SECTION 23 24 00

INTERNAL-COMBUSTION ENGINE PIPING

BASED ON DFD MASTER SPECIFICATION DATED 10/26/2016

This section has been written to cover most (but not all) situations that you will encounter. Depending on the requirements of your specific project, you may have to add material, delete items, or modify what is currently written. The Division of Facilities Development expects changes and comments from you.

# P A R T 1 - G E N E R A L

## SCOPE

This section contains specifications for internal combustion engine piping for this project. Included are the following topics:

PART 1 - GENERAL

Scope

Related Work

Reference

Reference Standards

Shop Drawings

Quality Assurance

Delivery, Storage, and Handling

Design Criteria

Welder Qualifications

PART 2 - PRODUCTS

Remote Radiator

Engine Exhaust

Unions and Flanges

Gaskets

PART 3 - EXECUTION

Preparation

Erection

Welded Pipe Joints

Threaded Pipe Joints

Copper Pipe Joints

Remote Radiator

Engine Exhaust

Unions and Flanges

Gaskets

Piping System Leak Tests

Construction Verification

Piping System Leakage Test Report

## RELATED WORK

Section 01 91 01 or 01 91 02 – Commissioning Process

Section 23 05 23 - General-Duty Valves for HVAC Piping

Section 23 05 15 - Piping Specialties

Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment

Section 23 07 00 - HVAC Insulation

Section 23 08 00 – Commissioning of HVAC

## REFERENCE

Applicable provisions of Division 1 govern work under this section.

## REFERENCE STANDARDS

Edit the following list so only the standards that are needed in your spec are included in it.

ANSI B16.3 Malleable Iron Threaded Fittings

ANSI B16.4 Cast Iron Threaded Fittings

ANSI B16.5 Pipe Flanges and Flanged Fittings

ANSI B16.22 Wrought Copper and Wrought Copper Alloy Solder Joint Pressure Fittings

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

ASTM A126 Gray Cast Iron Castings for Valves, Flanges, and Pipe Fittings

ASTM A181 Forgings, Carbon Steel for General Purpose Piping

ASTM A197 Cupola Malleable Iron

ASTM A234 Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures

ASTM B88 Seamless Copper Water Tube

## SHOP DRAWINGS

Refer to division 1, General Conditions, Submittals.

Contractor shall submit schedule indicating the ASTM specification number of the pipe being proposed along with its type and grade and sufficient information to indicate the type and rating of fittings for each service.

### TYPE F STEEL PIPE:

Statement from manufacturer on his letterhead that the pipe furnished meets the ASTM specification contained in this section.

### COPPER TUBE:

Statement from manufacturer on his letterhead that the pipe furnished meets the ASTM specification contained in this section.

## QUALITY ASSURANCE

Order all copper water tube with each length marked with the name or trademark of the manufacturer and type of tube; with each shipping unit marked with the purchase order number, metal or alloy designation, temper, size, and name of supplier; all in accordance with ASTM B88.

Any installed material not meeting the specification requirements must be replaced with material that meets these specifications without additional cost to the Owner.

## DELIVERY, STORAGE, AND HANDLING

Promptly inspect shipments to insure that the material is undamaged and complies with specifications.

Cover pipe to eliminate rust and corrosion while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends so they are not damaged. Where end caps are provided or specified, take precautions so the caps remain in place. Protect fittings, flanges, and unions by storage inside or by durable, waterproof, above ground packaging.

Offsite storage agreements will not relieve the contractor from using proper storage techniques.

Storage and protection methods must allow inspection to verify products.

## DESIGN CRITERIA

Use only new material, free of defects, rust and scale, and meeting the latest revision of ASTM specifications as listed in this specification.

Construct all piping for the highest pressures and temperatures in the respective system in accordance with ANSI B31, but not less than 125 psig unless specifically indicated otherwise.

Where weld fittings are used, use only long radius elbows having a centerline radius of 1.5 pipe diameters.

Where ASTM A53 type F pipe is specified, ASTM A53 grade A type E or S, or ASTM A53 grade B type E or S may be substituted at Contractor's option. Where ASTM A53 grade A pipe is specified, ASTM A53 grade B pipe may be substituted at Contractor's option. Where the grade or type is not specified, Contractor may choose from those commercially available.

Where ASTM B88, type L hard temper copper tubing is specified, ASTM B88, type K hard temper copper tubing may be substituted at Contractor's option.

## WELDER QUALIFICATIONS

Before any metallic welding is performed, the Contractor shall submit his Standard Welding Procedure Specifications, Procedure Qualification Records and Qualification Test Records for each Welder along with associated continuity records to demonstrate compliance with ASME Section IX, paragraph QW-322.

Welder certifications are required to be renewed every three years. If qualification papers are needed on a project, verify that they are current.

The Contractor shall maintain a complete set of welder qualification documents at the jobsite, including Test Records and Continuity Records for each welder.

The A/E or DFD reserves the right to test the work of any welder employed on the project, at the Contractor's expense. Testing will include a visual examination of the pipe and weld and may include radiography of any suspect welds. If the work of the welder is found to be unsatisfactory, the welder shall be prevented from doing further welding on the project. Any welds deemed unacceptable will be repaired at the contractor’s expense.

# P A R T 2 - P R O D U C T S

## REMOTE RADIATOR PIPING

2" and Smaller: ASTM A53, type F, standard weight (schedule 40) black steel pipe with ASTM A126/ANSI B16.4, class 125, standard weight cast iron threaded fittings.

2-1/2" and Larger: ASTM A53, standard weight (schedule 40) black steel pipe with ASTM A234 grade WPB/ANSI B16.9 standard weight, seamless, carbon steel weld fittings.

Contractor may use ASTM B88 seamless, type L, hard temper copper tube with ANSI B16.22 wrought copper solder-joint fittings in lieu of steel pipe for all sizes. Mechanically formed tee fittings may be used in lieu of wrought copper solder-joint tee fittings for branch takeoff up to one-half (1/2) the diameter of the main.

This specification is intended to be used with the remote radiators associated with emergency generators.

If an antifreeze material is required in the system water, verify that the antifreeze material is compatible with the piping material specifications.

## ENGINE EXHAUST

2" and Smaller: ASTM A53, type F, standard weight (schedule 40) black steel pipe with ASTM A234 grade WPB/ANSI B16.9 standard weight, seamless, carbon steel weld fittings.

2-1/2" and Larger: ASTM A53, standard weight, black steel pipe with ASTM A234 grade WPB/ANSI B16.9 standard weight, seamless, carbon steel weld fittings.

## UNIONS AND FLANGES

2" and Smaller: ASTM A197/ANSI B16.3 malleable iron unions with brass seats. Use black malleable iron on black steel piping and galvanized malleable iron on galvanized steel piping. Use ANSI B16.18 cast copper alloy unions on copper piping. Use unions of a pressure class equal to or higher than that specified for the fittings of the respective piping service but not less than 250 psi.

2-1/2" and Larger: ASTM A181 grade I or A105, grade III hot forged steel flanges of threaded, welding and of a pressure class compatible with that specified for valves, piping specialties and fittings of the respective piping service. Flanges smaller than 2-1/2" may be used as needed for connecting to equipment and piping specialties. Use raised face flanges ANSI B16.5 for mating with other raised face flanges on equipment with flat ring or full face gaskets. Use ANSI B16.1 flat face flanges with full face gaskets for mating with other flat face flanges on equipment.

Provide ASTM A193 B7 Grade bolts, A194 2H Grade nuts, and hardened washers for connections. (Use star washers for grounding.)

Generator Exhaust System; Provide uncoated SAE J-429 Grade 8 bolts, SAE J-995 Grade 8 nuts, and hardened washers for connections.

## GASKETS

Remote radiator Systems: Branded, compressed, non-asbestos sheet gaskets. Klingersil C4401, Garlock 3000, JM Clipper 978 or approved equal.

AE to review generator exhaust temperatures. On most large natural gas generators, the exhaust temperature will be exceeding 1200 degrees F.

Generator Exhaust Systems: Spiral wound gasket suitable for use with flat face and raised face flanges. Construct gasket of Inconel X750/non-asbestos windings and heat resistant graphite filler. Gasket to be rated for 1800 degree F. Flexitallic Style 835, Garlock Heat Shield or approved equal.

# P A R T 3 - E X E C U T I O N

## PREPARATION

Remove all foreign material from interior and exterior of pipe and fittings.

## ERECTION

Install all piping parallel to building walls and ceilings and at heights which do not obstruct any portion of a window, doorway, stairway, or passageway. Where interferences develop in the field, offset or reroute piping as required to clear such interferences. In all cases, consult drawings for exact location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.

Provide anchors, expansion joints, swing joints and/or expansion loops so that piping may expand and contract without damage to itself, equipment, or building.

***See comment on expansion provisions in Section 23 05 15. Show all needed expansion loops, anchors and guides on the drawings.***

Mitered ells, notched tees, and orange peel reducers are not acceptable. On threaded piping, bushings are not acceptable.

"Weldolets" and "Threadolets" may be used for branch takeoffs up to one-half (1/2) the diameter of the main.

Install drains throughout the systems to permit complete drainage.

Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including the required service space for this equipment, unless the piping is serving this equipment.

This requirement is based on NFPA 70-1987, 384-4 and 450-47.

Install all valves, and piping specialties, including items furnished by others, as specified and/or detailed. Make connections to all equipment installed by others where that equipment requires the piping services indicated in this section.

## WELDED PIPE JOINTS

Make all welded joints by fusion welding in accordance with ASME Codes, ANSI B31, and State Codes where applicable.

All pipe welding shall be completed by Qualified Welders in accordance with the Contractor’s Procedure Specifications.

Contractor will ensure that these steps are followed where pipe sections will be joined by welding:

1. Cleaning – Welding surfaces will be clean and free of defects.
2. Alignment – Inside diameter of piping components will be aligned as accurately as possible. Internal misalignment shall not exceed 1/16”.
3. Spacing – Pipe sections will be spaced to allow deposition of weld filler material through the entire weld joint thickness.
4. Girth Butt Welds:
	1. Girth butt welds shall be complete penetration welds.
	2. Concavity will not exceed 1/32”
	3. Under cuts will not exceed 1/32”
	4. As welded surfaces are permitted however surfaces will be free from coarse ripples, grooves, abrupt ridges and valleys.

Electrodes shall be Lincoln, or approved equal, with coating and diameter as recommended by the manufacturer for the type and thickness of work being done.

## THREADED PIPE JOINTS

Use a Teflon based thread lubricant or Teflon tape when making joints; no hard setting pipe thread cement or caulking will be allowed.

## COPPER PIPE JOINTS

Remove all slivers and burrs remaining from the cutting operation by reaming and filing both pipe surfaces. Clean fitting and tube with emery cloth or sandpaper. Remove residue from the cleaning operation, apply flux, and assemble joint. Use 95-5 solder or brazing to secure joint as specified for the specific piping service.

Where mechanically formed tee fittings are allowed, form mechanically extracted collars in a continuous operation, consisting of drilling a pilot hole and drawing out the tube surface to form a collar having a height of not less than three times the thickness of the tube wall. Use an adjustable collaring device. Notch and dimple the branch tube. Braze the joint, applying heat properly so that pipe and tee do not distort; remove distorted connections.

## REMOTE RADIATOR

Surge tanks, heat exchanger, remote radiator, radiator pump, and engine pump are furnished by the Electrical Contractor. Install this equipment where indicated on the drawings and as detailed. Provide valves as detailed or as recommended by equipment manufacturer. Install the radiator surge tank 4" above radiator or as recommended by the equipment supplier. Install engine surge tank 4" above highest engine water outlet piping. Pitch all piping upward from heat exchanger to radiator and from heat exchanger to engine. Mount heat exchanger below cylinder head.

## ENGINE EXHAUST

Install engine exhaust lines where indicated on the drawings, including mufflers, flexible connections, and other required exhaust line components furnished with the engine. Isolate piping as indicated in Section 23 05 48. Pitch horizontal piping down and away from the muffler to a drain point where the pipe rises. Install a drain valve at this point, on the muffler body if it has provision for a drain connection, and at all low points in the exhaust line where condensate may collect. Drain valves to be accessible without the use of a ladder.

Exhaust pipes passing directly through combustible roofs to be guarded at the point of passage by ventilated metal thimbles which extended not less than 9 inches above and below roof construction and which are at least 6 inches larger in diameter than the vent pipe.

Terminate exhaust piping with a vent cap unless specifically detailed.

## UNIONS AND FLANGES

Install a union or flange, as required, at each automatic control valve and at each piping specialty or piece of equipment which may require removal for maintenance, repair, or replacement. Where a valve is located at a piece of equipment, locate the flange or union connection on the equipment side of the valve.

## GASKETS

Store horizontally in cool, dry location and protect from sunlight, water and chemicals. Inspect flange surfaces for warping, radial scoring or heavy tool marks. Inspect fasteners, nuts and washers for burrs or cracks. Replace defective materials.

Align flanges parallel and perpendicular with bolt holes centered without using excessive force. Center the gasket in opening. Lubricate fastener threads, nuts and washers with lubricant formulated for application.

Draw flanges together evenly to avoid pinching gasket. Tighten fasteners in cross pattern sequence (12 – 6 o’clock, 3 – 9 o’clock, etc.), one pass by hand and four passes by torque wrench at 30% full torque, 60% full torque and two passes at full torque per ASME B16.5.

## PIPING SYSTEM LEAK TESTS

Verify that the piping system being tested is fully connected to all components and that all equipment is properly installed, wired, and ready for operation. If required for the additional pressure load under test, provide temporary restraints at expansion joints or isolate them during the test. Verify that hangers can withstand any additional weight load that may be imposed by the test.

Provide all piping, fittings, blind flanges, and equipment to perform the testing.

Conduct pressure test with test medium of air or water unless specifically indicated. Minimum test time is indicated in the table below; additional time may be necessary to conduct an examination for leakage. Each test must be witnessed by the Division's representative. If leaks are found, repair the area with new materials and repeat the test; caulking will not be acceptable.

Do not insulate pipe until it has been successfully tested.

For hydrostatic tests, use clean water and remove all air from the piping being tested by means of air vents or loosening of flanges/unions. Measure and record test pressure at the high point in the system.

For air tests, gradually increase the pressure to not more than one half of the test pressure; then increase the pressure in steps of approximately one-tenth of the test pressure until the required test pressure is reached. Examine all joints and connections with a soap bubble solution or equivalent method. The piping system exclusive of possible localized instances at pump or valve packing shall show no evidence of leaking. After testing is complete, slowly release the pressure in a safe manner.

Consultant must verify that all system components have been designed for these test pressures; contact DFD engineering personnel if there are questions.

|  |  |  |  |
| --- | --- | --- | --- |
| System | Pressure | Medium | Duration |
| Emergency generator cooling (remote radiator) | 5 psig | - | 8 hr |

\*\*Verify operating system pressure with DFD and specify test pressure accordingly. Several state agencies have systems that operate at higher pressures and require test pressures in excess of that scheduled above.

All pressure tests are to be documented on a Division of Facilities Development form included in this specification.

On piping that cannot be tested because of connection to an active line, provide temporary blind flanges and hydrostatically test new section of piping. After completion of test, remove temporary flanges and make final connections to piping. Die penetrate test pass weld or x-ray the piping that was not hydrostatically tested up to the active system.

## CONSTRUCTION VERIFICATION

Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 23 08 00 in accordance with the procedures defined for construction verification in Section 01 91 01 or 01 91 02.

END OF SECTION

**PIPING SYSTEM LEAKAGE TEST REPORT**

**State of Wisconsin**

**Department of Administration Date**

**Division of Facilities Development Submitted:**

**Project Name:**

**Location: DFD Project No:**

**Contractor:**

 **□ HVAC □ Refrigeration □ Controls**

□ **Power Plant** □ **Plumbing** □ **Sprinkler**

 **Test Medium:** □ **Air** □ **Water** □ **Other**

**Test performed per specification section No.**

**Specified Test Duration \_\_\_\_\_ Hours Specified Test Pressure PSIG**

**System Identification:**

**Describe Location:**

 **Test Date:**

**Start Test Time: Initial Pressure: PSIG**

**Stop Test Time: Final Pressure: PSIG**

**Tested By: Witnessed By:**

**Title: Title:**

**Signed: Signed:**

**Date: Date:**

**Comments:**