crane #89, attached to coupling in top of main, 1/4" discharge pipe turned down with cap.

B. On branch lines and small heating units - Use coin-operated air vent equal to B&G #4V, attached to 1/8" coupling in top of pipe. Install air vents on all coils and terminal heating units.

2.4 AUTOMATIC AIR VENTS

A. Low capacity automatic air vent (for bladder tank anti-thermosyphon loops). Maximum operating pressure and temperature of at least 240°F and 125 psi, 1/2" or 3/4" inlet. B&G #87, Armstrong, Spirotherm, Taco, or Watts.

B. High/low capacity automatic air vent (for air separator connection). Maximum operating pressure and temperature of at least 240°F and 125 psi, 3/4" inlet, 3/8" minimum outlet. B&G #107, Armstrong, Spirotherm, Taco, or Watts.

2.5 STRAINERS

A. Unless otherwise indicated, strainers shall be Y-pattern and have stainless steel screens with perforations as follows:

Pipe Size	1/4" - 2"	2-1/2" - 8"	10" and Up
Air and Gases	1/32"	3/64"	1/16"
Water and Glycol/Water	1/32"	1/16"	1/8"

B. Furnish pipe nipple with ball valve, threaded hose connection, and cap to blow down all strainer screens.

C. Use bronze body strainers in copper piping and iron body strainers in ferrous piping.

2.6 SAFETY RELIEF VALVES

A. SRV-1 (Hydronic Heating Systems): Spring-loaded disc type with cast iron or bronze body, bronze or stainless steel disc, side outlet and lifting lever for maximum service of 125 psig at 250ºF. For relieving water during pressure fluctuations and in case of control failure. Capacities shall be ASME Section IV certified and labeled. Acceptable Manufacturers: Kunkle # 537, B&G, Conbraco, McDonnell & Miller, or Watts.

2.7 TRIPLE DUTY VALVE

A. Type TD-1: 2" and above, 175 psi working pressure, flanged, cast iron, non-slam check valve, calibrated throttling, shutoff capabilities, angle or straight pattern. Pressure drop with design flow at 100% open shall not exceed 10 feet. Size to match pipe (not pump outlet) size, but reduce size by not more than one (1) if needed to provide at least 3 feet of differential pressure across the flow measuring taps at scheduled flow rate. Acceptable Manufacturers: Armstrong, Bell & Gossett, Taco, Wheatley.

2.8 SUCTION DIFFUSER

A. Furnish and install on base mounted pumps with inlet size same as pipe size shown on the drawing.

B. In no case shall pressure drop exceed 1.1 psi.

C. Suction diffuser shall consist of angle body with inlet vanes and combination diffuser-strainer-orifice cylinder with 3/16" diameter openings for pump protection, gauge tappings, and blowdown connection. Orifice cylinder, with bronze or stainless steel strainer, designed for pressure differential equal to pump shutoff head, with free area at least 5 times cross section area of pump suction opening. Furnish adjustable foot to support weight of suction piping. Orifice cylinder and straightening vanes shall be steel in closed systems and stainless steel in open (cooling tower) systems. Connect drain valve to blowdown connection. Provide 16 mesh bronze startup strainer. The startup strainer shall be removed after the system has been started, cleaned, and is operating under normal conditions, but before the system is turned over to the Owner. Hang the startup strainer on the piping near the pump after it is removed.

D. Acceptable Manufacturers: Amtrol, Armstrong, Bell & Gossett, Patterson, Taco, Wheatley, Victaulic.

2.9 BALANCING VALVE

A. Rated for 125 psi working pressure and 250ºF operating temperature, taps for determining flow with a portable meter, positive shutoff valves for each meter connection, memory feature, tight shutoff, and a permanent pressure drop between 1' and 2' water column at full flow with valve 100% open. Furnish with molded, removable insulation covers.

B. Provide a nomograph to determine flow from meter reading (and valve position on units which sense pressure across a valve). Graph shall extend below the specified minimum flow.

C. Valves in copper piping shall be brass or bronze. Acceptable Manufacturers: Flow Design “Accusetter”, Presso “B+”, Armstrong "CVB", Bell & Gossett "Circuit Setter Plus", Griswold “Quickset”, Gerand “BALVALVE Venturi”, NIBCO 1710 (S1710L), Tour&Anderson (STAD), Nexus Valve “UltraXB Orturi”, Victaulic 785.

D. Valves in ferrous piping 2" or smaller shall have threaded ends and steel, brass or bronze construction. Acceptable Manufacturers: Flow Design “Accusetter”, Presso “B+”, TA Hydronics “786-789”, Armstrong "CVB", Bell & Gossett "Circuit Setter Plus", Autoflow “AB”, Gerand “BALVALVE Venturi”, NIBCO 1710 (T1710L), Nexus Valve “UltraXB Orturi”, Victaulic 787, or flow sensors specified in Section 23 09 00 with a specified throttling valve.

E. Balancing valves in ferrous piping over 2" size shall have flanged or grooved ends and steel or cast iron construction. Acceptable Manufacturers: Flow Design “Accusetter”, Presso “B+”, Taco “Accu-flo”, Armstrong "CVB-II", B&G “Circuit Setter”, NIBCO 737, Nexus Valve “Nextrol NXFB”, Tour&Anderson (STAF, STAG), Victaulic 788/789, or flow sensor specified in Section 23 09 00 with a specified throttling valve.

F. Manufacturer shall size balancing valves for the scheduled flow rate. Flow rate shall be measurable on manufacturer's standard meters.

2.10 COMBINATION PIPING PACKAGES

A. Combination piping packages are allowed in lieu of individual components specified for hydronic coils and devices containing hydronic coils. Combination piping packages shall include shutoff valves, wye strainers, 1/4 turn strainer blow down valves with hose thread and cap, manual balancing valves with memory stop, test plugs, manual air vents, and unions. Automatic flow control devices are not allowed. Configuration of combination pieces shall match layouts on the drawings. Each component of the combination piping packages shall meet these specifications for the individual components being combined.

B. Acceptable Manufacturers: Nexus Coil Pak, FDI Flowset, Griswold, HCI Terminator, Hays Mesurflo.

2.11 DRAIN VALVES AND BLOWDOWN VALVES

A. Drain valve and blowdown valve shall mean a shutoff valve as specified for the intended service with added 3/4" male hose thread outlet, cap, and retaining chain.

2.12 CONNECTIONS BETWEEN DISSIMILAR METALS

A. Connections between dissimilar metals shall be insulating dielectric types that provide a water gap between the connected metals, and that either allow no metal path for electron transfer or that provide a wide water gap lined with a non-conductive material to impede electron transfer through the water path.

B. Joints shall be rated for the temperature, pressure, and other characteristics of the service in which they are used, including testing procedure.

C. Aluminum, iron, steel, brass, copper, bronze, and stainless steel are commonly used and require isolation from each other with the following exceptions:

1. Iron, steel, and stainless steel connected to each other.

2. Brass, copper, and bronze connected to each other.

3. Brass or bronze valves and specialties connected to steel, iron, or stainless steel in closed systems. Where two brass or bronze items occur together, they shall be connected with brass nipples.

D. Dielectric protection is required at connections to equipment of a material different than the piping.

E. Screwed Joints (acceptable up to 2" size):

1. Dielectric waterway rated for 300 psi CWP and 225°F.

2. Acceptable Manufacturers: Elster Group ClearFlow fittings, Victaulic Series 47, Grinnell Series 407, Matco-Norca.

F. Flanged Joints (any size):

1. Use 1/8" minimum thickness, non-conductive, full-face gaskets.

2. Employ one-piece molded sleeve-washer combinations to break the electrical path through the bolts.

3. Sleeve-washers are required on one side only, with sleeves minimum 1/32" thick and washers minimum 1/8" thick.

4. Install steel washers on both sides of flanges to prevent damage to the sleeve-washer.

5. Separate sleeves and washers may be used only if the sleeves are manufactured to exact lengths and installed carefully so the sleeves must extend partially past each steel washer when tightened.

6. Acceptable Manufacturers: EPCO, Central Plastics, Pipeline Seal and Insulator, F. H. Maloney, or Calpico.

2.13 LOCK OUT TRIM

A. Provide lock out trim for all quarter turn valves opening to atmosphere installed in heating water piping over 120°F and as indicated on the drawings.

PART 3 - EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends, remove burrs, bevel plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Connect to all equipment with flanges or unions.

D. After completion, fill, clean, and treat systems. Refer to Section 23 25 00 for treatment.

3.2 TESTING PIPING

A. Heating Water:
Chilled Water:

1. Test pipes underground or in chases and walls before piping is concealed.

2. Complete testing before insulation is applied. If insulation is applied before pipe is tested and a leak ruins the insulation, replace all damaged insulation.

3. Test the pipe with 100 psig water pressure. Hold pressure for at least two hours.

4. Test to be witnessed by the Architect/Engineer or their representative, if requested by the Architect/Engineer.

3.3 CLEANING PIPING

A. Assembly:

1. Prior to assembly of pipe and piping components, remove all loose dirt, scale, oil and other foreign matter on internal or external surfaces by means consistent with good piping practice subject to approval of the Architect/Engineer. Blow chips and burrs out of pipe before assembly. Wipe cutting oil from internal and external surfaces.

2. During fabrication and assembly, remove slag and weld spatter from both internal and external joints by peening, chipping and wire brushing to the degree consistent with good piping practices.

3. Notify the Architect/Engineer prior to starting any post erection cleaning operation in time to allow witnessing the operation. Properly dispose of cleaning and flushing fluids.

4. Prior to blowing or flushing erected piping systems, disconnect all instrumentation and equipment, open wide all valves, control valves, and balance valves, and verify all strainer screens are in place.

B. Chemical Cleaning:

1. Flush pipe and components with clean water until all discharge from system is clean. Maintain minimum velocities at all points of 5 feet/second for 30 minutes. Flow shall be in same direction as when system is in normal operation. Discharge shall be from low points of pipes, ends of headers and as otherwise needed to flush entire system. After flushing, all residual water shall be drained and/or blown out.

2. Add 2 pounds of trisodium phosphate per 100 gallons of system capacity. Use an alternate chemical if discharge of trisodium phosphate is not permitted. Maintain 150°F in the system if possible. If heat is not available, use 3 pounds per 100 gallons.

3. Drain the system after circulating the chemical cleaner for six hours at 150°F, or 12 hours at a lower temperature. Refill. Test a water sample. Drain and fill again if excessive cleaning chemicals remain and until water appears clear.

4. After circulating the chemical cleaner for six hours at 150ºF, or 12 hours at less than 90ºF, connect fresh water to the system and discharge to a drain. Run circulating pumps and flush until discharge is clear water.

5. When system water is clear, remove, clean and replace all strainers.

6. Add chemical treatment as specified in Section 23 25 00.

7. Water samples may be taken by the Architect/Engineer to verify a clean system. If system is not clean, the entire process, including chemical treatment specified in Section 23 25 00, shall be repeated at the Contractor's expense.

8. Chemical cleaning applies to the following systems:

a. Heating Water
b. Chilled Water

3.4 INSTALLATION

A. General Installation Requirements:

1. Route piping in orderly manner, straight, plumb, with consistent pitch, parallel to building structure, with minimum use of offsets and couplings. Provide only offsets required for needed headroom or clearance and needed flexibility in pipe system.

2. Install piping to conserve building space, and not interfere with other work.

3. Group piping whenever practical at common elevations.

4. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

5. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it. Where pipe sizes are not shown, the larger size in either direction shall continue through the fitting nearest to the indication of a smaller pipe size.

6. Install bell and spigot pipe with bells upstream.

7. Seal pipes passing through exterior walls with a wall seal per Section 23 05 29. Provide Schedule 40 galvanized sleeve at least 2 pipe sizes larger than the pipe.

8. Branch takeoffs shall be from the top, side, or bottom of piping.

B. Installation Requirements in Electrical Rooms:

1. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment plus its required clearance space.

C. Valves/Fittings and Accessories:

1. Provide chain operators for all valves over 2" size that are over 10'-0" above finished floor. Extend to 7'-0" above finished floor.

2. Provide valve position indicator on all valves 10’-0” or greater above finish floor and not located above ceiling.

3. Provide clearance for installation of insulation, and access to valves and fittings.

4. Provide access doors where valves are not exposed.

5. Install balancing valves with the manufacturer’s recommended straight upstream and downstream diameters of pipe.

6. Prepare pipe, fittings, supports, and accessories for finish painting.

7. Install valves with stems upright or horizontal, not inverted, except install manual quarter turn valves in radiation cabinets and all butterfly valves with stems horizontal.

8. Provide shutoff valves and flanges or unions at all connections to equipment, traps, and items that require servicing.

9. Provide flanges or unions at all final connections to equipment, traps and valves.

10. Arrange piping and piping connections so equipment may be serviced or totally removed without disturbing piping beyond final connections and associated shutoff valves.

3.5 PIPE ERECTION AND LAYING

A. Carefully inspect all pipe, fittings, valves, equipment and accessories prior to installation. Immediately reject and remove from the job any items which are unsuitable, cracked or otherwise defective.

B. All pipe, fittings, valves, equipment and accessories shall have factory-applied markings, stampings, or nameplates sufficient to determine their conformance with specified requirements.

C. Exercise care at every stage of storage, handling, laying and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not erect or install any unclean item.

D. During construction, until system is fully operational, keep all openings in piping and equipment closed at all times except when actual work is being performed on that item. Closures shall be plugs, caps, blind flanges or other items designed for this purpose.

E. Change direction of pipes only with fittings or pipe bends. Change size only with fittings. Do not use miter fittings, face or flush bushings, or street elbows. **All fittings shall be long radius type**, unless otherwise shown on the drawings or specified. Construct welded elbows of angles not available as standard fittings by cutting and welding standard elbows to form smooth, long radius fittings.

F. Use full and double lengths of pipe wherever possible.

G. Unless otherwise indicated, install all inlet and outlet piping, including shutoff valves and strainers, to coils, pumps and other equipment at line size with reduction in size being made only at control valve or pump.

H. Cut all pipe to exact measurement and install without springing or forcing except in the case of expansion loops where cold springing is indicated on the drawings.

I. Do not create, even temporarily, undue loads, forces or strains on valves, equipment or building elements.

3.6 DRAINING AND VENTING

A. Unless otherwise indicated on the drawings, all horizontal pipes, including branches, shall pitch 1" in 40 feet to low points for complete drainage, removal of condensate, and venting.

B. Provide drain valves at all low points of water piping systems or where indicated on drawings for complete or sectionalized draining. Drain valves are defined above.

C. Use eccentric reducing fittings on horizontal runs when changing size for proper drainage and venting. Install all liquid lines with top of pipe and eccentric reducers in a continuous line.

D. Provide air vents at all high points and wherever else required for elimination of air in all water piping systems. Do not use automatic air vents in glycol systems unless they are piped to the fill tank.

E. Air vents shall be in accessible locations. If needed to trap and vent air in a remote location, a 1/8" pipe shall connect the tapping location to a venting device in an accessible location.

F. All vent and drain piping shall be of same materials and construction as the service involved.

3.7 BRANCH CONNECTIONS

A. Make branch connections with standard tee or cross fittings of the type required for the service unless otherwise specified herein or detailed on the drawings.

B. At the option of the Contractor, branch connections from headers and mains may be cut into black steel pipe using forged weld-on fittings.

C. Use of forged weld-on fittings is also limited as follows:

1. Must have at least same pressure rating as the main.
2. Header or main must be 2-1/2" or over.
3. Branch line is at least two pipe sizes under header or main size.

3.8 JOINING OF PIPE

A. Threaded Joints:

1. Ream pipe ends and remove all burrs and chips.
2. Protect plated pipe and valve bodies from wrench marks when making up joints.
3. Apply Teflon tape to male threads.

B. Flanged Joints:

1. Bronze flanges shall conform to B16.24 and ductile iron flanges to B16.42. Steel flanges shall be raised face except when bolted to flat face cast iron flange.

2. Bolting shall be ASTM A307 Grade B with bolts and heavy hexagonal nuts conforming to ASME B18.2.1 and B18.2.2.

3. Torque bolts in at least three passes, tightening to 1/3, 2/3, and final torque in a cross pattern with an indicating torque wrench for equal tension in all bolts.

4. Gaskets for flat face flanges shall be full-face type. Gaskets for raised faced flanges shall conform to requirements for "Group I gaskets" in ASME B16.5. All gaskets shall conform to ASME B16.21. Unless otherwise specified, gaskets shall meet the following requirements:

   a. Gasket material and thickness approved by manufacturer for intended service, chemical compatibility, pipe system test pressure, and operating temperature range.

   b. Maximum pressure rating of at least 250 psig.

   c. Minimum temperature rating: -10°F.

   d. Maximum temperature rating of at least 170°F for water and glycol solution systems operating 140°F and less.

   e. Maximum temperature rating of at least 250°F for water and glycol solution systems operating above 140°F and up to 180°F.

C. Solder Joints:

1. Make up joints with 95% tin and 5% antimony (95-5) solder conforming to ASTM B32 Grade 95TA. Cut copper tubing ends perfectly square and remove all burrs inside and outside. Thoroughly clean sockets of fittings and ends of tubing to remove all oxide, dirt and grease just prior to soldering. Apply flux evenly, but sparingly, to all surfaces to be joined. Heat joints uniformly to proper soldering temperature so solder flows to all mated surfaces. Wipe excess solder, leaving a uniform fillet around cup of fitting.

2. Flux shall be non-acid type conforming to ASTM B813.

3. Solder end valves may be installed directly in the piping system if the entire valve is suitable for use with 470ºF melting point solder. Remove composition discs and all seals during soldering if not suitable for 470ºF.

D. Welded Joints:

1. Welding of all pipe joints, both as to procedures and qualification of welders, shall be in accordance with Section IX, ASME "Boiler & Pressure Vessel Code" unless local codes take precedence.

2. Furnish certificates qualifying each welder to the Owner's Representative prior to start of work.

3. The Owner's Representative reserves the right to require qualifying demonstration, at the Contractor's expense, of any welders assigned to the job.

4. Ends of pipe and fittings to be joined by butt-welding shall be beveled, cleaned to bare metal and internal diameters aligned before tack welding.

5. Backing rings shall be used for all butt weld joints 3" pipe size and over and for all sizes where operating pressure is over 200 psig and/or temperature is over 400ºF. Backing rings shall be of the material being welded.

E. Grooved Joints:

1. Grooved connections shall mechanically engage, lock and seal the grooved pipe ends in a positive couple. Each coupling shall have malleable iron housing clamps, steel bolts and nuts, and sealing gasket designed so internal pressure increases the tightness of the seal.

2. All work, including pipe grooving, shall be accomplished in accordance with manufacturer's published instructions.

3. Final tightening of bolts shall be with a torque wrench to ensure equal tension in all bolts.

4. All fittings shall be provided by one manufacturer. Mixing fittings will not be acceptable.

5. Acceptable Manufacturers: Victaulic, Gruvlok, or Star Fittings.

F. Mechanical Press Connection:

1. Copper press fitting shall be made in accordance with the manufacturer’s installation instructions.

2. Fully insert tubing into the fitting and mark tubing.

3. Prior to making connection, the fitting alignment shall be checked against the mark made on the tube to ensure the tubing is fully engaged in the fitting.

4. Joint shall be pressed with a tool approved by the manufacturer.

END OF SECTION

SECTION 23 11 23
NATURAL GAS PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Pipe and Pipe Fittings.
B. Valves.
C. Natural Gas Piping System.

1.2 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body. Remanufactured valves are not acceptable.

B. Welding Materials, Procedures, and Operators: Conform to ASME Section 9, ANSI/AWS D1.1, and applicable state labor regulations.

C. Welders Certification: In accordance with ANSI/ASME Sec 9 or ANSI/AWS D1.1.

1.3 REFERENCES

A. ANSI/AWS D1.1 - Structural Welding Code.

B. ANSI AGA-LC1 - Standards for Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing.

C. ANSI/AWWA C111/A21.11 - Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings.

D. ASME - Boiler and Pressure Vessel Code - Section 9.

E. ASME B1.20.1 - Pipe Threads, General Purpose.

F. ASME B16.3 - Malleable Iron Threaded Fittings Class 150 and 300.

G. ASME B16.5 - Pipe Flanges and Flanged Fittings.

H. ASME B16.9 - Factory-Made Wrought Steel Butt Welding Fittings.

I. ASME B16.11 - Forged Steel Fittings, Socket-Welding and Threaded.

J. ASME B16.21 - Nonmetallic Flat Gaskets for Pipes Flanges.

K. ASME B16.39 - Malleable Iron Threaded Pipe Unions.

L. ASME B18.2.1 - Square and Hex Bolts and Screws, Inch Series.

M. ASME B18.2.2 - Square and Hex Nuts, Inch Series.

N. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.

O. ASTM A105 - Standard Specification for Carbon Steel Forgings for Piping Applications.

P. ASTM A181 - Forgings, Carbon Steel for General Purpose Piping.

Q. ASTM A197 - Standard Specification for Cupola Malleable Iron.

R. ASTM A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

S. ASTM A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

T. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

U. ASTM D2513 - Thermoplastic Gas Pressure Pipe, Tubing and Fittings.

V. ASTM D2683 - Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe.

W. ASTM D2774 - Standard Practice for Underground Installation of Thermoplastic Pressure Piping.

X. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

Y. NFPA 54 - National Fuel Gas Code.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store and protect piping to prevent entrance of foreign matter into pipe and to prevent exterior corrosion.

B. Deliver and store valves in shipping containers with labeling in place.

1.5 COORDINATION DRAWINGS

A. Reference Coordination Drawings article in Section 22 05 00 for the required natural gas piping system electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

PART 2 - PRODUCTS

2.1 NATURAL GAS (0 TO 125 PSI)

A. Design Pressure: 125 psi.
Maximum Design Temperature: 350ºF

B. Piping - 2" and Under:

1. Pipe: Standard weight steel, threaded and coupled, ASTM A53.

2. Joints: Screwed. (NOTE: For below ground, all sizes to have welded joints.)

3. Fittings: 150# steam - 300# CWP, black malleable iron, banded, ASTM A197, ANSI B16.3.

4. Unions: 250# - 500# CWP, black malleable iron, ANSI B16.39, ground joint with brass seat.

C. Piping - 2-1/2" and Over:

1. Pipe: Standard weight black steel, beveled ends, ASTM A53.

2. Joints: Butt welded and flanged.

3. Fittings: Standard weight seamless steel, butt weld type, ASTM A234, Grade I, ANSI B16.9.

4. Flanges: 150# forged steel, weld neck or slip-on, ASTM A181, Grade I, ANSI B16.5.

D. For Underground Gas Piping - Refer to paragraph “Underground Piping Protection."

E. Shutoff Valves/Throttling Valves:

1. BA-13: 2” and under, threaded 600 psi CWP; UL listed for 250# LP, flammable liquid, heating oil, natural and manufactured gases, 150 psi steam, bronze body and chrome plated brass ball, Teflon seats and packing. Apollo #80-100, Nibco #T580-70-UL or #T585-70-UL, Watts #B-6000.

2. PL-1: 2" and under, 125# steam @ 450ºF, 175# CWP @ 180ºF, cast iron body, screwed, full port. Walworth #1700, DeZurik #425, S-RS49.

3. PL-2: 2-1/2" thru 4", 125# steam @ 450ºF, 175# CWP @ 180ºF, flanged, cast iron body, full port. Walworth #1700F, DeZurik #425, F-RS49.

4. PL-3: 6" and larger, 125# steam @ 450ºF, 175# CWP, cast iron body, flanged, resilient faced plug, gear and handwheel operator, full port. Walworth #1707F, DeZurik #118, F-RS24.

F. Check Valves:

1. CK-1: 2" and under, 125# steam @ 406ºF, 200# CWP @ 150ºF, screwed, bronze, horizontal swing. Crane #37, Hammond #IB904, Stockham #B319-Y, Walworth #3406, Milwaukee #509, Watts #B-5000, Nibco Y-413B.

2. CK-13: 2-1/2" thru 12", 200# CWP, double disc wafer type, iron body, bronze or aluminum-bronze discs, 316SS shaft and spring, Viton, EPDM or BUNA-N, Cv of at least 700 in 6" size. Mueller Steam Specialty Co. #71-AHB-6-H, Stockham #WG-961 EPDM or #WG970 BUNA, NIBCO W-920-W, Crane.

G. Strainers:

1. ST-2: Cast iron body, 125 lb. flanged ends, bolted cover, 125 psi S @ 350°F, 175 psi CWP @ 150°F. Armstrong #A1FL, Metraflex #TF, Mueller Steam Specialty Co.#751, Sarco #CI-125, Watts #77F-D.

2. ST-4: Cast iron body, screwed ends, screwed cover, 250# steam @ 406°F, 300# CWP @ 150°F. Armstrong #A1SC, Metraflex #SM, Mueller Steam Specialty Co. #11, Sarco #IT.

2.2 DRAIN VALVES AND BLOWDOWN VALVES

A. Drain valve and blowdown valve shall mean a shutoff valve as specified for the intended service with added 3/4” male hose thread outlet, cap, and retaining chain.

PART 3 - EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends, remove burrs, bevel plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Connect to all equipment with flanges or unions.

D. After completion, fill, clean, and treat systems. Refer to Section 23 25 00 for treatment.

3.2 TESTING PIPING

A. Low Pressure - Up to 1 psi:

1. Test piping with 20 psi air pressure. System must hold this pressure without adding air for two hours.

B. A non-combustible odorant, such as oil of wintergreen, may be added to help locate leaks.

3.3 CLEANING PIPING

A. Assembly:

1. Prior to assembly of pipe and piping components, remove all loose dirt, scale, oil and other foreign matter on internal or external surfaces by means consistent with good piping practice subject to approval of the Architect/Engineer. Blow chips and burrs out of pipe before assembly. Wipe cutting oil from internal and external surfaces.

2. During fabrication and assembly, remove slag and weld spatter from both internal and external joints by peening, chipping and wire brushing to the degree consistent with good piping practices.

3. Notify the Architect/Engineer prior to starting any post erection cleaning operation in time to allow witnessing the operation. Properly dispose of cleaning and flushing fluids.

4. Prior to blowing or flushing erected piping systems, disconnect all instrumentation and equipment, open wide all valves, control valves, and balance valves, and verify all strainer screens are in place.

3.4 INSTALLATION

A. Route piping in orderly manner, straight, plumb, with consistent pitch, parallel to building structure, with minimum use of offsets and couplings. Provide only offsets required for needed headroom or clearance and needed flexibility in pipe system.

B. Install piping to conserve building space, and not interfere with other work.

C. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment.

D. Group piping whenever practical at common elevations.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

F. Install thrust blocking and restraints on all buried piping at elbows and other changes in pipe direction.

G. Provide chain operators for all valves over 2" size that are over 10'-0" above finished floor. Extend to 7'-0" above finished floor.

H. Provide valve position indicator on all valves 10’-0” or greater above finish floor and not located above ceiling.

I. Provide clearance for access to valves and fittings.

J. Provide access doors where valves are not exposed.

K. Prepare pipe, fittings, supports, and accessories for finish painting.

L. Install valves with stems upright or horizontal, not inverted.

M. Provide shutoff valves and flanges or unions at all connections to equipment, traps, and items that require servicing.

N. Arrange piping and piping connections so equipment may be serviced or totally removed without disturbing piping beyond final connections and associated shutoff valves.

O. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it. Where pipe sizes are not shown, the larger size in either direction shall continue through the fitting nearest to the indication of a smaller pipe size.

P. Lay all underground piping in trenches. Provide and operate pumping equipment to keep trenches free of water.

Q. Provide flanges or unions at all final connections to equipment, traps and valves.

R. Seal pipes passing through exterior walls with a wall seal per Section 23 05 29. Provide Schedule 40 galvanized sleeve at least 2 pipe sizes larger than the pipe.

S. All vertical pipe drops to equipment installed below the ceiling shall be routed within a wall cavity, unless specifically noted otherwise to be surface mounted.

T. Each above ground portion of a gas piping system, other than corrugated stainless steel tubing systems, that is likely to become energized shall be electrically continuous and bonded to an effective ground-fault current path. Gas piping, other than corrugated stainless steel tubing, shall be considered to be bonded when it is connected to appliances that are connected to the appliance grounding conductor of the circuit supplying that appliance.

U. Gas piping shall not be used as a grounding conductor or electrode.

V. Where a lightning protection system is installed, the bonding of the gas piping shall be in accordance with NFPA 780, Standard for the Installation of Lightning Protection Systems.

3.5 PIPE ERECTION AND LAYING

A. Carefully inspect all pipe, fittings, valves, equipment and accessories prior to installation. Immediately reject and remove from the job any items which are unsuitable, cracked or otherwise defective.

B. All pipe, fittings, valves, equipment and accessories shall have factory-applied markings, stampings, or nameplates sufficient to determine their conformance with specified requirements.

C. Exercise care at every stage of storage, handling, laying and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not erect or install any unclean item.

D. During construction, until system is fully operational, keep all openings in piping and equipment closed at all times except when actual work is being performed on that item. Closures shall be plugs, caps, blind flanges or other items designed for this purpose.

E. Change direction of pipes only with fittings or pipe bends. Change size only with fittings. Do not use miter fittings, face or flush bushings, or street elbows. **All fittings shall be long radius type**, unless otherwise shown on the drawings or specified. Construct welded elbows of angles not available as standard fittings by cutting and welding standard elbows to form smooth, long radius fittings.

F. Use full and double lengths of pipe wherever possible.

G. Cut all pipe to exact measurement and install without springing or forcing.

H. Do not create, even temporarily, undue loads, forces or strains on valves, equipment or building elements.

3.6 DRAINING AND VENTING

A. Unless otherwise indicated on the drawings, all horizontal pipes, including branches, shall pitch 1" in 40 feet to low points for complete drainage.

B. Use eccentric reducing fittings on horizontal runs when changing size for proper drainage and venting. Install gas pipes with bottom of pipe and eccentric reducers in a continuous line.

C. Provide drip legs at low points and at the base of all risers in gas pipes. Drip legs shall be full line size on pipes through 4" and at least 4", but not less than half line size over 4". Drip legs shall be 12" minimum length, capped with a reducer to a drain valve.

3.7 BRANCH CONNECTIONS

A. Make branch connections with standard tee or cross fittings of the type required for the service unless otherwise specified herein or detailed on the drawings.

B. At the option of the Contractor, branch connections from headers and mains may be cut into black steel pipe using forged weld-on fittings.

C. Use of forged weld-on fittings is also limited as follows:

1. Must have at least same pressure rating as the main.
2. Header or main must be 2-1/2" or over.
3. Branch line is at least two pipe sizes under header or main size.

D. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it.

E. All branch piping connections for natural gas shall take off on the top or on the side of the main.

3.8 JOINING OF PIPE

A. Threaded Joints:

1. Ream pipe ends and remove all burrs and chips.
2. Protect plated pipe and valve bodies from wrench marks when making up joints.
3. Apply Teflon tape to male threads.

B. Welded Joints:

1. Welding of all pipe joints, both as to procedures and qualification of welders, shall be in accordance with Section IX, ASME "Boiler & Pressure Vessel Code" unless local codes take precedence.

2. Furnish certificates qualifying each welder to the Owner's Representative prior to start of work.

3. The Owner's Representative reserves the right to require qualifying demonstration, at the Contractor's expense, of any welders assigned to the job.

4. Ends of pipe and fittings to be joined by butt-welding shall be beveled, cleaned to bare metal and internal diameters aligned before tack welding.

5. Backing rings shall be used for all butt weld joints 3" size and over, and for all sizes where operating pressure is over 200 psig and/or temperature is over 400ºF. Backing rings shall be of the material being welded.

3.9 SERVICE CONNECTIONS

A. Provide new gas service complete with gas meter and regulators. Verify gas service pressure with the Utility Company.

END OF SECTION