PIP PNSC0036
High Density Polyethylene (HDPE)
Piping Installation Specification
PURPOSE AND USE OF PROCESS INDUSTRY PRACTICES

In an effort to minimize the cost of process industry facilities, this Practice has been prepared from the technical requirements in the existing standards of major industrial users, contractors, or standards organizations. By harmonizing these technical requirements into a single set of Practices, administrative, application, and engineering costs to both the purchaser and the manufacturer should be reduced. While this Practice is expected to incorporate the majority of requirements of most users, individual applications may involve requirements that will be appended to and take precedence over this Practice. Determinations concerning fitness for purpose and particular matters or application of the Practice to particular project or engineering situations should not be made solely on information contained in these materials. The use of trade names from time to time should not be viewed as an expression of preference but rather recognized as normal usage in the trade. Other brands having the same specifications are equally correct and may be substituted for those named. All Practices or guidelines are intended to be consistent with applicable laws and regulations including OSHA requirements. To the extent these Practices or guidelines should conflict with OSHA or other applicable laws or regulations, such laws or regulations must be followed. Consult an appropriate professional before applying or acting on any material contained in or suggested by the Practice.

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1. **Scope**

   This Practice describes the requirements for purchasing, fabrication, installation, examination, and testing of general purpose high density polyethylene piping (HDPE) piping and Factory Mutual (FM) approved piping.

2. **References**

   Applicable parts of the following industry codes and standards should be considered an integral part of this Practice. The edition in effect on the date of contract award should be used, except as otherwise noted. Short titles will be used herein where appropriate.

   **Industry Codes and Standards**

   - American Society of Mechanical Engineers (ASME)
     - ASME B31.3 - *Process Piping*
   - American Society for Testing and Materials (ASTM)
     - ASTM D2774 – *Standard Practice for Underground Installation of Thermoplastic Pressure Piping*
     - ASTM F2620 – *Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings*
   - National Fire Protection Association (NFPA)
     - NFPA 24 - *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*
   - Plastic Pipe Institute (PPI)
     - The Plastics Pipe Institute Handbook of Polyethylene Pipe
     - TR-33 - Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe
     - TR-41 – Generic Saddle Fusion Joining Procedure for Polyethylene Piping

3. **Definitions**

   - **manufacturer**: The party responsible for making the HDPE pipe and fittings
   - **owner**: The party who owns the facility wherein the HDPE piping will be used
   - **purchaser**: The party who awards the contract to the supplier. The purchaser may be the owner or the owner’s authorized agent.
supplier: The party responsible for purchasing and installing the HDPE piping

4. Requirements

4.1 Design

4.1.1 Unless otherwise specified, general purpose piping shall be in accordance with ASME B31.3.

4.1.2 FM approved piping shall be in accordance with NFPA 24.

4.2 Materials

4.2.1 All material substitutions shall be approved by the purchaser.

4.2.2 HDPE pipe and fittings to be joined by heat fusion shall be provided by the same manufacturer.

4.2.3 Pipe and fittings from different manufacturers shall not be interchanged.

4.3 Fabrication

4.3.1 Heat Fusion Joining

4.3.1.1 Joints between plain end pipes and fittings shall be made by butt fusion, and joints between the main and saddle branch fittings shall be made by saddle fusion in accordance with ASTM F2620, PPI TR-33 and procedures recommended by the manufacturer.

4.3.1.2 For piping installations in cold weather, procedures for saddle and butt heat fusion joining shall be in accordance with and ASTM D2620, Annex A-1 and PPI TR-33 and TR-41.

4.3.1.3 The procedures and procedure qualification records shall be reviewed by the purchaser’s inspector before any heat fusion joining is started.

4.3.1.4 External and internal beads shall not be removed.

4.3.2 Heat Fusion Training

4.3.2.1 Persons making heat fusion joints shall have received training in the manufacturer’s recommended procedure.

4.3.2.2 Records shall be maintained of trained personnel, and shall certify that training was received 12 months maximum before commencing construction.

4.3.2.3 If required by purchaser, installation personnel, purchaser’s inspectors, and owner’s personnel shall be trained in the manufacturer’s recommended butt fusion and saddle fusion procedures by the manufacturer.
4.3.3 Butt Fusion of Different Wall Thicknesses for General Purpose Piping

4.3.3.1 Butt fusion shall be performed between pipe ends or between pipe ends and fitting outlets of the same outside diameter and wall thickness.

4.3.3.2 Butt fusion joining between pipe ends with the same outside diameters and different wall thicknesses or between pipe ends and fitting outlets with the same outside diameters and different wall thicknesses is permitted if the difference in standard dimension ratio (SDR) of the two pieces is two SDRs or less. For example, a component with a SDR of 11 can be joined to a component with a SDR of 15.5. Joining pipe of different thicknesses represents a special situation and subject to special restrictions the user is advised to consult with the pipe manufacturer to determine if special procedures can be applied. Recommendations and pipe joining procedures should be obtained from the manufacturer.

4.3.3.3 Transitions between the same outside diameters and different wall thicknesses greater than two standard dimension ratios (SDRs) shall be made with a transition nipple (i.e., a short length of the heavier wall pipe with one end machined to the lighter wall) or by mechanical means. For example, a transition piece is required if joining a component with an SDR of 11 to a component with an SDR of 17.

4.3.3.4 Transitions represents a special situation it is subject to limitations. Therefore, the user is advised to consult with the pipe manufacturer to determine if special procedures can be applied to the pipe components involved in the particular installation in question.

4.3.3.5 Most pipe manufacturers have detailed parameters and procedures to follow and have approved the Plastic Pipe Institute (PPI) Technical Report TR-33 and ASTM F2620 for generic butt fusion joining procedures for PE pipe.

4.3.4 Butt Fusion of Different Wall Thicknesses for FM Approved Piping

4.3.4.1 Butt fusion shall be performed between pipe ends or between pipe ends and fitting outlets of the same class.

4.3.4.2 Butt fusion jointing between Class 150 and Class 200 is not permitted.

4.3.4.3 Transitions between Class 150 and Class 200 shall be made with flange connections.

4.3.5 Mechanical Joining for General Purpose Piping

4.3.5.1 HDPE pipe and fittings shall be joined together or joined to other materials by either of the following methods:

a. Flanged connections (flange adapters and back-up rings)

b. Mechanical couplings designed for joining HDPE pipe or for joining HDPE pipe to another material.

4.3.5.2 Mechanical couplings shall be fully pressure-rated and fully thrust-restrained such that if installed in accordance with manufacturer’s
recommendations, a longitudinal load applied to the mechanical coupling will cause the pipe to yield before the mechanical coupling disjoins.

4.3.5.3 External joint restraints shall not be used in lieu of fully restrained mechanical couplings.

4.3.6 Mechanical Joining for FM Approved Piping

4.3.6.1 HDPE pipe and fittings may be joined together or to other materials by means of flanged connections with flange adapters and backup rings.

4.3.6.2 Mechanical couplings and external joint restraints are not generally permitted.

4.3.6.3 FM approved mechanical couplings may be used in situations where use of butt fusion equipment may not be feasible due to space or location limitations. Mechanical couplings may only be used with the approval of the appropriate authority.

4.3.7 Branch Connections

4.3.7.1 Branch connections to the main shall be made with saddle fittings or tees.

4.3.7.2 HDPE saddle fittings shall be saddle-fused to the main pipe.

4.4 Installation

4.4.1 General

4.4.1.1 Installation shall be in accordance with the manufacturer’s recommendations and this Practice.

4.4.1.2 All necessary precautions shall be taken to ensure a safe working environment in accordance with applicable codes and standards.

4.4.2 Large Diameter Fabricated Fittings

4.4.2.1 Fabricated directional fittings equal to or greater than DN 400 NPS 16 shall be butt-fused to the end of a pipe.

4.4.2.2 Flanged directional outlet connections shall be made up in the trench.

4.4.3 Mechanical Joint and Flange Installation for General Purpose Piping

4.4.3.1 Mechanical joints and flange connections shall be installed in accordance with manufacturer’s recommended procedure.

4.4.3.2 Flange faces shall be centered and aligned to each other before assembling and tightening bolts. The flange bolts shall not be used to draw the flanges into alignment.

4.4.3.3 Bolt threads shall be lubricated, and flat washers shall be fitted under the flange nuts.

4.4.3.4 Bolts shall be evenly tightened in accordance with the tightening pattern and manufacturer’s torque step recommendations.
4.4.3.5 A minimum of one hour after initial assembly and full tightening, flange connections shall be re-tightened in accordance with the tightening pattern and manufacturer’s torque step recommendations.

4.4.3.6 About four hours after the second tightening, flange connections should be re-tightened a third and final time in accordance with the tightening pattern and manufacturer’s torque step recommendations.

4.4.4 **Flange Installation for FM Approved Piping**

4.4.4.1 Flange connections shall be installed in accordance with manufacturer’s recommended procedure.

4.4.4.2 Flange faces shall be centered and aligned to each other before assembling and tightening bolts. The flange bolts shall not be used to draw the flanges into alignment.

4.4.4.3 Bolt threads shall be lubricated, and flat washers shall be fitted under the flange nuts.

4.4.4.4 Bolts shall be evenly tightened in accordance with the tightening pattern and manufacturer’s torque step recommendations.

4.4.4.5 A minimum of one hour after initial assembly and full tightening, flange connections shall be re-tightened following the tightening pattern and manufacturer’s torque step recommendations.

4.4.4.6 About four hours after the second tightening, flange connections should be re-tightened a third and final time in accordance with the tightening pattern and manufacturer’s torque step recommendations.

4.4.4.7 The bolt torque values shall be in accordance with gasket manufacturer’s recommendation.

4.4.5 **Pipe Handling**

4.4.5.1 If lifting with slings, only wide fabric choker slings shall be used to lift, move, or lower pipe and fittings.

4.4.5.2 Slings shall be of sufficient capacity for the load, and shall be inspected before use.

4.4.5.3 Lifting using wire rope or chain is not permitted.

4.4.5.4 Use of worn or defective equipment is not permitted.

4.4.5.5 For handling piping in cold weather, lifting shall be in accordance with ASTM F2620, Annex A-1.

4.4.6 **Pipe Burial**

4.4.6.1 Where HDPE pipe is to be buried, refer to general requirements of plastic pipe burial found in ASTM D2774 - Standard Practice for Underground Installation of Thermoplastic Pressure Piping.

4.5 Visual Examination

4.5.1 Butt fusion joints shall be visually examined to ensure joint quality.

*Comment:* The size and shape of the fusion beads indicate if a proper joint has been made.

4.5.2 The width of the double bead shall be 2 to 2-1/2 times the height of the bead from the pipe surface.

4.5.3 The double bead shall be uniform in size and shape all around the joint.

4.5.4 The depth of the V-groove between the beads shall not be greater than half the bead height.

4.5.5 If butt fusion is between pipe and a molded fitting, the fitting-side bead can exhibit some shape irregularities that are caused by the molding process. A slightly irregular fitting-side bead shall not be cause for rejection provided that the pipe-side bead is properly shaped and the V-groove between the beads is correct. This shall only apply to molded fittings and not to fittings that are fabricated from pipe shapes.

4.5.6 Visual inspection requirements shall apply to both outside fusion beads and inside fusion beads.

4.5.7 Inside fusion beads shall be examined if accessible (e.g., at flange adapters, the first fusion of an elbow, and the first and second fusion of a tee).

4.6 Testing

4.6.1 Butt Fusion Testing

4.6.1.1 For each fusion operator, the first fusion of each day shall be a trial fusion.

4.6.1.2 Butt fusion of pipe to be installed shall not be performed until a trial fusion has passed the bend test.

4.6.1.3 After the trial fusion has cooled completely, fusion test strips shall be cut out.

4.6.1.4 Weld samples for testing shall be obtained by cutting a ring section, 300 mm (12-inches) or 3t mm (inches) wide whichever is greater, of HDPE pipe with the butt fusion weld area centered; where t equals the pipe wall thickness.

4.6.1.5 Four test strips, 90° apart, shall be cut out of a ring section for visual examination and a bend test.

4.6.1.6 Width of the bend test strips shall be proportional to the pipe wall thickness, t, as follows:

a. If t is less than or equal to 17 mm (0.67 inch), test strip shall be 25 mm (1.0-inch) wide.

b. If t is greater than 17 mm (0.67 inch), the width of the test strips shall be equal to 1.5t.
4.6.1.7 The cross section of the weld shall be examined visually, and voids and discontinuities shall not be permitted.

4.6.1.8 A bend test shall consist of the following steps:

a. Each test strip shall be clamped in a vise 25 mm (1.0 inch) or 4.3t mm (inches) whichever is greater, under the weld bead.

b. A steel extension pipe of appropriate diameter and length shall be slipped over the free end of the test strip to 25 mm (1.0 inch) or 4.3t mm (inches) whichever is greater, above the weld bead.

c. The bend test shall be performed by bending the test strip a minimum of 90° in the direction that places the concave interior surface of the pipe wall and root of the butt fusion weld in tension.

4.1.1.9 The bent test strips shall be examined visually, and failures in the butt fusion area shall not be permitted in all four bend test strips.

4.6.1.10 If the fusion fails at the joint, a new trial fusion shall be made, cooled completely, and tested.

4.6.1.11 ASTM F2620 shows how to cut the bend test strips out of the pipe and how to bend the strips.

4.6.1.12 ASTM F2620 provides guidance for visually examining the butt fusion welds to determine good and poor fusions.

4.6.1.12 ASTM F2620 for additional testing requirements.

4.6.2 Pressure Testing

4.6.2.1 All joints (i.e., mechanical, flanged, and fusion) shall be inspected for leakage during a pressure test.

4.6.2.2 Heat fusion joints shall be completely cooled before pressure testing.

4.6.2.3 The temperature of the test medium and the pipe test section shall be the same, and if possible, less than 38°C (100°F).

4.6.2.4 Before applying test pressure, ample time shall be permitted for test medium and pipe test section temperatures to equalize.

4.6.2.5 If the equalized temperature is above 38°C (100°F), test pressure shall be reduced in accordance with pipe manufacturer’s recommendations.

4.6.2.6 Valves or other lower pressure rated components in the piping system may not be designed to withstand the required system test pressure. These components shall be either removed or isolated from the test section to avoid damage or failure of these components.

4.6.2.7 If the test pressure is 1 to 1-1/2 times the system operating design pressure, the total test time including initial pressurization, initial expansion, and time at test pressure shall not be greater than eight hours.

4.6.2.8 If a test cannot be completed because of leakage, equipment failure, etc., the test section shall be depressurized and permitted to “relax” for at least eight hours before test pressure is applied again.
4.6.2.9 Unless otherwise specified by purchaser, the testing medium shall be clean water.

4.6.2.10 Test section shall be completely filled with the test medium.

4.6.2.11 Test section shall be vented at high points as required to completely purge all air from the system.

4.6.2.12 A pressure test shall consist of the following phases:
   a. Initial expansion phase:
      The test section shall be pressurized to the test pressure, and makeup test medium shall be added each hour for three hours to return to test pressure.
   b. Test phase:
      Immediately following the initial expansion phase, the test section shall be held under pressure for two hours. Makeup test medium shall not be added.
   c. End of test phase:
      The test section shall be returned to test pressure by adding a measured amount of test medium. If the amount of test medium added is not greater than the values shown in Table 1, leakage is not indicated.

Table 1 - Test Phase Makeup Amount

<table>
<thead>
<tr>
<th>Pipe Size, DN (NPS)</th>
<th>Liters/30 meters (Gallons/100 ft) of Pipe After 2 Hour Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>80 (3)</td>
<td>0.5 (0.15)</td>
</tr>
<tr>
<td>100 (4)</td>
<td>1.0 (0.25)</td>
</tr>
<tr>
<td>150 (6)</td>
<td>2.3 (0.60)</td>
</tr>
<tr>
<td>200 (8)</td>
<td>3.8 (1.0)</td>
</tr>
<tr>
<td>250 (10)</td>
<td>4.9 (1.3)</td>
</tr>
<tr>
<td>300 (12)</td>
<td>8.7 (2.3)</td>
</tr>
<tr>
<td>350 (14)</td>
<td>10.6 (2.8)</td>
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<tr>
<td>400 (16)</td>
<td>12.5 (3.3)</td>
</tr>
<tr>
<td>450 (18)</td>
<td>16.3 (4.3)</td>
</tr>
<tr>
<td>500 (20)</td>
<td>20.8 (5.5)</td>
</tr>
<tr>
<td>600 (24)</td>
<td>33.7 (8.9)</td>
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<tr>
<td>750 (30)</td>
<td>48.1 (12.7)</td>
</tr>
<tr>
<td>900 (36)</td>
<td>68.1 (18.0)</td>
</tr>
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</table>