Process Industry Practices
Piping

PIP PNSC0001
ASME B31.3 Metallic Piping
Fabrication and Examination 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.

This Practice is subject to revision at any time.

© Process Industry Practices (PIP), Construction Industry Institute, The University of Texas at Austin, 3925 West Braker Lane (R4500), Austin, Texas 78759. PIP Member Companies and Subscribers may copy this Practice for their internal use. Changes or modifications of any kind are not permitted within any PIP Practice without the express written authorization of PIP. Authorized Users may attach addenda or overlays to clearly indicate modifications or exceptions to specific sections of PIP Practices. Authorized Users may provide their clients, suppliers and contractors with copies of the Practice solely for Authorized Users’ purposes. These purposes include but are not limited to the procurement process (e.g., as attachments to requests for quotation/purchase orders or requests for proposals/contracts) and preparation and issue of design engineering deliverables for use on a specific project by Authorized User’s client. PIP’s copyright notices must be clearly indicated and unequivocally incorporated in documents where an Authorized User desires to provide any third party with copies of the Practice.

PRINTING HISTORY
February 1998     Issued
October 2006     Complete Revision
November 2014     Complete Revision

Not printed with State funds
PIP PNSC0001
ASME B31.3 Metallic Piping
Fabrication and Examination Specification

Table of Contents

1. Introduction ......................... 2
   1.1 Purpose ................................. 2
   1.2 Scope ..................................... 2

2. References ............................ 2
   2.1 Process Industry Practices ....... 2
   2.2 Industry Codes and Standards ..... 2

3. Definitions ............................. 3

4. Requirements .......................... 3
   4.1 General ................................... 3
   4.2 Materials ................................. 3
   4.3 Welding ................................... 4
   4.4 Branch Connections .................... 6
   4.5 Machined Surfaces ...................... 6
   4.6 Forming and Bending ................... 7
   4.7 Flanges ................................. 7
   4.8 Orifice Runs ............................ 7
   4.9 Cleaning ................................. 7
   4.10 Examination and Testing .......... 7
   4.11 Heat Treatment ....................... 11
   4.12 Painting ............................... 14
   4.13 Marking ............................... 14
   4.14 Shipping and Storage ............ 15
   4.15 Documentation ....................... 15
1. Introduction

1.1 Purpose

This Practice provides requirements for fabricating and examining piping systems in accordance with *ASME B31.3 Process Piping*, (hereinafter referred to as the *Code*).

1.2 Scope

This Practice describes the requirements for both shop and field fabricated piping. Piping fabrication requirements are provided for materials, welding, forming, and heat treatment.

Examination requirements are provided for piping materials, components, fabrication, assembly, and erection. Requirements for examination documentation are provided. Examination methods, acceptance criteria, and requirements for correction of defective work are also provided.

2. References

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

2.1 Process Industry Practices (PIP)

- PIP PNE00012 - *Piping Examination and Leak Test Guide*
- PIP PNFS0001 - *Pipe Supports Details*
- PIP PNSC0021 - *Specification for Leak Tests of Piping*

2.2 Industry Codes and Standards

- American Petroleum Institute (API)
  - API RP 582 - *Recommended Practice Welding Guidelines for the Chemical, Oil and Gas Industries*
- American Society of Mechanical Engineers (ASME)
  - ASME *Boiler and Pressure Vessel Code*
    - Section V - “Nondestructive Examination” (*BPV Code, Section V*)
  - ASME B16.25 - *Buttwelding Ends*
  - ASME B31.3 - *Process Piping (Code)*
- American Society for Testing and Materials (ASTM)
  - ASTM E165 - *Standard Practice for Liquid Penetrant Examination for General Industry*
- Piping Fabrication Institute (PFI)
  - PFI Standard ES-3 - *Fabricating Tolerances*
3. Definitions

contract documents: Any and all documents, including codes, studies, design drawings, specifications, sketches, practices, and data sheets, that the purchaser has transmitted or otherwise communicated, either by incorporation or reference, and made part of the legal contract agreement or purchase order between the purchaser and the supplier

examiner: A person qualified in accordance with the Code, who performs quality control examinations on behalf of the supplier, contractor or pipe fabricator

inspector: A person qualified in accordance with the Code, employed by the owner or a delegate authorized by the owner, responsible for verifying that all required examinations, testing and welding documentation have been completed. They are also responsible for inspecting the piping and documentation to the extent necessary to be satisfied that they are in accordance with all applicable examination requirements of the Code and the engineering design.

owner: The party who owns the facility wherein the fabricated 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 providing the fabricated piping

4. Requirements

4.1 General

4.1.1 Piping shall be fabricated in accordance with all the requirements of the Code.

4.1.2 Unless otherwise specified, tolerances for dimensions of fabricated pipe sections shall be in accordance with PFI Standard ES-3.

4.1.3 Pipe support systems shall be in accordance with PIP PNFS0001.

4.1.4 The opportunity to witness part or all of the work, including access to facilities required to verify the results shall be provided to the purchaser, owner, and inspector.

4.2 Materials

4.2.1 All materials shall be in accordance with the piping material specifications specified in the contract documents.

4.2.2 Material substitutions, including thicker wall materials, shall be permitted only with the owner’s or purchaser’s written approval.

4.2.3 Cleanliness

4.2.3.1 Components shall be clean and dry before welding.
4.2.3.2 For fabrication operations that include heating, affected surfaces shall be cleaned of harmful contaminants such as lubricants, paint, rust, and scale before performing the operations.

4.2.3.3 For P-Numbers 8, 2X, 4X, 5X, and 6X materials, the following shall apply:
   a. Direct contact operation such as brushing shall be performed using stainless steel tools that have not been used on other materials.
   b. Grinding shall be performed with wheels that have not been used on other materials.
   c. Brushes and grinding wheels shall be stored in separate areas that are isolated from any carbon steel tools or equipment.

4.2.4 If welding is required to repair a component, approval from the owner or purchaser shall be obtained before proceeding.

4.2.5 A marking system approved by the owner or purchaser shall be used to maintain material traceability.

4.3 Welding

4.3.1 General

4.3.1.1 Welding requirements including welding procedure preparation, filler metals, approved welding processes, hardness testing, weld overlay, and miscellaneous requirements shall be in accordance with API RP 582.

Comment: This Practice supplements welding requirements contained in API RP 582 and provides requirements applicable to all welding processes and requirements for specific processes and materials.

4.3.1.2 Qualifications of the welding procedures to be used and of the performance of welders and welding operators shall be in accordance with the Code, Paragraph 328.2, and API RP 582.

4.3.1.3 Welds shall be identified in accordance with the Code.

4.3.1.4 Each qualified welder and welding operator shall be identified in accordance with the Code.

4.3.1.5 Stamped marks shall not be permitted on nickel alloys.

4.3.1.6 See Section 4.13 of this Practice for permissible marking.

4.3.1.7 Weld maps shall be an acceptable alternative to marking if approved by the owner.

4.3.1.8 Unless tack welds shall be removed during the welding operation, tack welds shall be of the same quality and material as the completed weld and shall be fully fused with weld beads.

4.3.1.9 Arc strikes on pipe and fitting surfaces shall be avoided. If arc strikes occur, they shall be removed.
4.3.1.10 Repairs to the pipe and fitting surfaces shall not reduce the wall below the minimum required thickness.

4.3.2 Buttwelds

4.3.2.1 If seam-welded pipes are joined by butt welding, longitudinal weld seams should be positioned at least 25 mm (1 in) or 30 degrees apart.

4.3.2.2 Buttweld joints shall be prepared in accordance with the appropriate figure in ASME B16.25.

4.3.2.3 For buttwelded joints of unequal thickness, the weld ends shall be prepared in accordance with ASME B16.25.

4.3.2.4 Buttweld end valves that have PTFE or other heat-sensitive parts shall be protected from the heat of welding, or post weld heat treatment (PWHT), in accordance with the valve manufacturer’s instructions.

4.3.2.5 Internal misalignment of piping components to be joined shall not exceed the dimension as specified in the welding procedure specification (WPS) or shall not be greater than 1.5 mm (1/16 inch).

4.3.2.6 The following methods shall be used as applicable in descending order of preference to minimize misalignment:

a. Rotating the pipe or fitting

b. Correcting out-of-round conditions by using spreaders or line-up clamps

c. Tapering or counter boring with taper to align butt weld ends. Slopes, angles and minimum remaining thickness shall be in accordance with ASME B16.25, Figure 1.

d. Back welding of the root pass

4.3.3 Socket Welds

4.3.3.1 Weld leg length shall be equal to or greater than the nominal wall thickness of the pipe.

4.3.3.2 If hardness control for sulfide stress cracking is a concern, welds shall be made with a minimum of two passes.

4.3.3.3 Pipe insertion into a socket weld fitting should be a minimum of 6 mm (1/4 inch) or the pipe nominal wall thickness, whichever is greater.

4.3.3.4 The minimum gap between the end of the pipe and the bottom of the socket shall be approximately 1.5 mm (1/16 inch) before welding.

4.3.3.5 Socket weld end valves that have PTFE or other heat-sensitive parts shall be protected from the heat of welding or PWHT in accordance with the valve manufacturer’s instructions.

4.3.4 Slip-On Flanges

4.3.4.1 Slip-on flanges shall be welded inside and outside in accordance with the Code, Figure 328.5.2B(1).
4.3.4.2 The toe of the inside fillet weld shall be 1.5 to 5 mm (1/16 to 3/16 inch) back from the face of the flange.

4.3.4.3 The flange face shall be protected from weld spatter.

4.3.5 Seal Welding

4.3.5.1 Seal welding of threaded joints shall be permitted only if specified by the owner, inspector, or purchaser.

4.3.5.2 Both male and female threads shall be free of oil and joint sealant, and the threads shall be fully engaged.

4.3.5.3 All exposed threads shall be covered by the weld metal.

4.3.6 Backing Rings and Inserts

4.3.6.1 Permanent backing rings shall not be permitted.

4.3.6.2 Consumable inserts shall be permitted with the owner’s approval.

4.3.6.3 Consumable inserts, if approved by owner, shall be in accordance with the Code, Paragraph 328.3.3.

4.4 Branch Connections

4.4.1 Unless otherwise specified in the contract documents, 90-degree branch connections shall be in accordance with the branch connection chart in the applicable piping material specification.

4.4.2 Unless otherwise specified in the contract documents, welding of unreinforced stub-ins shall be in accordance with the Code, Figure 328.5.4D(2).

4.4.3 Reinforced Stub-Ins

4.4.3.1 Reinforcing pads shall be of the same nominal composition and properties as the header (run) pipe.

4.4.3.2 Each reinforcing pad, or separately welded portion of the pad, shall have a 6 mm (1/4 inch) diameter vent hole drilled before installation of the pad. Vent hole shall be provided at side of reinforcing pad, not at crotch in accordance with the Code, Paragraph 328.5.4 (g).

4.4.3.3 All required pipe examinations and repairs shall be completed and approved before reinforcing pads are welded onto the pipe.

4.4.3.4 Unless otherwise specified in the contract documents, welding shall be in accordance with the Code, Figure 328.5.4D(4).

4.5 Machined Surfaces

4.5.1 Machined surfaces (e.g., flange faces) shall be protected from damage and deterioration during all operations.

4.5.2 Damaged machined surfaces shall be repaired, or the component shall be replaced. See Section 4.2.4 of this Practice.
4.6 Forming and Bending
4.6.1 Cold bends shall be in accordance with the *Code*, Paragraph 332.
4.6.2 Induction bends shall be in accordance with the *Code*, Paragraph 332.
4.6.3 Induction bending performed below the upper transformation temperature shall be in accordance with the *Code* requirements for cold bending.
4.6.4 Unless otherwise specified in the contract documents, tolerances for dimensions of pipe bends shall be in accordance with *PFI Standard ES-24* or the *Code*, Paragraph 332.2.1.

4.7 Flanges
4.7.1 Unless otherwise specified, bolt holes of fixed flanges shall be oriented as follows:
   a. Vertical flange faces: A pair of bolt holes shall straddle the vertical centerline
   b. Horizontal flange faces: A pair of bolt holes shall straddle the plant north-south centerline
   c. Sloping flange faces: A pair of bolt holes shall straddle the plane defined by the centerline of the pipe and a vertical line
4.7.2 Lapped flanges shall be prevented from sliding back more than 13 mm (1/2 inch) by two or more evenly spaced weld buttons or other means that do not hinder rotation.

4.8 Orifice Runs
4.8.1 Welding neck orifice flanges shall have the same bore as the pipe.
4.8.2 Orifice runs shall not contain welds except at the flanges.
4.8.3 Welds at orifice flanges shall be ground or machined smooth and flush on the inside of the pipe.

4.9 Cleaning
4.9.1 Fabricated assemblies shall be cleaned and completely drained of all liquid after fabrication and examination in accordance with *PFI Standard ES-5*, Standard Cleaning.
4.9.2 Water used to clean piping shall be completely removed and the piping dried.
4.9.3 Water used to clean stainless steel piping shall contain 50 ppm chlorides maximum.
4.9.4 Flange faces shall be cleaned of any applied paint or coating using a method that shall not damage the machined surface.

4.10 Examination and Testing
4.10.1 General
4.10.1.1 Examinations shall be performed after required heat treatment and before leak testing.
4.10.1.2 External and accessible internal surfaces of joints and components to be examined shall be free of rust, scale, weld flux or spatter, and paint.
The surfaces shall be ground if necessary, to eliminate irregularities that can obscure or confuse the interpretation of imperfections.

4.10.1.3 Examinations shall be performed in accordance with a written procedure as required by the Code, Paragraph 343. The procedure, with evidence of its qualification, shall be submitted to the owner, inspector, and purchaser for approval.

4.10.1.4 All examination personnel shall be qualified in accordance with the Code, Paragraph 342, and approved by the owner, inspector, and purchaser.

4.10.1.5 Acceptance criteria for welds are those stated in “Criterion Value Notes” to the Code, Table 341.3.2. Acceptance criteria for examination of other materials, components, and workmanship stated elsewhere in the Code or in the applicable reference specification shall also be followed.

4.10.1.6 Any items rejected because of defects shall be repaired or replaced and re-examined in accordance with this Practice and the Code, Paragraph 341.3.3.

4.10.1.7 Examination requirements for Normal fluid service, category D, severe cyclic conditions, and elevated temperature fluids shall be in accordance with the Code, Paragraphs 341.4 and 341.5, and Section 4.10.3 of this Practice.

4.10.2 Examination Methods

4.10.2.1 General

1. Visual examination, including any in-process examination, shall be performed and repairs made before any other examinations are performed.

2. Methods of examination shall be in accordance with the BPV Code, Section V, except as modified in this Practice. BPV Code, Section V, Article 1 shall apply to all methods of examination included in this Practice.

3. The owner, inspector, and purchaser shall retain the right to designate the piping that shall be randomly tested.

4.10.2.2 Visual Examination (VT)

1. Direct Examination

   a. Mirrors, magnifying lenses, and supplementary illumination may be used to aid direct vision, within 600 mm (24 inches) and at least a 30-degree angle from the surface to be examined. Rulers, calipers, and other instruments may be used to evaluate imperfections.

   b. Qualified examiners shall have passed an examination within the preceding 12 months demonstrating ability to read J-1 letters on a standard Jaeger near-vision chart.
2. Indirect Examination
   a. Indirect examination may be used to resolve uncertainties from direct examination or if specified by the owner.
   b. Devices such as telescopes, borescopes, fiber optics, and remote-operated cameras may be used.

3. In-Process Examination
   a. In-process examination shall be performed in accordance with the Code, Paragraph 344.7.
   b. The method of visual examination shall be in accordance with the BPV Code, Section V, Article 9.

4.10.2.3 Radiographic Examination (RT)
   1. The method of radiographic examination shall be in accordance with the BPV Code, Section V, Article 2, and BPV Code, Section V, Article 22.
   2. If the BPV Code permits, and the owner or inspector approves, ultrasonic examination may be substituted for radiography.

4.10.2.4 Liquid Penetrant Examination (PT)
   1. Materials
      a. Only visible post-emulsifiable penetrants shall be used. See ASTM E165, Procedure B-2.
      b. Penetrant products shall be subject to the owner, inspector, or purchaser’s approval.
      c. If more than one penetrant manufacturer’s products or product lines are approved, intermixing of the products shall not be permitted.
   2. The method of liquid penetrant examination shall be in accordance with the BPV Code, Section V, Article 6, and BPV Code, Section V, Article 24.

4.10.2.5 Ultrasonic Examination (UT)
   The method of ultrasonic examination shall be in accordance with the BPV Code, Section V, Article 5.

4.10.2.6 Magnetic Particle Examination (MT)
   The method of magnetic particle examination shall be in accordance with the BPV Code, Section V, Article 7.

4.10.3 Examination Types

Comment: The examination symbols shown in this Section are used to indicate the type and extent of examination required for each piping system. Recommended examination symbols by fluid service type are provided in PIP PNE00012.
4.10.3.1 Examination “D”

1. A minimum 20 percent random visual examination of materials, components, fabrication, joint assembly, and alignment and supports during or after erection.

2. If pneumatic testing is specified, visual examination of 100 percent of bolted and threaded joints.

3. If a defect is found, progressive examination in accordance with the Code, Paragraph 341.3.4.

4.10.3.2 Examination “N”

1. A minimum of 20 percent random visual examination of materials, components, fabrication, joint assembly, and alignment and supports during or after erection.

2. Visual examination of 100 percent of longitudinal welds made during fabrication.

3. If pneumatic testing is specified, visual examination of 100 percent of bolted and threaded joints.

4. A minimum of 5 percent random radiographic examination of circumferential butt and miter welds. The work product of each welder and welding operator shall be included in random sample.

5. If a defect is found, progressive examination in accordance with the Code, Paragraph 341.3.4.

4.10.3.3 Examination “S”

1. Visual examination of 100 percent of materials, components, fabrication, joint assembly, and of alignment and supports during or after erection.

2. Radiographic examination of 100 percent of circumferential butt and miter welds, and of branch connections similar to those shown in the Code, Figure 328.5.4E.

3. Examination of 100 percent of all other pressure-containing welds by the liquid penetrant method.

4.10.3.4 Examination “M”

1. Visual examination of 100 percent of materials, components, fabrication, joint assembly, and of alignment and supports during or after erection.

2. Visual examination of 100 percent of longitudinal welds.

3. A minimum of 20 percent random radiographic examination of circumferential butt and miter welds. The work product of each welder and welding operator shall be included in random sample.
4. If a defect is found, progressive examination in accordance with the Code, Paragraph 341.3.4.

4.10.3.5 Examination “T”

1. A minimum of 20 percent random visual examination of materials and components for pipe fabrication.

2. Visual examination of 100 percent of all fabrication, joint assembly, and of alignment and supports during or after erection.

3. Visual examination of 100 percent of longitudinal welds.

4. Radiographic examination of 100 percent of circumferential butt and miter welds, and of branch connections similar to those shown in the Code, Figure 328.5.4E.

5. If a defect is found, progressive examination in accordance with the Code, Paragraph 341.3.4.

4.10.3.6 Examination “C”

1. See Sections 4.10.3.1, 4.10.3.2, 4.10.3.3, 4.10.3.4, and 4.10.3.5 as they apply to high purity pipe systems.

2. Borescope is an acceptable method for visual examination. See the Code, Paragraph U344.2.

3. If orbital welding practices are used in fabrication, weld coupons may be utilized in lieu of radiography or ultrasonic examinations. See the Code, Paragraphs U341.4 and U344.8.

4.10.4 Leak Testing

Leak testing shall be performed in accordance with PIP PNSC0021.

4.11 Heat Treatment

4.11.1 General

4.11.1.1 The supplier shall be responsible for determining if heat treatment is required by the Code.

4.11.1.2 Using the process for heat treating a piping system shall be specified by the owner.

4.11.1.3 Particular care shall be exercised in determining the requirements for PWHT of branch outlet fittings (e.g., o’let type fittings) in accordance with the Code, Paragraph 331.1.3 because the dimensions through the welds can differ between manufacturers’ fittings.

4.11.2 Preparation for Heat Treatment

4.11.2.1 Spool pieces shall be fully fabricated including the attachment of welded pipe support components.

4.11.2.2 Specified examinations shall be complete.
4.11.2.3 If P-Numbers 3, 4, or 5 material is to be heat treated, examination shall follow heat treatment, as specified in the Code, Paragraph 341.3.1a.

4.11.2.4 Weld end valves shall be locally heat treated only. If recommended by the valve manufacturer, heat-sensitive parts (e.g., PTFE packing, seats, or gaskets) of weld end valves shall be removed, and bonnets or covers shall be reassembled with new gaskets.

4.11.2.5 Thermocouples and the multipoint temperature recorder shall be calibrated to within 3°C (5°F) of actual temperature in the specified range.

4.11.3 Furnace Heat Treatment

4.11.3.1 General

1. Direct flame impingement on the piping shall not be permitted.

2. The furnace atmosphere shall be controlled during heating and holding periods to minimize surface oxidation.

4.11.3.2 Preparation

1. In addition to the preparations specified in Section 4.11.2, piping shall be supported so that expansion and contraction shall not be hindered and dimensional tolerances shall be maintained after heat treatment.

2. For a large, complex spool that cannot fit in the furnace:
   a. The spool shall be fabricated in pieces.
   b. The pieces shall be furnace heat treated and welded.
   c. The assembly welds shall be locally heat treated.

4.11.3.3 Heating and Cooling

1. Unless otherwise specified in the contract documents, temperature, holding time, and cooling rate for stress relieving heat treatment of materials shall be in accordance with the Code, Table 331.1.1.

2. For temperatures greater than 315°C (600°F), cooling rate shall not be greater than 260°C (500°F) per hour.

3. For temperatures less than 315°C (600°F), cooling in still air may be permitted.

4.11.3.4 Temperature Measurement and Control

1. Two or more thermocouples shall be used to measure and record the entire heat treating cycle.

2. A sufficient number of thermocouples shall be distributed on the thicker parts of weldments and pipe to ensure uniformity of temperature throughout the heat treatment batch.
3. Unless otherwise specified in the contract documents, for temperature uniformity, the differential between any two thermocouples shall not be greater than:
   a. 83°C (150°F) for the heating period
   b. 14°C (25°F) for the hold period
   c. 56°C (100°F) for the cooling period.

4. Controlling thermocouples shall be attached to the pipe.

4.11.3.5 Acceptance Criteria

1. A minimum of 10 percent of welds per furnace load shall be hardness tested after heat treatment in accordance with the Code, Paragraph 331.1.7.

2. Hardness shall not be greater than the value in the Code, Table 331.1.1.

3. If heat treatment is performed for service reasons, the hardness testing and acceptance requirements shall be as specified by the owner.

4.11.4 Local Heat Treatment

4.11.4.1 General

1. Piping welds and hot forming that require heat treatment but cannot be furnace heat treated, shall be locally heat treated by either induction or electric resistance heating.

2. Rosebud flame heating shall not be permitted.

3. Unless otherwise specified in the contract documents, the requirements in Section 4.11.4 shall apply to each weld.

4.11.4.2 Heating and Cooling Requirements

See Section 4.11.3.3 of this Practice.

4.11.4.3 Temperature Measurement and Control

1. The minimum number of equally spaced thermocouples for each weld shall be the greater of separately controlled heating zones and the numbers of thermocouples shown in Table 1 for each pipe size range.

<table>
<thead>
<tr>
<th>Pipe Size Range</th>
<th>Number of Thermocouples</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPS 10 and less</td>
<td>1</td>
</tr>
<tr>
<td>NPS 12 through NPS 16</td>
<td>2</td>
</tr>
<tr>
<td>NPS 18 through NPS 28</td>
<td>3</td>
</tr>
<tr>
<td>NPS 30 and larger</td>
<td>4</td>
</tr>
</tbody>
</table>
2. The measured temperature differential among all thermocouples during cooling shall not be greater than 56°C (100°F).

3. Local heat treatment shall extend a minimum of 25 mm (1 inch) beyond the required pipe section heating band as indicated in the Code, Paragraph 331.2.6.

4.11.4.4 Thermal Insulation
An insulating blanket compatible with the heat treating temperature shall be used to ensure uniform temperature.

4.11.4.5 Acceptance Criteria
1. Every local heat-treated weld shall be hardness tested after heat treatment in accordance with the Code, Paragraph 331.1.7.

2. Hardness shall not be greater than the value in the Code, Table 331.1.1.

3. If heat treatment is performed for service reasons, the hardness shall be as specified by the owner.

4.11.5 Threads and Machined Surfaces
4.11.5.1 All threaded ends shall be gauge-checked for fit and roundness following heat treatment. If the thread is not acceptable, the thread shall be chased with a tap or die.

4.11.5.2 Threads and machined surfaces shall be protected from oxidation during heat treatment.

4.12 Painting
4.12.1 Piping shall be painted only if specified by the owner or purchaser.

4.12.2 Painting shall be in accordance with the specifications furnished by owner or purchaser.

4.12.3 Flange faces, pipe ends to be field welded, and pipe threads shall not be painted.

4.13 Marking
4.13.1 An identification number shall be plainly marked on each fabricated section.

Comment: Bar coding is an acceptable means of identification.

4.13.2 Stamping of piece mark numbers or of any identification other than the welder’s mark (see Section 4.3.1 of this Practice) shall not be permitted.

4.13.3 Carbon steel piping shall be marked in white, other metallic piping in red.

4.13.4 For stainless steel and nickel alloy piping, marking paint or ink shall not contain chlorides, metals (e.g., zinc, lead, or copper), or metal salts that could cause corrosive attack on the piping.
4.13.5 If adhesive labels are used on stainless steel or nickel alloy piping, the labels shall have a chloride-free adhesive, or the piping shall have a protective barrier of paint containing no chlorides, metals or metal salts.

4.14 Shipping and Storage

4.14.1 Flange faces shall be protected from damage during shipment and storage by wood or plastic covers bolted, snapped, or wired on.

4.14.2 Carbon steel flange faces shall be kept rust-free.

4.14.3 Pipe ends shall be covered by durable self-fastening plastic covers.

4.14.4 Threaded nipples, couplings, and bosses shall be protected with metal or plastic thread protectors.

4.15 Documentation

4.15.1 Unless otherwise specified in the contract documents, documentation required by the Code, and any other documentation required by the owner or inspector shall be retained by the supplier.

4.15.2 Documentation retention times shall be in accordance with owner requirements.

4.15.3 The documentation shall be made available to the owner, inspector, and purchaser upon request.

4.15.4 A copy of each WPS, Procedure Qualification Record, and the qualification record of each welder and welding operator shall be available and shall be provided to the owner, inspector, and purchaser if requested.

4.15.5 Documentation shall be provided to the owner, inspector, and purchaser stating the types of examination applied to each piping system and/or pipe spool and recording defects and corrective measures applied.

4.15.6 Documentation shall be provided to the owner, inspector, and purchaser certifying the specified heat treatment of all piping covered by this Practice, including the following information:

   a. All temperature charts, properly identified and dated, with a list of spools and components to which each chart applies.

   b. A description of the equipment used and calibration dates of thermocouples and the recorder.

   c. Hardness test results.