Areas where grinding reduces the remaining wall thickness to less than the design thickness calculated in accordance with para. 404.1.2, decreased by an amount equal to the manufacturing tolerance applicable to the pipe or component, should be analyzed using an appropriate fitness-for-purpose criterion [see para. 451.6.2.2(b)]. The remaining wall thickness after grinding shall not be less than 60% of the nominal wall thickness of the pipe.

If grinding is to be the sole means of repair of a dent containing cracks or other stress risers, the cracks, stress risers, or other defects must be completely removed and the remaining wall thickness after grinding shall not be less than 87.5% of the nominal wall thickness of the pipe. If the remaining wall thickness after grinding is less than 87.5% of the nominal wall thickness of the pipe, another acceptable repair method shall be used.

(c) Deposited Weld Metal. Defects in welds produced with a filler metal, small corroded areas, gouges, grooves, and arc burns may be repaired by depositing weld metal provided that they are not located within the confines of an indented region of the pipe. The welding processes shall be in accordance with the appropriate pipe specification for the grade and type of pipe being repaired. Weld imperfections, arc burns, gouges, and grooves shall be removed by grinding prior to depositing the weld filler metal. The qualification test for welding procedures to be used on pipe containing a liquid shall include the cooling effects of the pipe contents on the soundness and physical properties of the weld. Welding procedures on pipe not containing liquid shall be qualified in accordance with para. 434.8.3. A welding procedure specification for repairing by means of deposited weld metal shall be established. The welding procedure specification shall define the minimum allowable remaining wall thickness in areas where weld deposition is to be used and the appropriate value of pressure in the carrier pipe during this type of repair. Low hydrogen electrodes shall be used to prevent hydrogen cracking in carbon steel materials.

(d) Full-Encirclement Sleeves. Repairs may be made by the installation of a full encirclement welded split sleeve. Sleeve configurations may be one of the following:

(1) Nonpressure Containing Sleeve Configuration (Type A). For full encirclement split sleeves installed for repair by reinforcement only and not internal pressure containment, circumferential welding of the ends is not allowed. A hardenable filler material such as non-shrink epoxy shall be used to fill any voids that exist between the sleeve and the defective area being repaired. The ends of the sleeve shall extend past the edge of the defect for a minimum of 2 in. (50 mm). When a reinforcing sleeve is used for defects with length less than $L$, as defined in the following equation, the thickness of the sleeve material may be a minimum of two-thirds that of the carrier pipe. For flaws with length greater than
### Table 451.6.2.9-1  Acceptable Pipeline Repair Methods
(Nonindented, Nonwrinkled, and Nonbuckled Pipe)

<table>
<thead>
<tr>
<th>Type of Defect</th>
<th>1 Replace as Cylinder</th>
<th>2 Removal by Grinding</th>
<th>3 Deposition of Weld Metal</th>
<th>4a Reinforcing Full Encirclement Sleeve (Type A)</th>
<th>4b Pressure Containing Full Encirclement Sleeve (Type B)</th>
<th>5 Composite Sleeve</th>
<th>6 Mechanical Bolt-On Clamps</th>
<th>7 Hot Tap</th>
<th>8 Fittings</th>
</tr>
</thead>
<tbody>
<tr>
<td>External corrosion ≤ 80% t</td>
<td>Yes [Note (1)]</td>
<td>No</td>
<td>Limited [Note (2)]</td>
<td>Limited [Note (3)]</td>
<td>Yes [Note (3)]</td>
<td>Yes</td>
<td>Yes [Note (4)]</td>
<td>Limited [Note (4)]</td>
<td>Limited [Note (5)]</td>
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<tr>
<td>(excluding grooving, selective, or preferential corrosion of ERW, EFW seams)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>External corrosion &gt; 80% t</td>
<td>Yes [Note (1)]</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes [Note (4)]</td>
<td>Limited [Note (4)]</td>
<td>Limited [Note (5)]</td>
</tr>
<tr>
<td>Internal corrosion ≤ 80% t</td>
<td>Yes [Note (1)]</td>
<td>No</td>
<td>No</td>
<td>Limited [Note (6)]</td>
<td>Yes [Note (6)]</td>
<td>Yes</td>
<td>Limited [Note (4)]</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Internal corrosion &gt; 80% t</td>
<td>Yes [Note (1)]</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes [Note (4)]</td>
<td>No</td>
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<tr>
<td>Grooving, selective or preferential corrosion of ERW, EFW seam</td>
<td>Yes [Note (1)]</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes [Note (4)]</td>
<td>No</td>
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<tr>
<td>Gouge, groove, or arc burn</td>
<td>Yes [Note (1)]</td>
<td>Limited [Note (7)]</td>
<td>No</td>
<td>Limited [Notes (3),(8)]</td>
<td>Yes [Notes (3),(8)]</td>
<td>Yes</td>
<td>Limited [Note (4)]</td>
<td>Limited [Notes (6),(5)]</td>
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<tr>
<td>Crack</td>
<td>Yes [Note (1)]</td>
<td>Limited [Note (7)]</td>
<td>No</td>
<td>Limited [Note (7)]</td>
<td>Yes [Note (7)]</td>
<td>Yes</td>
<td>Limited [Note (4)]</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Hard spot</td>
<td>Yes [Note (1)]</td>
<td>No</td>
<td>No</td>
<td>Limited [Note (7)]</td>
<td>Yes [Note (7)]</td>
<td>Yes</td>
<td>Limited [Note (4)]</td>
<td>No</td>
<td></td>
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<tr>
<td>Blisters</td>
<td>Yes [Note (1)]</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes [Note (4)]</td>
<td>No</td>
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<tr>
<td>Defective girth weld</td>
<td>Yes [Note (1)]</td>
<td>No</td>
<td>Limited [Note (2)]</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes [Note (4)]</td>
<td>No</td>
<td></td>
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<tr>
<td>Lamination</td>
<td>Yes [Note (1)]</td>
<td>No</td>
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<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes [Note (4)]</td>
<td>No</td>
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</table>

*Note: Limited [Notes (2),(7)]
Table 451.6.2.9-1  Acceptable Pipeline Repair Methods  
(Nonindented, Nonwrinkled, and Nonbuckled Pipe) (Cont'd)

**NOTES:**

1. Replacement pipe should have a minimum length of one-half of its diameter or 3 in. (76.2 mm), whichever is greater, and shall meet or exceed the same design requirements as those of the carrier pipe.

2. The welding-procedure specification shall define minimum remaining wall thickness in the area to be repaired and maximum level of internal pressure during repair. Low-hydrogen welding process must be used.

3. Tight-fitting sleeve at area of defect must be assured or a hardenable filler such as epoxy or polyester resin shall be used to fill the void or annular space between the pipe and the repair sleeve.

4. Defect must be contained entirely within the area of the largest possible coupon of material that can be removed through the hot-tap fitting.

5. The defect shall be contained entirely within the fitting and the fitting size shall not exceed NPS 3.

6. May be used only if internal corrosion is successfully mitigated.

7. Gouge, groove, arc burn, or crack must be entirely removed without penetrating more than 40% of the wall thickness. The allowable length of metal removal is to be determined by para. 451.6.2.2(a). Removal of gouge, groove, arc burn, or crack must be verified by visual and magnetic-particle or dye-penetrant inspection (plus etchant in the case of arc burns).

8. May be used only if gouge, groove, arc burn, or crack is entirely removed and removal is verified by visual and magnetic-particle or dye-penetrant inspection (plus etchant in the case of arc burns).
Item 11-1644 - Offshore Design Limits on Axial Stress Due to Use of Von Mises

Description
Remove longitudinal stress limitation for offshore risers.

Explanation
The axial stress limitation to 80% in section A402.3.5 (2) results in an underutilization of riser wall thickness as compared to the true limit state (Von Mises Stress Envelope).

For a riser, the hoop stress will always be < 60% of SMYS, so with an allowable longitudinal stress of 80% of SMYS, the maximum equivalent (Von Misses Stress) could only reach 72% SMYS (versus code allowable of 90% SMYS). In some cases, this has required an increase in wall thickness of up to 20%. This can add 10% or more to the weight of the riser, increases pay load, welding time, and does not significantly enhance the safety of the riser.

In the attached background information further explanation is given to the above with illustrative graphs and tables.

As a short-term fix, it is proposed to add references to API Std 2RD - Dynamic Risers for Floating Production Systems - 2nd Ed 2013 and DNVGL-ST-F201 Dynamic risers to Paragraph A400 to allow the user to bring in additional industry guidance to their design

In support of this change it should be noted that this will not increase the risk or compromise the safety of offshore riser systems since the actual combined stress will not be approaching the limit state of the material (0.9*SMYS). In fact, this change will allow more streamlined (i.e. lighter) riser designs reducing the construction and also operational risk because of excessively heavy equipment.

Upon completion of this item, a new item will be opened to perform a holistic review of the offshore stress equations in light of these referenced standards, Item 11-1639, Item 17-484 and Item 15-2143 (B31.8). It would be expected that this full review would be completed with B31.8 as appropriate.

Proposal

A400 GENERAL STATEMENTS

(a) Chapter IX pertains only to offshore pipeline systems as defined in para. A400.1.

(b) This Chapter is organized to parallel the numbering and content of the first eight chapters of the Code. Paragraph designations are the same as those in the first eight chapters, with the prefix “A.”

(c) All provisions of the first eight chapters of the Code are also requirements of this Chapter unless specifically modified herein. If the text in this Chapter adds requirements, the requirements in the original Chapter with the same title and number also apply. If a provision in this Chapter is in conflict with one or more provisions in other chapters, the provision in this Chapter shall apply.

(d) It is the intent of this Chapter to provide requirements for the safe and reliable design, installation, and operation of offshore liquid pipeline systems. It is not the intent of this Chapter to be all inclusive. Engineering judgment must be used to identify special considerations that are not specifically addressed. API RP 1111, API Std 2RD, and
DNVGL-ST-F201 may be used as a guide. It is not the intent of this Chapter to prevent the development and application of new equipment and technology. Such activity is encouraged as long as the safety and reliability requirements of the Code are satisfied.
MANDATORY APPENDIX I
REFERENCED STANDARDS

Specific editions of standards incorporated in this Code by reference, and the names and addresses of the sponsoring organizations, are shown in this Mandatory Appendix. It is not practical to refer to a specific edition of each standard throughout the Code text; instead, the specific edition reference dates are shown here. Mandatory Appendix I will be revised at intervals as needed. An asterisk (*) is used to indicate those standards that have been accepted as American National Standards by the American National Standards Institute (ANSI). For ASME codes and standards, the latest published edition in effect at the time this Code is specified is the specific edition referenced by this Code unless otherwise specified in the design.

<table>
<thead>
<tr>
<th>API Standards and Other Publications</th>
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<th>ASME Codes and Standards (Cont'd)</th>
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<tr>
<td>[Note (1)]</td>
<td>*RP 1110, 5th Ed., 2007</td>
<td>*B36.10M</td>
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<td>(Incorporates 5L1, 5L5, and 5L6)</td>
<td>RP 1130, 1st Ed., 2007</td>
<td>ASTM Specifications</td>
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<td>*Spec. 12D, 11th Ed., 2008</td>
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<td>A53/A53M-07</td>
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<td>ASME Codes and Standards</td>
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<td>A105/A105M-05</td>
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<td>*B1.1</td>
<td>A106/A106M-08 [Note (3)]</td>
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<td>*B1.20.1</td>
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<td>[Note (2)]</td>
<td>A216/A216M-07</td>
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FOR ASME COMMITTEE USE ONLY
### REFERENCED STANDARDS (CONT’D)

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**GENERAL NOTE:** The issue date shown immediately following the number of the standard (e.g., A53/A53M-07 and SP-6-2007) is the effective date of issue (edition) of the standard.

**NOTES:**

1. Use of bell and spigot line pipe not permitted.
2. Limited as set forth in para. 402.2.1.
3. Approved only if mill hydrostatic test is performed.
4. A420/A420M Grade WPL9 is not suitable for anhydrous ammonia due to copper content.

Titles of standards and specifications listed above that are referenced in the text but do not appear in Table 423.1-1 — Material Standards or Table 426.1-1 — Dimensional Standards are as follows:

<table>
<thead>
<tr>
<th>API</th>
<th>Manual of Petroleum Measurement Standards</th>
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<tr>
<td>API</td>
<td>Recommended Practice for Planning, Designing, and Constructing Fixed Offshore Platforms — Working Stress Design</td>
</tr>
<tr>
<td>API</td>
<td>Recommended Practice for Railroad Transportation of Line Pipe</td>
</tr>
<tr>
<td>API</td>
<td>Recommended Practice for Transportation of Line Pipe on Barges and Marine Vessels</td>
</tr>
<tr>
<td>API</td>
<td>Specification for Bolted Tanks for Storage of Production Liquids</td>
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<td>API</td>
<td>Specification for Field Welded Tanks for Storage of Production Liquids</td>
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<td>Specification for Shop Welded Tanks for Storage of Production Liquids</td>
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<td>API</td>
<td>Recommended Practice for Flexible Pipe</td>
</tr>
<tr>
<td>API</td>
<td>Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Division 1 and Division 2</td>
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<tr>
<td>API</td>
<td>Design and Construction of Large, Welded, Low-Pressure Storage Tanks</td>
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<td>API</td>
<td>Welded Tanks for Oil Storage</td>
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<td>API</td>
<td>Steel Pipelines Crossing Railroads and Highways</td>
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<td>API</td>
<td>Welding of Pipelines and Related Facilities</td>
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<td>API</td>
<td>Marking Liquid Petroleum Pipeline Facilities</td>
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<td>API</td>
<td>Pressure Testing of Steel Pipelines for the Transportation of Gas, Petroleum Gas, Hazardous Liquids, Highly Volatile Liquids, or Carbon Dioxide</td>
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<td>API</td>
<td>Design, Construction, Operation, and Maintenance of Offshore Hydrocarbon Pipelines (Limit State Design)</td>
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<td>API</td>
<td>Computational Pipeline Monitoring for Liquids</td>
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<td>API</td>
<td>Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks</td>
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<td>API</td>
<td>Repairing Crude Oil, Liquefied Petroleum Gas, and Product Pipelines</td>
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<tr>
<td>API</td>
<td>Safe Hot Tapping Practices in the Petroleum and Petrochemical Industries</td>
</tr>
<tr>
<td>ASME</td>
<td>Boiler and Pressure Vessel Code, Section VIII Division 1 Pressure Vessels, Section VIII Division 2 Alternative Rules for Pressure Vessels, and Section IX Welding, Brazing, and Fusing Qualifications</td>
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### REFERENCED STANDARDS (CONT'D)

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<th>Notes</th>
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<tbody>
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<td>ASME B31G</td>
<td>Manual for Determining the Remaining Strength of Corroded Pipelines: A Supplement to B31, Code for Pressure Piping</td>
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<tr>
<td>ASME B31T</td>
<td>Standard Toughness Requirements for Piping</td>
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<td>ASME B31.5</td>
<td>Refrigeration Piping</td>
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<td>ASME PCC-2</td>
<td>Repair of Pressure Equipment and Piping</td>
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<td>AWS A3.0</td>
<td>Welding Terms and Definitions</td>
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<td>AWS D3.6</td>
<td>Specification for Underwater Welding</td>
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<td>EPRI EL-3106</td>
<td>Safety of Pipelines in Close Proximity to Electrical Transmission Lines</td>
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<td>NACE 57519</td>
<td>Corrosion Data Survey — Metals Section</td>
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<tr>
<td>NACE MR0175</td>
<td>Sulfide Stress Cracking Resistant Metallic Materials for Oil Field Equipment</td>
</tr>
<tr>
<td>NACE SP0169</td>
<td>Standard Practice — Control of External Corrosion on Underground or Submerged Metallic Piping Systems</td>
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<td>NACE SP0177</td>
<td>Standard Practice — Mitigation of Alternating Current and Lightning Effects on Metallic Structures and Corrosion Control Systems</td>
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<td>NACE SP0185</td>
<td>Standard Practice — Extruded Polyolefin Resin Coating Systems With Soft Adhesives for Underground or Submerged Pipe</td>
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<td>NACE SP0188</td>
<td>Standard Practice — Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates</td>
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<tr>
<td>NACE RP0192</td>
<td>Recommended Practice — Monitoring Corrosion in Oil and Gas Production With Iron Counts</td>
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<td>NACE RP0200</td>
<td>Standard Practice — Steel-Based Pipeline Practices</td>
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<tr>
<td>NACE RP0274</td>
<td>Recommended Practice — High-Voltage Electrical Inspection of Pipeline Coatings Counts</td>
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<td>NACE RP0286</td>
<td>Recommended Practice — Electrical Isolation of Cathodically Protected Pipelines</td>
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<td>NACE RP0303</td>
<td>Recommended Practice — Field-Applied Heat-Shrinkable Sleeves for Pipelines: Application, Performance, and Quality Control</td>
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<td>NACE RP0375</td>
<td>Recommended Practice — Wax Coating Systems for Underground Piping Systems</td>
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<td>Recommended Practice — Application, Performance, and Quality Control of Plant-Applied, Fusion-Bonded Epoxy External Pipe Coating</td>
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<tr>
<td>NACE RP0399</td>
<td>Recommended Practice — Plant-Applied, External Coal Tar Enamel Pipe Coating Systems: Application, Performance, and Quality Control</td>
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<tr>
<td>NACE RP0402</td>
<td>Recommended Practice — Field-Applied Fusion-Bonded Epoxy (FBE) Pipe Coating Systems for Girth Weld Joints: Application, Performance, and Quality Control</td>
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<td>NACE SP0490</td>
<td>Standard Practice — Holiday Detection of Fusion-Bonded Epoxy External Pipeline Coatings of 250 to 760 μm (10 to 30 mils)</td>
</tr>
<tr>
<td>NACE RP0602</td>
<td>Recommended Practice — Field-Applied Coal Tar Enamel Pipe Coating Systems: Application, Performance, and Quality Control</td>
</tr>
<tr>
<td>NFPA 30</td>
<td>Flammable and Combustible Liquids Code</td>
</tr>
<tr>
<td>NFPA 70</td>
<td>National Electrical Code</td>
</tr>
</tbody>
</table>

Specifications and standards of the following organizations appear in Mandatory Appendix I:

- **ANSI** (American National Standards Institute)
  - 25 West 43rd Street, 4th Floor
  - New York, NY 10036
  - Phone: 212 642-4900
  - Fax: 212 398-0023
  - www.ansi.org

- **API** (American Petroleum Institute)
  - 1220 L Street, NW
  - Washington, DC 20005-4070
  - Phone: 202 682-8000
  - www.api.org

- **ASME** (The American Society of Mechanical Engineers)
  - Two Park Avenue
  - New York, NY 10016-5990
  - Phone: 973 882-1167
  - Fax: 973 882-1717, 5155
  - www.asme.org

- **ASTM** (American Society for Testing and Materials)
  - 100 Barr Harbor Drive
  - P.O. Box C700
  - West Conshohocken, PA 19428-2959
  - Phone: 610 832-9500
  - Fax: 610 832-9555
  - www.astm.org

- **AWS** (American Welding Society)
  - 8669 NW 36 Street, No. 130
  - Miami, FL 33166
  - Phone: 305 443-9353 or 800 443-9353
  - www.aws.org

- **EPRI** (Electric Power Research Institute)
  - 3420 Hillview Avenue
  - Palo Alto, CA 94304
  - Phone: 650 855-2121
  - www.epri.org

- **MSS** (Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.)
  - 127 Park Street, NE
  - Vienna, VA 22180-4602
  - Phone: 703 281-6613
  - www.mss-hq.com

- **NACE** (NACE International)
  - 1440 South Creek Drive
  - Houston, TX 77084-4906
  - Phone: 218 228-6200
  - www.nace.org

- **NFPA** (National Fire Protection Association)
  - 1 Batterymarch Park
  - Quincy, MA 02169-7471
  - Phone: 617 770-3000 or 800 344-3555
  - Fax: 617 770-0700
  - www.nfpa.org

- **DNV GL**
  - Veritasveien 1
  - 1363 Hovik
  - Norway
  - www.dnvgl.com
Item 14-444 - Revision to para A451.6 Pipeline Integrity Assessment and Repair

Description
To review the Offshore sections of the Code to consider new and existing inspection technology in the Pipeline Integrity Assessment and Repair Section

Explanation
The 2012 version of B31.4 has a para. "A451.11 Inspection." This section was changed to "A451.6 Pipeline Integrity Assessment and Repair" for the 2015 edition due to changes earlier in the code. In light of these changes, the intent of the paragraph has changed and warrants updating following publication of the 2015 edition. The changes will include improvements to the sections of the paragraph that are related to inspection and maintenance of risers. See document from Fall 2014 meeting for history of why this item was opened. Original request was to approve a specific company’s process. The request was rejected but showed the committee a location for improvement.

Summary of changes
1) Insertion of an approval to use API 579 / ASME FFS for fit for service assessment
2) Insertion of API 579 / ASME FFS to Appendix I

Proposal
A451.6 Pipeline Integrity Assessment and Repairs

As a means of maintaining the integrity of its pipeline system, each operating company shall establish and implement procedures for continuing surveillance of its facilities. Studies shall be initiated and appropriate action taken when unusual operating and maintenance conditions occur, such as failures, leakage history, unexplained changes in flow or pressure, or substantial changes in cathodic protection requirements.

Consideration should be given to inspection of pipelines and pipeline protection measures in areas most susceptible to damage by outside forces. Such areas may include shore crossings, areas near platforms, shipping fairways, pipeline crossings, span rectifications, subsea assemblies, and shallow water areas. If the operating company discovers that the cover or other conditions do not meet the original design, it shall determine whether the existing conditions are unacceptable. If unacceptable, the operating company shall provide additional protection by replacing cover, lowering the line, installing temporary or permanent warning markers or buoys, or using other suitable means.

When such studies indicate the facility is in an unsatisfactory condition, a planned program shall be initiated to abandon, replace, or repair. If such a facility cannot be repaired or abandoned, the maximum operating pressure shall be reduced commensurate with the requirements described in paras. 451.1(a) and A451.1(a).

Offshore pipeline risers shall be visually inspected annually for physical damage and corrosion in the splash zone and above. Consideration should also be given to periodic visual inspection of the submerged zone of the riser. The extent of any observed damage shall be determined, and if the serviceability of the riser is affected, the riser shall be repaired or replaced.

Consideration should be given to the periodic use of internal or external inspection tools to monitor internal and external pipeline corrosion and to detect other unsafe conditions.
Fitness: For-Service methodologies as outlined in API RP 579-1 / ASME FFS-1 may be used for offshore pipeline systems.
### MANDATORY APPENDIX I

**REFERRED STANDARDS**

Specific editions of standards incorporated in this Code by reference, and the names and addresses of the sponsoring organizations, are shown in this Mandatory Appendix. It is not practical to refer to a specific edition of each standard throughout the Code text; instead, the specific edition reference dates are shown here. Mandatory Appendix I will be revised at intervals as needed. An asterisk (*) is used to indicate those standards that have been accepted as American National Standards by the American National Standards Institute (ANSI). For ASME codes and standards, the latest published edition in effect at the time this Code is specified is the specific edition referenced by this Code unless otherwise specified in the design.

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<tr>
<th>API Standards and Other Publications</th>
<th>ASME Codes and Standards (Sec*6)</th>
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<tr>
<td>Spec. 6D, 1st Ed. 2007 &amp; En. 1-2007</td>
<td>*B16.1W</td>
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<tr>
<td><em>Spec. 12C, 12th Ed., 2003</em></td>
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<td>A105/A105M-05</td>
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<td>Spec. 3, 2nd Ed., 1997</td>
<td>A106/A106M-08 [Nota (3)]</td>
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<td>Spec. 6, 11th Ed., 2005</td>
<td>A139-98 (2005)</td>
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<td>Spec. 6, 11th Ed., 2005 &amp; Add. 1-2009</td>
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<td>Spec. 6, 11th Ed., 2005 &amp; Add. 1-2009</td>
<td>A320/A320M-08</td>
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*RF 575/ASME FFS-1*
Proposed Revision

404.1.2 Components Having Specific Pressure—Temperature Ratings. Within the metal temperature limits of —20°F (—30°C) to 250°F (120°C), pressure ratings for components shall conform to those stated for 100°F (40°C) in material standards and specifications listed in Table 403.2.1-1423.1-1.

The nonmetallic trim, packing, seals, and gaskets shall be made of materials that are not injuriously affected by the fluid in the piping system and shall be capable of withstanding the pressures and temperatures to which they will be subjected in service. Consideration shall be given to possible conditions that may cause low temperatures on pipelines transporting liquids that become gases at or near atmospheric conditions.
Table 423.1-1  Material Standards and Specifications

<table>
<thead>
<tr>
<th>Standard or Specification</th>
<th>Designation</th>
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Table 423.1-1  Material Standards and Specifications (Cont’d)

<table>
<thead>
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<th>Standard or Specification</th>
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<tr>
<td>Current Language</td>
<td>Proposal</td>
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<tr>
<td><strong>437.4.3 Leak Testing</strong></td>
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</tr>
<tr>
<td>A 1 hr hydrostatic or pneumatic leak test may be used for piping systems to be operated at a hoop stress of 20% or less of the specified minimum yield strength of the pipe. The hydrostatic test pressure shall be not less than 1.25 times the internal design pressure. The pneumatic test gage pressure shall be 100 psi (7 bar) or that pressure which would produce a nominal hoop stress of 25% of the specified minimum yield strength of the pipe, whichever is less.</td>
<td>A <em>minimum</em> 1 hr hydrostatic or pneumatic leak test <em>may</em> <em>shall</em> be used for piping systems to be operated at a hoop stress of 20% or less of the specified minimum yield strength of the pipe. The hydrostatic test pressure shall be not less than 1.25 times the internal design pressure. <em>If the required</em> the pneumatic test gage pressure shall be <em>exceeds</em> 100 psi (7 bar), <em>pneumatic testing is not allowed</em>, or that pressure which would produce a nominal hoop stress of 25% of the specified minimum yield strength of the pipe, whichever is less.</td>
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<tr>
<td>Current Language</td>
<td>Proposal</td>
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</tr>
<tr>
<td><strong>434.8.2(a) Welding Processes and Filler Metal</strong>&lt;br&gt;Welding shall be performed by a manual, semiautomatic, or automatic process or combination of processes that have been demonstrated to produce sound welds.</td>
<td><strong>434.8.2(a) Welding Processes and Filler Metal</strong>&lt;br&gt;(a) Welding shall be performed by a process or combination of processes that produce welds that meet the procedure qualification requirements of this Code. <strong>Note:</strong> Welds may be produced by position welding, roll welding, or a combination of position and roll welding.</td>
</tr>
<tr>
<td>Standards Committee comments</td>
<td>Proposed response</td>
</tr>
<tr>
<td>------------------------------</td>
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</tr>
<tr>
<td><strong>TatarF</strong> (Approved)</td>
<td>Period after 403.8.6 will be deleted. Thanks for your comment.</td>
</tr>
<tr>
<td>Date Posted: 09/28/18</td>
<td></td>
</tr>
<tr>
<td>The period that is shown after &quot;403.8.6&quot; needs to be deleted.</td>
<td></td>
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<tr>
<td><strong>FrikkenD</strong> (Disapproved)</td>
<td>The proposed wording is updated below to include your comment. Thank you.</td>
</tr>
<tr>
<td>Date Posted: 10/07/18</td>
<td></td>
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<tr>
<td>The proposed words do not provide for the case where the existing pipeline is adequate and no action beyond calculation is required.</td>
<td></td>
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<tr>
<th>451.9 (a) current language, 2016</th>
<th>451.9 (a) Proposed wording changes</th>
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<tbody>
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<td>451.9 Railroads and Highways Crossing Existing Pipelines</td>
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</tr>
<tr>
<td>(a) When an existing pipeline is to be crossed by a new road or railroad, the operating company shall analyze the pipeline in the area to be crossed in terms of the new anticipated external loads. If the sum of the circumferential stresses caused by internal pressure and newly imposed external loads (including sustained, occasional and transient loads) exceeds 0.90 Sy (specified minimum yield strength), the operating company shall install mechanical reinforcement, structural protection, or suitable pipe to reduce the stress to 0.90 Sy or less, or redistribute the external loads acting on the pipeline. API RP 1102 provides methods that may be used to determine the total stress caused by internal pressure and external loads. API RP 1102 also provides methods to check cyclic stress components for fatigue.</td>
<td>(a) When an existing pipeline is to be crossed by a new road or railroad, the operating company shall analyze the pipeline in the area to be crossed in terms of the new anticipated external loads in accordance with para. 402.8. If the sum of the circumferential stresses caused by internal pressure and newly imposed external loads (including sustained, occasional and transient loads) exceeds 0.90 Sy (specified minimum yield strength), If existing pipeline stresses exceed the allowable stress requirement of 403.8.6, the operating company shall install mechanical reinforcement, structural protection, or suitable pipe to reduce the stress to 0.90 Sy or less, or redistribute the external loads acting on the pipeline. API RP 1102 provides methods that may be used to determine the total stress caused by internal pressure and external loads. API RP 1102 also provides methods to check cyclic stress components for fatigue.</td>
</tr>
</tbody>
</table>
434.18 Line Markers

(a) Except as provided in para. 434.18(d), adequate pipeline location markers for the protection of the pipeline, the public, and persons performing work in the area shall be placed over each buried pipeline in accordance with the following:

(1) Markers shall be located at each public road crossing, at each railroad crossing, at each navigable stream crossing, and in sufficient numbers along the remainder of the buried line so that the pipeline location, including direction of the pipeline, is adequately known. It is recommended that markers are installed on each side of each crossing whenever possible.

(2) Markers shall be installed at locations where the line is aboveground in areas that are accessible to the public.

(b) The marker shall state at least the following on a background of sharply contrasting colors:

(1) The word “Warning,” “Caution,” or “Danger” followed by the words “Petroleum (or the name of the hazardous liquid transported) Pipeline” or “Slurry Pipeline” all of which, except for markers in heavily developed urban areas, shall be in letters at least 1 in. (25.4 mm) high with an approximate stroke of 1/4 in. (6.4 mm).

(2) The name of the operator and a telephone number (including area code) where the operator can be reached at all times.

(c) API RP 1109 should be used for additional guidance.

(d) Unless required by applicable regulatory agencies, line markers are not required for buried pipelines located offshore or under waterways and other bodies of water, or in heavily developed urban areas such as downtown business centers where the placement of markers is impractical and would not serve the purpose for which markers are intended and where the local government maintains substructure records.

435.4.3 Manifold headers with multiple outlets shall have outlets designed as specified in para. 404.3. Assembly may be with the use of jigs to ensure alignment of outlets and flanges with other components. The fabricated unit shall be stress relieved before removal from the jig.
**Original Text**

404.11 Used Piping Components

Used piping components such as fittings, elbows, bends, intersections, couplings, reducers, closures, flanges, valves, and equipment may be reused. (Reuse of pipe is covered by para. 403.10). However, such components and equipment shall be cleaned, examined, and reconditioned, if necessary, to ensure that they meet all requirements for the intended service and are free of defects. See ASME PCC-2 for more information about flange repair and conversion.

451.6 Pipeline Integrity Assessments and Repairs

451.6.1 General...(g) Repair welding procedures and welders performing repair work shall be qualified in accordance with API 1104 or ASME Section IX. The welders shall also be familiar with safety precautions and other problems associated with cutting and welding on pipe that is or has been in service. Cutting and welding shall commence only after compliance with para. 434.8.1(c). See ASME PCC-2 for more information about welding on pipe containing liquid.

451.6.2.9 Permanent Repairs. Defects may be removed or repaired by one or more of the methods described below subject to the limitations listed for each type of defect and repair method (see Tables 451.6.2.9-1 and 451.6.2.9-2 for some acceptable methods). Other methods can be used provided that they are supported by sound engineering principles and meet the requirements of this Code. See ASME PCC-2 for more information about repair options in this paragraph.

451.6.2.9 Permanent Repairs...(d) Full Encirclement Sleeves. Repairs may be made by the installation of a full encirclement welded split sleeve. Sleeve configurations may be one of the following:

**Revised Text**

404.11 Used Piping Components

Used piping components such as fittings, elbows, bends, intersections, couplings, reducers, closures, flanges, valves, and equipment may be reused. (Reuse of pipe is covered by para. 403.10). However, such components and equipment shall be cleaned, examined, and reconditioned, if necessary, to ensure that they meet all requirements for the intended service and are free of defects. See ASME PCC-2, Article 3.5 for more information about flange repair and conversion.

451.6 Pipeline Integrity Assessments and Repairs

451.6.1 General (g) Repair welding procedures and welders performing repair work shall be qualified in accordance with API 1104 or ASME Section IX. The welders shall also be familiar with safety precautions and other problems associated with cutting and welding on pipe that is or has been in service. Cutting and welding shall commence only after compliance with para. 434.8.1(c). See ASME PCC-2, Article 2.6, Section 4.6 for more information about welding on pipe containing liquid.

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451.6.2.9 Permanent Repairs...(d) Full Encirclement Sleeves. Repairs may be made by the installation of a full encirclement welded split sleeve. See ASME PCC-2, Article 2.6 for more information on steel repair sleeves.
Original Text

451.6.2.9 Permanent Repairs....(b) Grinding. Defects may be removed by grinding within the limitations stated below. Prior to grinding, limits on grinding imposed by the operating pressure, the remaining wall thickness, and the proximity of defects should be considered. The ground area should have a smooth transition (minimum 4-to-1 slope) between it and the surrounding pipe.

Revised Text

451.6.2.9 Permanent Repairs....(b) Grinding. Defects may be removed by grinding within the limitations stated below. Prior to grinding, limits on grinding imposed by the operating pressure, the remaining wall thickness, and the proximity of defects should be considered. The ground area should have a smooth transition (minimum 4-to-1 slope) between it and the surrounding pipe. See ASME PCC-2, Article 3.4 for more information on grind repairs.
461.1.2 Coating Requirements

(a) The surface preparation shall be compatible with the coating to be applied. The pipe surface shall be free of deleterious materials, such as rust, scale, moisture, dirt, oils, lacquers, and varnish. The surface shall be inspected for irregularities that could protrude through the coating. Any such irregularities shall be removed. Further information can be obtained from NACE Joint Surface Preparation Standards Numbers 1, 2, 3, 4, and 5.

(b) Suitable coatings, including compatible field joint and patch coatings, shall be selected, giving consideration to handling, shipping, storing, installation condition, moisture adsorption, operating temperatures of the pipeline, environmental factors (including the nature of the soil or water in contact with the coating), adhesion characteristics, and dielectric strength. Further information can be obtained from NACE Recommended or Standard Practices (RPs or SPs) 0185, 0188, 0198, 0274, 0303, 0375, 0394, 0399, 0402, 0490, and 0602.
461.1.7 Casings. The use of metallic casings should be avoided insofar as possible from a corrosion control standpoint. However, it is recognized that installation of metallic casings is frequently required or desirable to facilitate construction. Where metallic casing is used, care shall be exercised to ensure that coating on the carrier pipe is not damaged during installation. The carrier pipe should be insulated from metallic casings, and the casing ends shall be sealed with a durable material to minimize the accumulation of solids and liquids in the annular space. Special attention shall be given to the casing ends to prevent electrical shorting due to backfilling movement or settling. Where electrical isolation is not achieved, action shall be taken to correct the condition by clearing the short if possible, by mitigating the potential for corrosion inside of the casing by installation of a high resistivity inhibited material in the annular space, by supplementing cathodic protection, or by other sound engineering practice. Further information can be obtained from NACE RP 0200.

461.1.7 Casings. The use of metallic casings should be avoided insofar as possible from a corrosion control standpoint. However, it is recognized that installation of metallic casings is frequently required or desirable to facilitate construction. Where metallic casing is used, care shall be exercised to ensure that coating on the carrier pipe is not damaged during installation. The carrier pipe should be insulated from metallic casings, and the casing ends shall be sealed with a durable material to minimize the accumulation of solids and liquids in the annular space. Special attention shall be given to the casing ends to prevent electrical shorting due to backfilling movement or settling. Where electrical isolation is not achieved, action shall be taken to correct the condition by clearing the short if possible, by mitigating the potential for corrosion inside of the casing by installation of a high resistivity inhibited material in the annular space, by supplementing cathodic protection, or by other sound engineering practice. Further information can be obtained from NACE RP 0200.
462.1 General
When a corrosive liquid is transported, provision shall be made to protect the piping system from detrimental corrosion. Hydrocarbons containing free water, under the conditions at which they will be transported, shall be assumed to be corrosive, unless proven to be noncorrosive by recognized tests or experience. Further information can be obtained from NACE RP 0192, Test Method 0172, and MR 0175.

462.2 New Installations

(g) Erosion–Corrosion
(1) It is usually necessary to control erosion–corrosion of liquid or slurry pipelines to mitigate premature failure of the line due to reduced wall thickness. Use of corrosion inhibitors and/or control of the pH, particle size, and flow velocity of the slurry or internal coating of the pipe may be used to limit erosion–corrosion of liquid or slurry pipelines. Other means of dealing with this effect, such as periodic replacement of components or the use of wear plates, are acceptable. See NACE MR 0175 for guidance.

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When a corrosive liquid is transported, provision shall be made to protect the piping system from detrimental corrosion. Hydrocarbons containing free water, under the conditions at which they will be transported, shall be assumed to be corrosive, unless proven to be noncorrosive by recognized tests or experience. Further information can be obtained from NACE RP 0192, Test Method 0172, and MR 0175 / ISO 15156.

462.2 New Installations

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(1) It is usually necessary to control erosion–corrosion of liquid or slurry pipelines to mitigate premature failure of the line due to reduced wall thickness. Use of corrosion inhibitors and/or control of the pH, particle size, and flow velocity of the slurry or internal coating of the pipe may be used to limit erosion–corrosion of liquid or slurry pipelines. Other means of dealing with this effect, such as periodic replacement of components or the use of wear plates, are acceptable. See NACE MR 0175 / ISO 15156 for guidance.
463 EXTERNAL CORROSION CONTROL FOR PIPELINES EXPOSED TO ATMOSPHERE

463.1 General

(a) Steel pipelines exposed to the atmosphere shall be protected from external corrosion by a suitable coating or jacket, unless it can be demonstrated by test or experience that the materials are resistant to corrosion in the environment in which they are installed. Further information can be obtained from NACE RP0281.

(b) The surface to be coated shall be free of deleterious materials, such as rust, scale, moisture, dirt, salt, oil, lacquer, and varnish. The surface preparation shall be compatible with the coating or jacket to be applied. Further information can be obtained from NACE Joint Surface Preparation Standards Numbers 1, 2, 3, 4, and 5.
466 EXTERNAL CORROSION CONTROL FOR THERMALLY INSULATED PIPELINES

466.1 New Installations

466.1.1 General. Special consideration must be given to the external corrosion control requirements of pipelines and other facilities that are thermally insulated due to operational requirements or for personnel safety.

Corrosion under insulation of facilities associated with liquid pipelines (piping, tanks, etc.) shall be addressed in accordance with NACE RP 0198.

The external surfaces of thermally insulated pipelines constructed as “pipe-in-pipe” shall be protected from corrosion as detailed elsewhere in this Chapter. The external metallic surfaces of thermally insulated pipelines constructed as “pipe-in-plastic” shall be protected from corrosion as detailed below.

Due to the physical characteristics of thermal insulating systems, cathodic protection of the external metallic surfaces under the insulation system cannot be ensured. As such, ensuring the integrity of the thermal insulation system and the isolation of the metal surface from a corrosive environment is critical.

The external corrosion mitigation (or pipeline integrity) program for thermally insulated pipelines shall include either the monitoring of the integrity of the insulation system or an appropriate external metal loss monitoring program.
467 STRESS CORROSION AND OTHER PHENOMENA

Environmentally induced and other corrosion-related phenomena, including stress corrosion cracking, corrosion fatigue, hydrogen stress cracking, hydrogen embrittlement, corrosion under insulation, and microbiologically influenced corrosion, have been identified as causes of pipeline failure. Considerable knowledge and data have been acquired and assembled on these phenomena, and research is continuing as to their causes and prevention. Operating companies should be alert for evidence of such phenomena during all pipe inspections and at other such opportunities. Where evidence of such a condition is found, an investigative program shall be initiated and remedial measures taken as necessary. Any such evidence shall be given consideration in all pipeline failure investigations. Operating companies should avail themselves of current technology on the subject or consult with knowledgeable experts, or both.

This paragraph must be limited to general statements rather than specific limits in regard to stress corrosion. Stress corrosion is currently the subject of investigative research programs and more specific data will certainly be available to the pipeline designer and operating company in the future. In the interim, this Code suggests that the user refer to the current state of the art. Cathodic protection current levels, quality of pipe surface preparation and coating, operating temperatures, stress levels, and soil conditions shall be considered in pipeline design and operations. Further information can be obtained from NACE RP 0204.

467 STRESS CORROSION AND OTHER PHENOMENA

Environmentally induced and other corrosion-related phenomena, including stress corrosion cracking, corrosion fatigue, hydrogen stress cracking, hydrogen embrittlement, corrosion under insulation, and microbiologically influenced corrosion, have been identified as causes of pipeline failure. Considerable knowledge and data have been acquired and assembled on these phenomena, and research is continuing as to their causes and prevention. Operating companies should be alert for evidence of such phenomena during all pipe inspections and at other such opportunities. Where evidence of such a condition is found, an investigative program shall be initiated and remedial measures taken as necessary. Any such evidence shall be given consideration in all pipeline failure investigations. Operating companies should avail themselves of current technology on the subject or consult with knowledgeable experts, or both.

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452.7 Prevention of Accidental Ignition

(a) Smoking shall be prohibited in all areas of a pump station, terminal, or tank farm in which the possible leakage or presence of vapor constitutes a hazard of fire or explosion.

(b) Flashlights or hand lanterns, when used, shall be of the approved type.

(c) Welding shall commence only after compliance with para. 434.8.1(c).

(d) Consideration should be given to the prevention of other means of accidental ignition. See NACE RP 0177 for additional guidance.

452.7 Prevention of Accidental Ignition

(a) Smoking shall be prohibited in all areas of a pump station, terminal, or tank farm in which the possible leakage or presence of vapor constitutes a hazard of fire or explosion.

(b) Flashlights or hand lanterns, when used, shall be of the approved type.

(c) Welding shall commence only after compliance with para. 434.8.1(c).

(d) Consideration should be given to the prevention of other means of accidental ignition. See NACE RP SP0177 for additional guidance.
Specific editions of standards incorporated in this Code by reference, and the names and addresses of the sponsoring organizations, are shown in this Mandatory Appendix. It is not practical to refer to a specific edition of each standard throughout the Code text; instead, the specific edition reference dates are shown here. Mandatory Appendix I will be revised at intervals as needed. An asterisk (*) is used to indicate those standards that have been accepted as American National Standards by the American National Standards Institute (ANSI). For ASME codes and standards, the latest published edition in effect at the time this Code is specified is the specific edition referenced by this Code unless otherwise specified in the design.

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<tr>
<td>*RP 5LW, 2nd Ed., 1996 (Incorporates 5L1, 5L5, and 5L6)</td>
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<td>API 17B</td>
<td>Corrosion Data Survey — Metals, Section, 6th Ed., 1985</td>
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NOTES (Cont’d):

ASME B31G Manual for Determining the Remaining Strength of Corroded Pipelines: A Supplement to B31, Code for Pressure Piping

ASME B31T Standard Toughness Requirements for Piping

ASME B31.5 Refrigeration Piping

ASME PCC-2 Repair of Pressure Equipment and Piping

AWS A3.0 Welding Terms and Definitions

AWS D3.6 Specification for Underwater Welding

EPRI EL-3106 Safety of Pipelines in Close Proximity to Electrical Transmission Lines

NACE MR0175 Sulfide Stress Cracking Resistant Metallic Materials for Oil Field Equipment

NACE SP0169 Standard Practice — Control of External Corrosion on Underground or Submerged Metallic Piping Systems

NACE SP0177 Standard Practice — Mitigation of Alternating Current and Lightning Effects on Metallic Structures and Corrosion Control Systems

NACE SP0195 Standard Practice — Extruded Polyolefin Resin Coating Systems With Soft Adhesives for Underground or Submerged Pipe

NACE SP0198 Recommended Practice — Monitoring Corrosion in Oil and Gas Production With Iron Counts

NACE SP0209 Standard Practice — Steel-Cased Pipeline Practices

NACE SP0274 Recommended Practice — High-Voltage Electrical Inspection of Pipeline Coating Systems

NACE SP0286 Recommended Practice — Electrical Isolation of Cathodically Protected Pipelines

NACE SP0303 Recommended Practice — Field-Applied Heat-Shrinkable Sleeves for Pipelines: Application, Performance, and Quality Control

NACE SP0375 Recommended Practice — Wax Coating Systems for Underground Piping Systems

NACE SP0394 Recommended Practice — Application, Performance, and Quality Control of Plant-Applied Fusion-Bonded Epoxy External Pipe Coating

NACE SP0399 Recommended Practice — Plant-Applied, External Coal Tar Enamel Pipe Coating Systems: Application, Performance, and Quality Control

NACE SP0490 Standard Practice — Field-Applied Fusion-Bonded Epoxy (FBE) Pipe Coating Systems for Girth Weld Joints: Application, Performance, and Quality Control

NACE SP0602 Recommended Practice — Field-Applied Coastal Tar Enamel Pipe Coating Systems: Application, Performance, and Quality Control

NFPA 30 Flammable and Combustible Liquids Code

NFPA 70 National Electrical Code

Specifications and standards of the following organizations appear in Mandatory Appendix I:

ANSI American National Standards Institute

API American Petroleum Institute

ASME The American Society of Mechanical Engineers

ASTM American Society for Testing and Materials

AWS American Welding Society

EPRI Electric Power Research Institute

MSS Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.

NACE NACE International

NFPA National Fire Protection Association

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462.3 Existing Installations

A pipeline internal corrosion control program shall include, but not be limited to, the following:

(a) The establishment and evaluation of a program for the detection, prevention, or mitigation of detrimental internal corrosion should include the following:

1. Pipeline leak and repair records should be reviewed for indication of the effects of internal corrosion.
2. When any part of a pipeline is removed and the internal surface is accessible for inspection, it shall be visually examined and evaluated for internal corrosion. Additionally, visual examination shall be made for excessive weld penetration, high–low condition of a girth weld, and eccentrically located gaskets that should be avoided in a liquid or slurry pipeline.
3. If evidence of internal corrosion is discovered, the liquid or slurry shall be analyzed to determine the types and concentrations of any corrosive agents.
4. Liquids or solids removed from the pipeline by pigging, draining, or cleanup should be analyzed as necessary for determining the presence of corrosive materials and evidence of corrosion products.
5. Where it is determined that internal corrosion is taking place that could affect public or employee safety, one or more of the following protective or corrective measures shall be used to control detrimental internal corrosion:
   1. An effective chemical treatment may be applied in a manner and quantity to protect all affected portions of the piping system.
   2. Corrosive agents may be removed by recognized methods, such as dehydration.
   3. Additions may be used for removal of water from low spots, or reposition piping to reduce hold-up water.
   4. Components may be replaced of components or wear plates may be used of wear plates to control erosion–corrosion.
   5. The pipeline design or flow configuration may be modified. Sharp changes in direction should be avoided in liquid or slurry pipelines.
   6. Erosion–corrosion effects may be minimized by controlling the particle size.
6. Internal corrosion control measures shall be evaluated by an inspection and monitoring program, including, but not limited to, the following:
   1. The chemical and the injection system should be periodically checked.
   2. Corrosion coupons and test spools shall be removed and evaluated at periodic intervals.
   3. Corrosion probes should be checked manually at intervals, or continuously or intermittently monitored or recorded, or both, to evaluate control of pipeline internal corrosion.
   4. A record of the internal condition of the pipe, of leaks and repairs from corrosion, and of liquids or solids quantities and corrosivity shall be kept and used as a basis for changes in the cleaning pig schedules, chemical treatment program, or liquid treatment facility. (5) When pipe is uncovered, or on exposed piping where internal corrosion may be anticipated, pipe wall thickness measurement or monitoring should be made to evaluate internal corrosion.
6. Where inspections, observation, or record analysis indicates internal corrosion is taking place to an extent that may be detrimental to public or employee safety, that portion of the system shall be repaired or reconditioned, and appropriate steps taken to mitigate the internal corrosion.
466.1 New Installations

466.1.1 General. Special consideration must be given to the external corrosion control requirements of pipelines and other facilities that are thermally insulated due to operational requirements or for personnel safety.

Corrosion under insulation of facilities associated with liquid pipelines (piping, tanks, etc.) shall be addressed in accordance with NACE RP 0198.

The external surfaces of thermally insulated pipelines constructed as “pipe-in-pipe” shall be protected from corrosion as detailed elsewhere in this Chapter. The external metallic surfaces of thermally insulated pipelines constructed as “pipe-in-plastic” shall be protected from corrosion as detailed in para. 466.1.4 below.

Due to the physical characteristics of thermal insulating systems, cathodic protection of the external metallic surfaces under the insulation system cannot be ensured. As such, ensuring the integrity of the thermal insulation system and the isolation of the metal surface from a corrosive environment is critical.

The external corrosion mitigation (or pipeline integrity) program for thermally insulated pipelines shall include either the monitoring of the integrity of the insulation system or an appropriate external metal loss monitoring program.

466.1.2 External Coating Requirements. External corrosion mitigation of thermally insulated pipelines shall be provided by an anticorrosion coating applied to the surface of the pipe, under the thermal insulation system. Selection of anticorrosion coatings shall take into account the particular requirements for pipelines in thermally insulated services. In addition to the general considerations for pipeline coatings listed in para. 461.1.2, these coatings shall also be resistant to damage from the stresses of movement due to operational thermal expansion/contraction cycles, compatible with the insulation system, and resistant to thermal degradation.

466.1.3 Water Stops. The thermal insulation system for buried or submerged pipelines should include provisions for prevention of migration of water through the insulation that may impact adjacent pipe joints. This may be achieved with water stops or alternative means.

466.1.4 Cathodic Protection. The external corrosion mitigation provided by anticorrosion coating for buried piping and pipelines may be supplemented by cathodic protection when appropriate as detailed in paras. 466.1.4.1 and 466.1.4.2.

466.1.4.1 External Anodes. Cathodic protection may be provided using anodes that are located outside of the thermal insulation system jacket. Such anodes will provide cathodic protection to any external metallic pipeline surfaces that are exposed openly to the surrounding electrolyte.

466.1.4.2 Internal Anodes. Cathodic protection may be provided using anodes that are installed within the thermal insulation system jacket. Such anodes will provide cathodic protection to external metallic pipeline surfaces that are contained within the same electrolyte as are the anodes, in the event that the integrity of the insulation jacket has been compromised.
Proposed changes to B31.4-2016, PARA 400.1.1:

Also included within the scope of this Code are

(a) primary and associated auxiliary liquid petroleum
and liquid anhydrous ammonia piping at pipeline termi-
nals (marine, rail, and truck), tank farms, pump stations,
pressure reducing stations, and metering stations,
including scraper traps, strainers, and prover loops

(b) primary and auxiliary slurry piping at
storage facilities, pipeline terminals, pump stations,
choke stations, and pressure reducing stations,
including piping up to the first valve of attached
auxiliary water lines

(c) storage and working tanks, including pipe-type
storage fabricated from pipe and fittings, and piping
interconnecting these facilities

(d) liquid petroleum, and liquid anhydrous
ammonia, and slurry piping located on property that
has been set aside designated for such piping within
petroleum refinery, natural gasoline, gas processing,
ammonia, and bulk plants, and slurry transportation
systems

(e) those aspects of operation and maintenance of
liquid and slurry pipeline systems relating to the safety
and protection of the general public, operating company
personnel, environment, property, and the piping
systems [see paras. 400(c) and (d)]

FROM B31.11 PARA 1100.1.1:

Also included within the scope of this Code are

(a) primary and auxiliary slurry piping at storage
facilities, pipeline terminals, pump stations, and pressure
reducing stations, including piping up to the first valve of attached auxiliary water lines

(b) slurry piping, storage facilities, and other equip-
ment located on property which has been set aside for
the slurry transportation system

(c) those aspects of operation and maintenance of
slurry transportation piping systems relating to the
safety and protection of the general public, operating
company personnel, environment, property, and the piping
systems [see paras. 1100(c) and (d)].
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<tr>
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<th>Current Language</th>
<th>Proposal</th>
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<tr>
<td>425.3 Gaskets</td>
<td>Limitations on gasket materials are covered in para. 408.4.</td>
<td>Limitations on gasket materials are covered in para. 404.4.7.</td>
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<tr>
<td>425.4 Bolting</td>
<td>Limitations on bolting materials are covered in para. 408.5.</td>
<td>Limitations on bolting materials are covered in para. 404.4.8.</td>
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<td>426.3 Threads</td>
<td>The dimensions of all piping connection threads not otherwise covered by a governing component standard or specification shall conform to the requirements of the applicable standards listed in Table 426.1-1 (see para. 414.1).</td>
<td>The dimensions of all piping connection threads not otherwise covered by a governing component standard or specification shall conform to the requirements of the applicable standards listed in Table 426.1-1 (see para. 403.2.4).</td>
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<td>434.2.2 Inspection</td>
<td>Repairs required during new construction shall be in accordance with paras. 434.5, 434.8, and 461.1.2.</td>
<td>Repairs required during new construction shall be in accordance with paras. 434.5, 434.8.7, and 461.1.2.</td>
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<tr>
<td>434.7.1 Bends Made From Pipe</td>
<td>When hot bends are made in pipe that has been cold worked in order to meet the specified minimum yield strength, wall thicknesses shall be determined by using the lower stress values in accordance with para. 402.3.1(d).</td>
<td>When hot bends are made in pipe that has been cold worked in order to meet the specified minimum yield strength, wall thicknesses shall be determined by using the lower stress values in accordance with para. 403.11.</td>
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<tr>
<td><strong>403.2 Criteria for Pipe Wall Thickness and Allowances</strong></td>
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<tr>
<td><strong>403.2.1 Criteria.</strong> The nominal wall thickness of straight sections of steel pipe shall be equal to or greater than ( t_n ) determined in accordance with the following equation:</td>
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<td>[ t_n \geq t + A ]</td>
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<td>where</td>
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<tr>
<td>( A = \text{sum of allowances for threading, grooving, corrosion, and erosion as required in paras. 403.2.2 through 403.2.4, and increase in wall thickness if used as protective measure in para. 403.1} )</td>
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</tr>
<tr>
<td>( t_n = \text{nominal wall thickness satisfying requirements for pressure and allowances} )</td>
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<tr>
<td>( t = \text{pressure design wall thickness as calculated in inches (millimeters) in accordance with the following equations:} )</td>
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<tr>
<td>( (\text{U.S. Customary Units}) )</td>
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<tr>
<td>[ t = \frac{P_iD}{2S} ]</td>
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<tr>
<td>( (\text{SI Units}) )</td>
<td></td>
</tr>
<tr>
<td>[ t = \frac{P_iD}{20S} ]</td>
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<tr>
<td>where</td>
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<tr>
<td>( D = \text{outside diameter of pipe, in. (mm)} )</td>
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<tr>
<td>( P_i = \text{internal design gage pressure, psi (bar)} )</td>
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<tr>
<td>( S = \text{applicable allowable stress value, psi (MPa), as determined by the following equation:} )</td>
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<tr>
<td>[ S = F \times E \times S_y ]</td>
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<tr>
<td>specified minimum yield strength of the pipe, psi (MPa)</td>
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<tr>
<td>where</td>
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<tr>
<td>( E = \text{weld joint factor as specified in Table 403.2.1-1} )</td>
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</tr>
<tr>
<td>( F = \text{design factor based on nominal wall thickness} )</td>
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<tr>
<td>( S_y = \text{specified minimum yield strength of the pipe, psi (MPa)} )</td>
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<tr>
<td>In setting design factor, due consideration has been given to and allowance has been made for the underthickness tolerance and maximum allowable depth of imperfections provided for in the specifications approved by the Code. The value of ( F ) used in this Code shall be not greater than 0.72. Where indicated by service or location, users of this Code may elect to use a design factor, ( F ), less than 0.72.</td>
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<tr>
<td>( S_y = \text{specified minimum yield strength of the pipe, psi (MPa)} )</td>
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<tr>
<td>In setting design factor, due consideration has been given to and allowance has been made for the underthickness tolerance and maximum allowable depth of imperfections provided for in the specifications approved by the Code. The value of ( F ) used in this Code shall be not greater than 0.72. Where indicated by service or location, users of this Code may elect to use a design factor, ( F ), less than 0.72.</td>
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Supporting Info

Excerpt from ASME B31.8-2016 that shows how this formula is presented in another code

841 STEEL PIPE

841.1 Steel Piping Systems Design Requirements

841.1.1 Steel Pipe Design Formula

(a) The design pressure for steel gas piping systems or the nominal wall thickness for a given design pressure shall be determined by the following formula (for limitations, see para. 841.1.3):

(U.S. Customary Units)

\[ P = \frac{2St}{D} \text{FET} \]

(SI Units)

\[ (p = \frac{2000St}{D} \text{FET}) \]

where

\( D \) = nominal outside diameter of pipe, in. (mm)

\( E \) = longitudinal joint factor obtained from Table 841.1.7-1 [see also para. 841.1.3(d)]

\( F \) = design factor obtained from Table 841.1.6-1. In setting the values of the design factor, \( F \), due consideration has been given and allowance has been made for the various underthickness tolerances provided for in the pipe specifications listed and approved for usage in this Code.

\( P \) = design pressure, psig (kPa) (see also para. 841.1.3)

\( S \) = specified minimum yield strength, psi (MPa), stipulated in the specifications under which the pipe was purchased from the manufacturer or determined in accordance with paras. 817.1.3(h) and 841.1.4. The specified minimum yield strengths of some of the more commonly used piping steels whose specifications are incorporated by reference herein are tabulated for convenience in Mandatory Appendix D.
"Area of reinforcement" enclosed by ———— lines
Reinforcement area required $A_R = dt_h$
Area available as reinforcement = $A_1 + A_2 + A_3$

- $A_1 = (T_h - t_h) d$
- $A_2 = 2 (T_b - t_b) L$
- $A_3 =$ summation of area of all added reinforcement, including weld areas that lie within the "area of reinforcement"

$A_1 + A_2 + A_3$ must be equal to or greater than $A_R$

where

- $d =$ length of the finished opening in the header wall (measured parallel to the axis of the header)
- $M =$ actual (by measurement) or nominal thickness of added reinforcement
- $T_b =$ nominal wall thickness of branch
- $T_h =$ nominal wall thickness of header
- $t_b =$ design branch wall thickness required by para. 403.2
- $t_h =$ design header wall thickness required by para. 403.2
Proposal for Record 16-1731
Marked-Up Text & Figure

Fig. 404.3.5-1  Reinforcement of Branch Connections

“Area of reinforcement” enclosed by ______ lines

\[ A_R = \text{reinforcement area required} \]
\[ = d t_h \]

Reinforcement area required \( A_R = d t_h \)
\[ A_R \leq A_1 + A_2 + A_3 \]
\[ \leq \text{area available as reinforcement} \]

Area available as reinforcement = \( A_1 + A_2 + A_3 \)

Where

\[ A_1 = (T_h - t_h) d \]
\[ A_2 = 2(T_b - t_b)L \]
\[ A_3 = \text{summation of area of all added reinforcement, including weld areas that lie within the “area of reinforcement”} \]

\( A_1 + A_2 + A_3 \) must be equal to or greater than \( A_R \)

Where

\[ d = \text{length of the finished opening in the header wall} \]
\[ \text{(measured parallel to the axis of the header)} \]
\[ L = \text{smaller of } 2.5T_b \text{ and } 2.5T_h + M \]
\[ M = \text{actual (by measurement) or nominal thickness of added reinforcement} \]
\[ T_b = \text{nominal wall thickness of branch} \]
\[ T_h = \text{nominal wall thickness of header} \]
\[ t_b = \text{design branch wall thickness required by para. 403.2} \]
\[ t_h = \text{design header wall thickness required by para. 403.2} \]
Proposed Text & Figure

Fig. 404.3.5-1 Reinforcement of Branch Connections

"Area of reinforcement" enclosed by lines

\[ A_R = \text{reinforcement area required} \]
\[ = d t_h \]
\[ A_R \leq A_1 + A_2 + A_3 \]
\[ \leq \text{area available as reinforcement} \]

Where

\[ A_1 = (T_h - t_h)d \]
\[ A_2 = 2(T_b - t_b)L \]
\[ A_3 = \text{summation of area of all added reinforcement, including weld areas that lie within the "area of reinforcement"} \]
\[ d = \text{length of the finished opening in the header wall} \]
\[ (\text{measured parallel to the axis of the header}) \]
\[ L = \text{smaller of } 2.5T_h \text{ and } 2.5T_b + M \]
\[ M = \text{actual (by measurement) or nominal thickness of added reinforcement} \]
\[ T_b = \text{nominal wall thickness of branch} \]
\[ T_h = \text{nominal wall thickness of header} \]
\[ t_b = \text{design branch wall thickness required by para. 403.2} \]
\[ t_h = \text{design header wall thickness required by para. 403.2} \]
Chapter IX
Offshore Liquid Pipeline Systems

A400 GENERAL STATEMENTS

(a) Chapter IX pertains only to offshore pipeline systems as defined in para. A400.1.

(b) This Chapter is organized to parallel the numbering and content of the first eight chapters of the Code. Paragraph designations are the same as those in the first eight chapters, with the prefix “A.”

(c) All provisions of the first eight chapters of the Code are also requirements of this Chapter unless specifically modified herein. If the text in this Chapter adds requirements, the requirements in the original Chapter with the same title and number also apply. If a provision in this Chapter is in conflict with one or more provisions in other chapters, the provision in this Chapter shall apply.

(d) It is the intent of this Chapter to provide requirements for the safe and reliable design, installation, and operation of offshore liquid pipeline systems. It is not the intent of this Chapter to be all inclusive. Engineering judgment must be used to identify special considerations that are not specifically addressed. API RP 1111 may be used as a guide. It is not the intent of this Chapter to prevent the development and application of new equipment and technology. Such activity is encouraged as long as the safety and reliability requirements of the Code are satisfied.

A400.1 Scope
This Chapter covers the design, material requirements, fabrication, installation, inspection, testing, and safety aspects of the operation and maintenance of offshore pipeline systems. For purposes of this Chapter, offshore pipeline systems include offshore liquid pipelines, pipeline risers, offshore liquid-pumping stations, pipeline appurtenances, pipe supports, connectors, and other components as addressed specifically in the Code. See Fig. 400.1-2.

A400.2 Definitions (Applicable to This Chapter Only)
Some of the more common terms relating to offshore liquid pipelines are defined below.

buckle arrester: any device attached to, or made a part of, the pipe for the purpose of arresting a propagating buckle.

buckle detector: any means for detecting dents, excessive ovalization, or buckles in a pipeline.

external hydrostatic pressure: pressure acting on any external surface resulting from its submergence in water.
**flexible pipe**: pipe that is

(a) manufactured as a composite from both metal and nonmetal components

(b) capable of allowing large deflections without adversely affecting the pipe’s integrity

(c) intended to be an integral part of the permanent liquid transportation system

Flexible pipe does not include solid metallic pipe, plastic pipe, fiber-reinforced plastic pipe, rubber hose, or metallic pipes lined with nonmetallic linings or coatings.

**hyperbaric weld**: a weld performed at ambient hydrostatic pressure.

**offshore**: the area beyond the line of ordinary high water along that portion of the coast that is in direct contact with the open seas and beyond the line marking the seaward limit of inland coastal waters.

**offshore pipeline riser**: the vertical or near-vertical portion of an offshore pipeline between the platform piping and the pipeline at or below the seabed, including a length of pipe of at least five pipe diameters beyond the bottom elbow, bend, or fitting. Because of the wide variety of configurations, the exact location of transition among pipeline, pipeline riser, and platform piping must be selected on a case-by-case basis.

**offshore pipeline system**: includes all components of a pipeline installed offshore for the purpose of transporting liquid, other than production facility piping. Tanker or barge loading hoses are not considered part of the offshore pipeline system.

**offshore platform**: any fixed or permanently anchored structure or artificial island located offshore.

**pipe collapse**: flattening deformation of the pipe resulting in loss of cross-sectional strength and circular shape, which is caused by excessive external hydrostatic pressure acting alone.

**platform piping**: on offshore platforms producing hydrocarbons, platform piping is all liquid transmission piping and appurtenances between the production facility and the offshore pipeline riser(s). On offshore platforms not producing hydrocarbons, platform piping is all liquid transmission piping and appurtenances between the risers. Because of a wide variety of configurations, the exact location of the transition between the offshore pipeline riser(s), platform piping, and production facility must be selected on a case-by-case basis.

**propagating buckle**: a buckle that progresses rapidly along a pipeline caused by the effect of external hydrostatic pressure on a previously formed buckle, local collapse, or other cross-sectional deformation.

**pull tube**: a conduit attached to an offshore platform through which a riser can be installed.
pull-tube riser: riser pipe or pipes installed through a pull tube (e.g., J-tube or I-tube).

tube riser: see offshore pipeline riser.

seafloor bathymetry: refers to water depths along the pipeline route.

splash zone: the area of the pipeline riser or other pipeline components that is intermittently wet and dry due to wave and tidal action.

trawl board: a structure that is attached to the bottom of commercial fishing nets and is dragged along the seafloor.

vortex shedding: the periodic shedding of fluid vortices and resulting unsteady flow patterns downstream of a pipeline span.

**A401 DESIGN CONDITIONS LOADS**

**A401.1 General**

**A401.1.1 Offshore Design Conditions.**

A number of physical parameters, henceforth referred to as design conditionsloads, govern design of the offshore pipeline system so that it meets installation, operation, and other postinstallation requirements. Some of the conditions that may influence the safety and reliability of an offshore pipeline system are:

(a) pressure
(b) temperature
(c) waves
(d) current
(e) seabed
(f) wind
(g) ice
(h) seismic activity
(i) platform motion
(j) water depth
(k) support settlement
(l) accidental loads
(m) marine vessel activity
(n) fishing/recreational activities

The design of an offshore pipeline system is often controlled by installation considerations rather than by operating load conditions.
A401.1 Load Classifications

A401.9 Installation Design Considerations

A401.2.4 Construction Loads

A401.9.1 Loads for Installation Design.

The design of an offshore pipeline system suitable for safe installation and the development of offshore pipeline construction procedures shall be based on consideration of the parameters listed in paras. A401.9.2A401.2.4.1 and A401.9.3A401.2.4.3. These parameters shall be considered to the extent that they are significant to the proposed system and applicable to the method of installation being considered.

All parts of the offshore pipeline system shall be designed for the most critical combinations of installation and environmental loads, acting concurrently, to which the system may be subjected.

A401.9.2A401.2.4.1 Installation Loads.

Installation loads that shall be considered are those imposed on the pipeline system under anticipated installation conditions, excluding those resulting from environmental conditions.

Loads that should be considered as installation loads include

(a) weight, including (as appropriate) the weight of
   (1) pipe
   (2) coatings and their absorbed water
   (3) attachments to the pipe
   (4) fresh water or sea water content (if pipe is flooded during installation)

(b) buoyancy
(c) external pressure
(d) static loads imposed by construction equipment

When considering the effect of pipe and/or pipeline component weights (in air and submerged) on installation stresses and strains, the variability due to weight coating, manufacturing tolerances, and water absorption shall also be considered.

A401.9.3A401.2.4.3 Environmental Loads During Installation.

Environmental loads that shall be considered are those imposed on the pipeline system by environmental conditions. Loads that should be considered under this category include, as appropriate, those arising due to

(a) waves
(b) current
(c) wind
(d) tides
The effects of large tidal changes and water depth variations on construction equipment shall be considered. An appropriate design return interval storm shall be selected for the anticipated installation duration. This design return interval shall not be less than 3 times the expected exposure period for the pipeline during installation, or 1 yr, whichever is longer.

Direction of waves, wind, and currents shall be considered to determine the most critical expected combination of the environmental loads to be used with the installation loads, as described in para. A401.9.4.1.

Loads imposed by construction equipment and vessel motions vary with the construction method and construction vessel selected. The limitations and behavioral characteristics of installation equipment shall be considered in the installation design. The effect of vessel motions on the pipe and its coating shall be considered. Local environmental forces are subject to radical change in offshore areas. As a result, those potential changes should be considered during installation contingency planning as well as during installation design.

**A401.9.4 Bottom Soils.**

Soil characteristics shall be considered in on-bottom stability analysis during the installation period, span analysis, and when installation procedures are developed for the following:

- (a) riser installation in pull tubes
- (b) laying horizontal curves in the pipeline routing
- (c) pipeline bottom tows
- (d) trenching and backfilling

**A401.10 Operational Design Considerations**

**A401.10.2 Sustained Loads**

The design of an offshore pipeline system suitable for safe operation shall be based on considerations of the parameters listed in paras. A401.10.2 and A401.10.3 below. These parameters shall be considered to the extent that they are significant to the proposed system.

All parts of the offshore pipeline system shall be designed for the most critical combinations of operational and environmental loads, acting concurrently, to which the system may be subjected. The most critical combination will depend upon operating criteria during storm conditions. If full operations are to be maintained during storm conditions, then the system shall be designed for concurrent action of full operational and design environmental loads. If operations are to be reduced or discontinued during storm conditions, then the system shall be designed for both...
A401.10.2 Operational Loads.

Sustained-operational loads that shall be considered are those imposed on the pipeline system during its operation, excluding those resulting from occasional-environmental conditions.

Loads that should be considered sustained-operational loads include

(a) weight, including (as appropriate) the weight of

(1) pipe
(2) coatings and their absorbed water
(3) attachments to the pipe
(4) transported contents

(b) buoyancy
(c) internal and external pressure
(d) thermal expansion and contraction
(e) residual loads
(f) overburden

Anticipated impact loads, such as those caused by trawl boards, should be considered as an operational load.

A401.10.3 Environmental Loads During Operation. A401.2.3 Occasional Loads.

Environmental-Occasional loads that shall be considered are those imposed on the pipeline system by occasional-environmental conditions. Loads that should be considered under this category include, as appropriate, those arising due to

(a) waves
(b) current
(c) wind
(d) tides
(e) ice loads (e.g., weight, floating impacts, scouring)
(f) seismic events
(g) dynamically induced soil loads (e.g., mudslides, soil liquefaction)

An appropriate design return interval storm shall be selected for the anticipated operational life of the offshore pipeline system but shall not be less than 100 yr.
Direction of waves, wind, and currents shall be considered to determine the most critical expected combination of the environmental occasional loads to be used with the operations other classifications of loads, as described in para. A401.10.1.

A401.10.4 Direction of waves, wind, and currents shall be considered to determine the most critical expected combination of the environmental occasional loads to be used with the operations other classifications of loads, as described in para. A401.10.1.

A401.2.5 Bottom Soils.
When establishing on-bottom stability requirements and maximum allowable spans for irregular seabeds, consideration shall be given to seabed soil characteristics.

A401.11 Hydrostatic Test Design Considerations Testing

A401.11.1 Loads for Hydrostatic Test Design.
The design of an offshore pipeline system suitable for safe hydrostatic testing and the development of offshore pipeline hydrostatic test procedures shall be based on consideration of the parameters listed in paras. A401.11.2, A401.2.4.2.2, and A401.11.3. These parameters shall be considered to the extent that they are significant to the proposed test.

All parts of the offshore pipeline system shall be designed for the most critical combinations of hydrostatic test and environmental occasional loads, acting concurrently, to which the system may be subjected.

A401.11.2 Hydrostatic Test Loads.
Hydrostatic test loads that shall be considered are those imposed on the offshore pipeline system under anticipated test conditions, excluding those resulting from environmental conditions.

Loads that should be considered hydrostatic test loads include:

(a) weight, including (as appropriate) the weight of
   (1) pipe
   (2) coatings and their absorbed water
   (3) attachments to the pipe
   (4) freshwater or seawater used for hydrostatic test
(b) buoyancy
(c) internal and external pressure
(d) thermal expansion and contraction
(e) residual loads
(f) overburden

A401.11.3 Environmental Occasional Loads During Hydrostatic Test.
Environmental loads that shall be considered are those imposed on the pipeline system by environmental conditions. Loads that should be considered under this category include, as appropriate, those arising due to

(a) waves
(b) current
(c) wind
(d) tides

An appropriate design return interval storm shall be selected for the anticipated hydrostatic test duration but shall not be less than 1 yr.

Direction of waves, wind, and currents shall be considered to determine the most critical expected combination of the environmental loads to be used with the hydrostatic test loads, as described in para. A401.11.1A401.2.4.2.1. A401.11.4A401.2.4.2.4 Bottom Soils.

When establishing on-bottom stability requirements and maximum allowable spans for irregular seabeds, consideration shall be given to seabed soil characteristics.

A401.12A401.4 Route Selection Considerations

(a) Offshore pipeline routes shall be selected to minimize the adverse effects of construction loads (see para. A401.2.4). These loads include the following:

(1) installation sustained and related environmental loads (see para. A401.9A401.2.2)

(2) operational and related environmental occasional loads (see para. A401.10A401.2.3)

(3) hydrostatic test and related environmental construction loads (see para. A401.11A401.2.4)

(b) Selection of offshore pipeline routes shall consider the capabilities and limitations of anticipated construction equipment.

(c) Surveys of the pipeline route shall be conducted to identify

(1) seabed materials

(2) subsea (including sub-bottom) and surface features that may represent potential hazards to the pipeline construction and operations

(3) subsea (including sub-bottom) and surface features that may be adversely affected by pipeline construction and operations, including archaeological and sensitive marine areas

(4) turning basins

(5) anchorage areas

(6) shipping lanes

(7) foreign pipeline and other utility crossings

(d) Routing shall be selected to avoid, to the extent practical, the identified hazards.
A402 CALCULATION OF STRESSES

A402.3 Stresses From Internal Pressure

The calculations of stresses in section 402 are superseded by the provisions of paras. A402.3.4 and A402.3.5.

Design and installation analyses shall be based upon accepted engineering methods, material strengths, and applicable design conditions.

A402.3.4 Strength Criteria During Installation and Testing

(a) Allowable Stress Values. The maximum longitudinal stress due to axial and bending loads during installation shall be limited to a value that prevents pipe buckling and that will not impair the serviceability of the installed pipeline system. Other stresses resulting from pipeline installation activities, such as spans, shall be limited to the same criteria. Instead of a stress criterion, an allowable installation strain limit may be used.

(b) Design Against Buckling. The offshore pipeline system shall be designed and installed in a manner to prevent local buckling of the pipe wall, collapse, and column buckling during installation. Design and installation procedures shall consider the effect of external hydrostatic pressure; bending, axial, and torsional loads; impact; mill tolerances in the wall thickness; out-of-roundness; and other applicable factors. Consideration shall also be given to mitigation of propagation buckling that may follow local buckling or denting. The pipe wall thickness shall be selected to resist collapse due to external hydrostatic pressure.

(c) Design Against Fatigue. The pipeline shall be designed and installed to limit anticipated stress fluctuations to magnitudes and frequencies that will not impair the serviceability of the installed pipeline. Loads that may cause fatigue include wave action and vibrations induced by vortex shedding. Pipelines and riser spans shall be designed to prevent vortex-induced resonant vibrations, when practical. When vibrations must be tolerated, the resulting stresses due to vibration shall be considered. If alternative acceptance standards for girth welds in API 1104 are used, the cyclic stress analysis shall include the determination of a predicted fatigue spectrum to which the pipeline is exposed over its design life.

(d) Design Against Fracture. Prevention of fractures during installation shall be considered in material selection in accordance with the requirements of para. A423.2. Welding procedures and weld defect acceptance criteria shall consider the need to prevent fractures during installation. See paras. 434.8.5 and 434.8.5.

Table A402.3.5 Design Factors for Offshore Pipeline Systems
(e) **Design Against Loss of In-Place Stability.** Design against loss of in-place stability shall be in accordance with the provisions of para. A402.3.2(e), A402.3.5(e), except that the installation design wave and current conditions shall be based upon the provisions of para. A401.2.4.3 A401.9.3. If the pipeline is to be trenched, it shall be designed for stability during the period prior to trenching.

(f) **Impact.** During the period when the pipe is susceptible to impact damage during installation and testing, consideration shall be given to impacts due to

1. anchors
2. trawl boards
3. vessels
4. ice keels
5. other foreign objects

(g) **Residual Stresses.** The pipeline system shall normally be installed in a manner so as to minimize residual stresses. The exception shall be when the designer purposefully plans for residual stresses (e.g., reeled pipe, cold springing of risers, pull-tube risers).

(h) **Flexible Pipe.** The manufacturer's recommended installation procedures should be adhered to during installation. Flexible pipe shall be designed or selected to prevent failure due to the combined effects of external pressure, internal pressure, torsional forces, axial forces, and bending. (See API RP 17B.)

### Table A402.3.5-1  Design Factors for Offshore Pipeline Systems

<table>
<thead>
<tr>
<th>Location</th>
<th>Hoop Stress, $F_{h}$</th>
<th>Longitudinal Stress, $F_{l}$</th>
<th>Combined Stress, $F_{c}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipeline</td>
<td>0.72</td>
<td>0.80</td>
<td>0.90</td>
</tr>
<tr>
<td>Riser and platform piping [Note (3)]</td>
<td>0.60</td>
<td>0.80</td>
<td>0.90</td>
</tr>
</tbody>
</table>

**GENERAL NOTE:** In the setting of design factors, due consideration has been given to, and allowance has been made for, the underthickness tolerance and maximum allowable depth of imperfections provided for in the specifications approved by the Code.

**NOTE:**

(3) Platform piping does not include production facility piping on a platform, see definitions in para. A400.2.

**A402.3.5A402.3.2 Strength Criteria During Operations**

(a) **Allowable Stress Values.** Allowable stress values for steel pipe during operation shall not exceed those calculated by the equations in paras. A402.3.2-A402.3.5(a)(1) through (a)(3).

(1) **Hoop Stress.** For offshore pipeline systems, the tensile hoop stress due to the difference between internal and external pressures shall not exceed the values given below, in eq. (1).

\[
Sh \leq F_{1} (Sy) \quad (1)
\]

Sh shall be calculated by eq. (2) or eq. (3). It is recommended that eq. (2) be used for $D/t$ greater than or equal to 20 and that eq. (3) be use for $D/t$ less than 30.

**NOTE:** Sign convention is such that tension is positive and compression is negative.

Commented [STMS1]: Modified with Item 10-457
Longitudinal Stress. For offshore pipeline systems, the longitudinal stress shall not exceed values found from

\[ S_L = (P_i - P_o) \frac{D}{2t} \] (U.S. Customary Units)  \hspace{1cm} (2)

\[ S_L = (P_i - P_o) \frac{D}{2t} \] (SI Units)

where:
- \( D \) = nominal outside diameter of pipe, in. (mm)
- \( P_i \) = hoop stress design factor from Table A402.3.5-1
- \( P_o \) = external pressure, psig (bar)
- \( P_i \) = internal design pressure, psig (bar)
- \( S_L \) = hoop stress, psi (MPa)
- \( S_y \) = specified minimum yield strength, psi (MPa)
- \( t \) = nominal wall thickness, in. (mm)

Combined Stress. For offshore pipeline systems, the combined stress shall not exceed the value given by the Maximum Shear Stress Equation (Tresca Combined Stress)

\[ S_h = (P_i - P_o) \frac{D - t}{2t} \] (U.S. Customary Units)  \hspace{1cm} (3)

\[ S_h = (P_i - P_o) \frac{D - t}{2t} \] (SI Units)

where:
- \( D \) = nominal outside diameter of pipe, in. (mm)
- \( P_i \) = hoop stress design factor from Table A402.3.5-1
- \( P_o \) = external pressure, psig (bar)
- \( P_i \) = internal design pressure, psig (bar)
- \( S_h \) = hoop stress, psi (MPa)
- \( S_y \) = specified minimum yield strength, psi (MPa)
- \( t \) = nominal wall thickness, in. (mm)

(2) Longitudinal Stress. For offshore pipeline systems, the longitudinal stress shall not exceed values found from

\[ F_1 \leq F_2(S_L) \]

where:
- \( A \) = cross-sectional area of pipe material, in.\(^2\) (mm\(^2\))
- \( F_2 \) = longitudinal stress design factor from Table A402.3.5-1
- \( F_m \) = axial force, lb (N)
- \( i \) = in-plane stress intensification factor from Table 402.1-1
- \( i_o \) = out-of-plane stress intensification factor from Table 402.1-1
- \( M_i \) = in-plane bending moment, in.-lb (N-m)
- \( M_o \) = out-of-plane bending moment, in.-lb (N-m)
- \( S_1 \) = axial stress, psi (positive tensile or negative compressive) (MPa) = \( F_m / A \)
- \( S_2 \) = maximum resultant bending stress, psi (MPa) = \( \pm \sqrt{(i_o M_i^2 + i M_i^2)/Z} \)
- \( S_3 \) = maximum longitudinal stress, psi (positive tensile or negative compressive) (MPa) = \( S_1 + S_2 \) or \( S_1 - S_2 \), whichever results in the larger stress value
- \( S_y \) = specified minimum yield strength, psi (MPa)
- \( Z \) = section modulus of the pipe, in.\(^3\) (cm\(^3\))
- \( \Pi \) = absolute value

(3) Combined Stress. For offshore pipeline systems, the combined stress shall not exceed the value given by the Maximum Shear Stress Equation (Tresca Combined Stress)
Alternatively, the Maximum Distortional Energy Theory (Von Mises Combined Stress) may be used for limiting combined stress values. Accordingly, the combined stress should not exceed values given by

\[ 2 \sqrt{\frac{(S_x - S_y)^2 + S_z^2}{A}} \leq F_d/S_y \]

where

- \( A \) = pipe cross-sectional area, \( \text{in}^2 \) (\( \text{mm}^2 \))
- \( F_d \) = combined stress design factor from Table A402.3.5-1
- \( F_t \) = axial force, lb (N)
- \( i_t \) = in-plane stress intensification factor from Table A402.1-1
- \( i_x \) = out-of-plane stress intensification factor from Table A402.1-1
- \( M_i \) = in-plane bending moment, in.-lb (N-m)
- \( M_o \) = out-of-plane bending moment, in.-lb (N-m)
- \( S_x \) = axial stress, psi (positive tensile or negative compressive) (MPa)
  \[ = F_t/A \]
- \( S_t \) = maximum resultant bending stress, psi (MPa)
  \[ = \sqrt{(i_t M_o)^2 + (i_t M_i)^2}/Z \]
- \( S_h \) = hoop stress, psi (MPa)
- \( S_l \) = maximum longitudinal stress, psi (positive tensile or negative compressive) (MPa)
  \[ = S_x + S_t \text{ or } S_h \text{ whichever results in the larger stress value} \]
- \( S_f \) = flexural stress, psi (MPa)
  \[ = M_t/2Z \]
- \( S_y \) = specified minimum yield strength, psi (MPa)
  \[ = S_y \]
- \( Z \) = section modulus of the pipe, \( \text{in}^3 \) (\( \text{cm}^3 \))

**4. Strain.** When the pipeline experiences a predictable noncyclic displacement of its support (e.g., fault movement along the pipeline route or differential subsidence along the line) or pipe sag before support contact, the longitudinal and combined stress limits may be replaced with an allowable strain limit, so long as the consequences of yielding do not impair the serviceability of the installed pipeline. The permissible maximum longitudinal strain depends upon the ductility of the material, any previously experienced plastic strain, and the buckling behavior of the pipe. Where plastic strains are anticipated, the pipe eccentricity, pipe out-of-roundness, and the ability of the weld to undergo such strains without detrimental effect should be considered. These same criteria may be applied to pull tube or bending shoe risers or pipe installed by the reel method.

**(b) Design Against Buckling.** The pipeline shall be designed with an adequate margin of safety to prevent local buckling of the pipewallpipe wall, collapse, and column buckling during operations. Design and operating procedures shall consider the effect of external hydrostatic pressure; bending, axial, and torsional loads; impact; mill tolerances in the
wall thickness; out-of-roundness; and other applicable factors. Consideration shall also be given to mitigation of propagation buckling that may follow local buckling or denting. The pipe wall thickness shall be selected to resist collapse due to external hydrostatic pressure.

(c) Design Against Fatigue. The pipeline shall be designed and operated to limit anticipated stress fluctuations to magnitudes and frequencies that will not impair the serviceability of the pipeline. Loads that may cause fatigue include internal pressure variations, wave action, and pipe vibration, such as that induced by vortex shedding. Pipe and riser spans shall be designed so that vortex-induced resonant vibrations are prevented, whenever practical. When vibrations must be tolerated, the resulting stresses due to vibration shall be considered in the combined stress calculations in para. A402.3.2(a)-A402.3.5(a). In addition, calculated fatigue failure shall not result during the design life of the pipeline and risers.

(d) Design Against Fracture. Prevention of fractures during operation shall be considered in material selection in accordance with the requirements of para. A423.2. Welding procedures and weld defect acceptance criteria shall consider the need to prevent fractures during operation. See paras. 434.8.5 and A434.8.5.

(e) Design Against Loss of In-Place Stability

(1) General. Pipeline design for lateral and vertical on-bottom stability is governed by permanent features such as seafloor bathymetry and soil characteristics and by transient events, such as hydrodynamic, seismic, and soil behavior events, having a significant probability of occurrence during the life of the system. Design conditions to be considered are provided in paras. A402.3.2A402.3.5(e)(2) through (e)(4).

The pipeline system shall be designed to prevent horizontal and vertical movements or shall be designed so that any movements will be limited to values not causing allowable stresses and strains to be exceeded. Typical factors to be considered in the stability design include

(a) wave and current forces  
(b) soil properties  
(c) scour and resultant spanning  
(d) soil liquefaction  
(e) slope failure

Stability may be obtained by such means as, but not limited to

(f) adjusting pipe submerged weight  
(g) trenching and or covering of pipe  
(h) anchoring

When calculating hydrodynamic forces, the fact that wave forces vary spatially along the length of the pipeline may be taken into account.
Two on-bottom stability design conditions that shall be considered are installation and operational.

(2) Design Wave and Current Conditions. Operational design wave and current conditions shall be based upon an event having a minimum return interval of not less than 100 yr. The most unfavorable expected combination of wave and current conditions shall be used. Maximum wave and maximum current conditions do not necessarily occur simultaneously. When selecting the most unfavorable condition, consideration must be given to the timing of occurrence of the wave and current direction and magnitude.

(3) Stability Against Waves and Currents. The submerged weight of the pipe shall be designed to resist or limit movement to amounts that do not cause the longitudinal and combined stresses, as calculated by the equations in para. A402.3.2(a)-A402.3.5(a), to exceed the limits specified in para. A402.3.2(a) A402.3.5(a). The submerged weight may be adjusted by weight coating and/or increasing pipe wall thickness. Hydrodynamic forces shall be based on the wave and current values for the design condition at the location. See para. A402.3.2(e)(2)A402.3.5(e)(2).

Wave and current direction and concurrence shall be considered. The pipeline and its appurtenances may be lowered below bottom grade to provide stability.

Backfill or other protective covering options shall use materials and procedures that preclude damage to the pipeline and coatings.

Anchoring may be used alone or in conjunction with other options to maintain stability. The anchors shall be designed to withstand lateral and vertical loads expected from the design wave and current condition. Anchors shall be spaced to prevent excessive stresses in the pipe. Scour shall be considered in the design of the anchoring system. The effect of anchors on the cathodic protection system shall be considered.

Intermittent block-type, clamp-on, or set-on weights (river weights) shall not be used on offshore pipelines where there is a potential for the weight to become unsupported because of scour.

(4) Shore Approaches. Pipe in the shore approach zone shall be installed on a suitable above water structure or lowered or bored to the depth necessary to prevent scouring, spanning, or stability problems that affect integrity and safe operation of the pipeline during its anticipated service life. Seasonal variation in the nearshore thickness of seafloor sediments and shoreline erosion over the pipeline service life shall be considered.

(5) Slope Failure and Soil Liquefaction. The pipelines shall be designed for slope failure in zones where they are expected (mud slide zones, steep slopes, areas of seismic slumping). If it is not practical to design the pipeline system to survive the event, the pipeline shall be designed for controlled breakaway with provisions to minimize loss of the pipeline contents.

Design for the effects of liquefaction shall be performed for areas of known or expected occurrence. Soil liquefaction normally results from cyclic wave overpressures or seismic
loading of susceptible soils. The bulk specific gravity of the pipeline shall be selected, or alternative methods shall be selected to ensure both horizontal and vertical stability.

Seismic design conditions used to predict the occurrence of bottom liquefaction or slope failure shall be at least as severe as those used for the operating design strength calculations for the pipeline. Occurrence of soil liquefaction due to wave overpressures shall be based on a storm interval of not less than 100 yr.

(6) Bottom Soils. The pipe–soil interaction factors that are used shall be representative of the bottom conditions at the site.

(f) Impact. During operations, consideration shall be given to impacts due to

(1) anchors
(2) trawl boards
(3) vessels
(4) ice keels
(5) other foreign objects

A402.3.3A402.3.7 Design of Clamps and Supports.
Clamps and supports shall be designed such that a smooth transfer of loads is made from the pipeline or riser to the supporting structure without highly localized stresses due to stress concentrations. When clamps are to be welded to the pipe, they shall fully encircle the pipe and be welded to the pipe by a full encirclement weld. The support shall be attached to the encircling member and not the pipe.

All welds to the pipe shall be nondestructively tested. Clamps and supports shall be designed in accordance with the requirements of API RP 2A-WSD.

Clamps and support design shall consider the corrosive effects of moisture-retaining gaps and crevices and galvanically dissimilar metals.

A402.3.4A402.3.8 Design of Connectors and Flanges.
Connectors and flanges shall be designed or selected to provide the smooth transfer of loads and prevent excessive deformation of the attached pipe.

A402.3.5A402.3.9 Design of Structural Pipeline Riser Protectors.
Where pipeline risers are installed in locations subject to impact from marine traffic, protective devices shall be installed in the zone subject to damage to protect the pipe and coating.

A402.3.6A402.3.10 Design and Protection of Special Assemblies.
Design of special assemblies, such as connections, subsea tie-in assemblies, subsea valves, expansion loops, seabed riser connections, and subsea pipeline manifolds, shall consider the additional forces and effects imposed by a subsea environment. Such additional considerations include design storm currents and potential for seabed movement in soft sediments, soil liquefaction, increased potential for corrosion, thermal expansion and contraction, and stress due to installation procedures.
Appropriate measures shall be taken to protect special assemblies in areas where the assemblies are subject to damage by outside forces, such as fishing and marine construction activities.

**A402.3.7 Design of Flexible Pipe.**

Due to its composite makeup, the mechanical behavior of flexible pipe is significantly different from that of steel pipe. Flexible pipe may be used for offshore pipelines if calculations and/or test results verify that the pipe can safely withstand loads considered in paras. **A401.2.4, A401.9, A401.2.2, and A401.2.4.2.** Careful consideration should be given to the use of flexible pipe due to its permeable nature and possible rapid decompression failure of the liner material and collapse of the inner liner due to residual gas pressure in the annulus upon pipeline depressurization. (See API RP 17B.)

**A402.3.8 Design of Pipeline Crossings.**

Subsea pipeline crossings shall be designed to provide a minimum 12 in. (300 mm) separation between the two lines. Dielectric separation of the two pipelines shall be considered in design of pipeline crossings. Soil settlement, scour, and cyclical loads shall be considered in the design of pipeline crossings in order to ensure that the separation is maintained for the design life of both lines.

When two liquid pipelines cross, the longitudinal stress and combined stress, as calculated by the equations in para. **A402.3.2(a)**, shall not exceed the limits specified in Table **A402.3.2-1**. Where appropriate, allowable strain criteria in para. **A402.3.5(a)** may be used in lieu of allowable stress criteria. Where crossing pipelines are governed by different codes, the allowable stress limits shall be in accordance with the provisions of the applicable code.

**A402.4 Allowances**

**A403.2 Criteria for Pipe Wall Thickness and Allowances**

**A403.2.1 Criteria**

For offshore pipeline systems, the applicable allowable stress value specified and defined in para. 403.2.1 shall be as follows:

\[ S = F_1 (S_y) \]

where

\[ F_1 = \text{hoop stress design factor from Table A402.3.2-1} \]

\[ S_y = \text{specified minimum yield strength, psi (MPa)} \]

**A403.9 Criteria for Expansion and Flexibility**
Unburied subsea pipeline systems and platform piping shall be considered as aboveground piping (see paras. 403.9.1 and 403.9.3) where such definition is applicable.

Thermal expansion and contraction calculations shall consider the effects of fully saturated backfill material on soil restraint.

Allowable strength criteria shall be in accordance with para. A402.3.2A402.3.5 in lieu of the calculation of stresses listed in section 402. Equations in paras. 402.5.1 and 402.5.2 are valid for calculating the indicated stresses. See paras. A401.2.2A401.10 and A401.2.4.2A401.11 for loads that must be considered in design. Where appropriate, allowable strain criteria in para. A402.3.2(a)(4)A402.3.5(a)(4) may be used in lieu of allowable stress criteria.

When an offshore pipeline is to be laid across a known fault zone or in an earthquake-prone area, consideration shall be given to the need for flexibility in the pipeline system and its components to minimize the possibility of damage due to seismic activity. Flexibility in the pipeline system may be provided by installation of the pipeline on or above the seabed and/or by use of breakaway couplings, slack loops, flexible pipe sections, or other site-specific solutions.

A404 CRITERIA FOR FITTINGS, ASSEMBLIES, AND OTHER COMPONENTS
(ALTERNATIVELY, CRITERIA FOR COMPONENTS)

A404.2 Directional Changes

A404.2.4 Mitered Bends.

Mitered bends are prohibited in offshore liquid pipeline systems.

A404.3 Branch Connections

A404.3.5 Reinforcement of Single Openings

(a) When welded branch connections are made to pipe in the form of a single connection, or in a header or manifold as a series of connections, the design shall be adequate to control stress levels in the pipe within safe limits. The construction shall take cognizance of the stresses in the remaining pipe wall due to the opening in the pipe or header, the shear stresses produced by the pressure acting on the area of the branch opening, and any external loading due to thermal movement, weight, vibration, etc., and shall meet the minimum requirements listed in Table 404.3.4-1. The following paragraphs provide design rules based on the stress intensification created by the existence of a hole in an otherwise symmetrical section. External loadings, such as those due to thermal expansion or unsupported weight of connecting pipe, have not been evaluated. These factors should be given attention in unusual designs or under conditions of cyclic loading.

Pipe that has been cold worked solely for the purpose of increasing the yield strength to meet the specified minimum yield strength is prohibited in offshore liquid pipeline systems. This does not preclude the use of pipe that has been cold worked specifically for the purpose of meeting dimensional requirements.

A404.3.6 Reinforcement of Multiple Openings
(d) Pipe that has been cold worked solely for the purpose of increasing the yield strength to meet the specified minimum yield strength is prohibited in offshore liquid pipeline systems. This does not preclude the use of pipe that has been cold worked specifically for the purpose of meeting dimensional requirements.

A404.4 Flanges

A404.4.1 General. A404.4.3 Cast Iron Flanges Within Scope of Standard Sizes

Paragraph 404.4.3 does not apply. Cast iron or ductile iron flanges are prohibited for applications in offshore liquid pipeline systems.

A404.4.6 Flange Facings.

Ring joint-type flanges are preferred in offshore liquid pipeline systems.

A404.5 Valves

A404.5.1 General.

Paragraph 404.5.1 as it relates to cast iron valves does not apply. Cast iron or ductile iron valves are prohibited for applications in offshore liquid pipeline systems.

A404.6 Reducers

A404.6.3 Orange Peel Swages.

Orange peel swages are prohibited in offshore liquid pipeline systems, other than temporary construction components or other non-pressure-containing components.

A404.7 Closures

A404.7.4 Fabricated Closures.

Orange peel bull plugs and fishtails are prohibited in offshore liquid pipeline systems, other than temporary construction components or other non-pressure-containing components.

A404.8 Joints

A404.8.3 Threaded Joints.

Threaded connections for in-line piping component sizes NPS 2 (DN 50, 60.3 mm) or larger are prohibited in offshore pipeline systems, except as permitted in para. A406.2.

A405 PIPE

A405.1 Steel Pipe

(a) New pipe of the specifications listed in Table 423.1-1 may be used in accordance with the design equations of para. 403.2.1 subject to para A403.2.1A404.1.1 and to the testing requirements of paras. 437.1.4(a)(1), (a)(2), (a)(4), and (a)(5); paras. 437.1.4(b) and (c); and paras. 437.4.1 and A437.1.4.

(b) Pipe that has been cold worked solely for the purpose of increasing the yield strength to meet the specified minimum yield strength is prohibited in offshore liquid pipeline systems. This does not preclude the use of pipe that has been cold worked specifically for the purpose of meeting dimensional requirements.
A405.2 Flexible Pipe
Selection of flexible pipe shall be in accordance with API RP 17B. (See also para. A403.2.1 A402.3.11.)

A406 OTHER DESIGN CONSIDERATIONS
A406.1 Pigs and Internal Inspection Tools
When specifying in-line piping components for offshore pipelines, consideration shall be given to the need for running pipeline pigs and internal inspection tools. Selection of bend radius, launcher and receiver traps, bend configuration, internal diameter variations (including ovality), and other internal obstructions shall allow the passage of such devices, except where not practical.

A406.2 Special Components
System components that are not specifically covered in this Code shall be validated for fitness by either of the following:

(a) documented full-scale prototype testing of the components or special assemblies
(b) a documented history of successful usage of these components or special assemblies produced by the same design method

Documentation shall include design and installation methods that have been proven for the service for which the component is intended.
Care should be exercised in any new application of existing designs to ensure suitability for the intended service.

A409 AND A419 DELETED

A406.3A421 DESIGN OF PIPE-SUPPORTING ELEMENTS
See para. A402.3.3A402.3.7 for additional provisions.

A423 MATERIALS — GENERAL REQUIREMENTS
A423.1 Acceptable Materials and Specifications
Concrete weight coating materials (cement, aggregate, reinforcing steel) shall meet or exceed the requirements of applicable ASTM standards.
Flexible pipe shall be manufactured from materials meeting the requirements of API RP 17B and ASTM or ASME standards applicable to the materials selected by the designer.

A423.2 Limitations on Materials
“Unidentified” pipe, plastic pipe, ASTM A120 pipe, plastic pipe with nonmetallic reinforcement, cast iron pipe, ductile iron pipe, and pipe that has been cold worked in order to meet the specified minimum yield strength are prohibited in offshore liquid...
pipeline systems. This does not preclude the use of pipe that has been cold worked specifically for the purpose of meeting dimensional requirements.

In addition to the requirements contained in referenced standards, certain other requirements may be considered for components used offshore, depending on water depth, water temperature, internal pressure, product composition, product temperature, installation method, and/or other loading conditions. For example, consideration of additional limitations or requirements for pipe may include one or more of the following:

(a) wall thickness tolerance
(b) outside diameter tolerance
(c) out-of-roundness tolerance
(d) maximum and minimum yield and tensile strengths
(e) pipe chemistry limitations
(f) fracture toughness
(g) hardness
(h) pipe mill hydrostatic testing and other nondestructive testing

For sour service (H2S), refer to NACE MR 0175 / ISO 15156.

A434 CONSTRUCTION

A434.2 Inspection

Repairs required during new construction shall also be in accordance with paras. A434.8 and A461.1.2.

A434.3 Right-of-Way

A434.3.3 Survey and Staking or Marking.

The route of the offshore pipeline shall be surveyed, and the pipeline shall be properly located within the right-of-way by maintaining survey route markers or by surveying during installation.

A434.6 Ditching

The provisions of para. 434.6 are not applicable for offshore pipelines. Offshore pipelines should be trenched where necessary for stability, mechanical protection, or prevention of interference with maritime activities.

The methods and details of the pipeline trenching and lowering operations shall be based on site-specific conditions. Methods and details shall be selected to prevent damage to the pipe, coating, and pipeline appurtenances.

A434.7 Bends, Miters, and Elbows

Miter bends shall not be used in offshore liquid pipeline systems.

A434.7.1 Bends Made From Pipe
(a) Pipe that has been cold worked solely for the purpose of increasing the yield strength to meet the specified minimum yield strength is prohibited in offshore liquid pipeline systems. This does not preclude the use of pipe that has been cold worked specifically for the purpose of meeting dimensional requirements.

**A434.8 Welding**

**A434.8.3 Welding Qualifications**

Welder and Welding Procedure Qualification. Welding procedures and welders performing hyperbaric welding on offshore pipeline systems shall be qualified in accordance with the testing provisions of either API 1104 or the ASME Boiler and Pressure Vessel Code, Section IX, as supplemented by AWS D3.6M for Type “O” welds.

**A434.8.5 Required Inspection and Acceptance Criteria**

(a) **Required Inspection Methods**

(2) Welds in offshore pipeline systems may also be evaluated on the basis of para. A434.8.5(b).

(3) The requirements of para. 434.8.5(a)(3) are superseded by the following provisions. All circumferential welds on offshore pipeline systems shall meet the requirements in para. 434.8.5(a) for a pipeline that would operate at a hoop stress of more than 20% of the specified minimum yield strength of the pipe. One hundred percent of the total number of circumferential butt welds on offshore pipeline systems shall be nondestructively inspected, if practical; but in no case shall less than 90% of such welds be inspected. The inspection shall cover 100% of the length of such inspected weld.

(b) **Standards of Acceptability**

Inspection Methods and Acceptable Standards. For girth welds in offshore pipeline systems, alternative flaw acceptance limits may be based upon fracture mechanics analysis and fitness-for-purpose criteria as described by API 1104. Such alternative acceptance standards shall be supported by appropriate stress analyses, supplementary welding procedure test requirements, and nondestructive examinations beyond the minimum requirements specified herein. The accuracy of the nondestructive techniques for flaw depth measurement shall be verified.

**A434.8.9 Stress Relieving**

(a) On offshore pipeline systems, the demonstration specified in para. 434.8.9(a) shall be conducted on materials and under conditions that simulate, as closely as practical, the actual production welding.

**A434.11 Backfilling**

Backfilling of trenched offshore pipelines is not normally required but may sometimes be utilized to provide additional stability or protection.

**A434.13 Special Crossings**

**A434.13.1 Water Crossings.**

See para. A402.3.2(e)(3) A402.3.5(e)(3) concerning the use of river weights.
**A434.14 Offshore Pipeline Construction**

**A434.14.1 Pipe Depth and Alignment.**

Plans and specifications shall describe alignment of the pipeline, its design depth below mean water level, and the depth below the sea bottom, if trenching is prescribed. Special consideration shall be given to depth of cover and other means of protecting the pipeline in the surf zone and other areas of potential hazards, such as near platforms, anchorage areas, and shipping fairways.

**A434.25 Installation Procedures and Equipment Selection.**

Installation procedures shall be prepared prior to beginning construction. Installation procedures shall address the design considerations in para. A401.9A401.2.4 and strength considerations in para. A402.3.4A402.3.1.

**A434.14.3 Movement of Existing Pipelines.**

Consideration should be given to reducing operating pressures in the existing pipelines to obtain the lowest practical stress levels prior to movement of the existing lines. Whether the pipeline pressure is reduced or not, the following steps should be taken prior to movement of the existing lines:

1. Perform a physical survey to determine the actual position of the pipeline.
2. Determine wall thickness and mechanical properties of the existing pipeline section to be moved.
3. Investigate possible pipe stress that may exist in the pipeline in its present condition.
4. Calculate additional stresses imposed by the proposed movement operation.
5. Prepare a detailed procedure for the proposed movement.

Investigation of the possible pipe stresses that may be induced in the existing pipeline during the relocation should be performed regardless of the anticipated internal pressure. This investigation should consider appropriate elevation tolerances for the lowering. Pipe stresses resulting from the relocation should not exceed the criteria in para. A402.3.4A402.3.1, and pipe stresses resulting from existing pipeline operation after lowering should not exceed the criteria in para. A402.3.5A402.3.2.

**A434.15 Block and Isolating Valves**

**A434.15.1 General**

(a) Block and isolating valves shall be selected to provide timely closure and to limit both property and environmental damage and provide safety under emergency conditions.
On offshore platforms, consideration shall be given to locating block and isolating valves, or valve operator controls where used, in areas that are readily accessible under emergency conditions.

Submerged valves shall be marked or spotted by survey techniques and recorded on permanently retained as-built records to facilitate location when operation is required.

**A434.18 Line Markers**

Line markers are not required on offshore pipeline systems.

**A436 INSPECTION**

**A436.2 Qualification of Inspectors**

In addition to the requirements of para. 436.2, offshore inspection personnel shall be capable of inspecting the following, as applicable:

(a) offshore vessel positioning systems
(b) diving operations
(c) remotely operated vehicle (ROV) operations
(d) pipeline trenching and burial operations
(e) special services for testing and inspection of offshore pipeline facilities, such as subsea pipeline lateral tie-ins, and subsea pipeline crossings as may be required
(f) pipelay parameters

**A436.5 Type and Extent of Examination Required**

**A436.5.1 Visual**

(b) Construction

(919) When offshore pipelines are trenched, the condition of the trench, trench depth, and fit of the pipe to the trench shall be inspected when feasible.

(4420) When offshore pipelines are to be backfilled, the backfilling operations shall be inspected for quality of backfill, possible damage to the pipe coating, and depth of cover.

(4221) Pipelines shall be inspected for spans.

(3322) Pipeline crossings shall be inspected for specified separation.

(4523) Where specified, special assemblies and protection measures as described in para. A402.3.10A402.3.6 shall be inspected for protection against damage by outside forces, such as fishing and other marine activities.

**A437 TESTING**

**A437.1 General**

**A437.1.4 Testing After New Construction**
(a) Systems or Parts of Systems

(3) Provisions of para. 437.1.4(a)(3) are superseded by the following. All pipe and pressure-containing piping components shall be tested in accordance with the provisions of para. 437.1.4(a)(2).

(b) Testing Tie-Ins. Nonwelded tie-in connections shall be observed for leaks at operating pressure. Tie-in welds and girth welds joining lengths of pretested pipe shall be inspected by radiographic or other accepted nondestructive methods in accordance with para. A434.8.5(a)(4), if system is not pressure-tested after tie-in.

(d) Hydrostatic Test Medium. The hydrostatic test medium for all offshore pipeline systems shall be water, except in arctic areas. Additives to mitigate the effects of corrosion, biofouling, and freezing should be considered. Such additives should be suitable for the methods of disposal of the test medium.

In arctic areas where freezing of water is a restraint, the use of air, inert gas, or glycol is allowable, provided appropriate detail considerations are addressed.

Disposal of all materials shall be done in an environmentally safe manner.

(e) Diameter Restrictions. Testing for buckles, dents, and other diameter restrictions shall be performed after installation. Testing shall be accomplished by passing a deformation detection device through the pipeline section, or by other methods capable of detecting a change in pipe cross section. Pipe having deformation that affects the serviceability of the pipeline facilities shall be repaired or replaced. Consideration should also be given to repairing ovality that may interfere with pigging operations or internal inspections.

A437.4 Test Pressure
A437.4.3 Leak Testing.

Provisions of para. 437.4.3 are not applicable for offshore pipeline systems.

A437.6 Qualification Tests

Pipe of unknown specification and ASTM A120 specification pipe are not allowed in offshore pipeline systems. See para. A423.1.

A437.7 Records

“As-built” records shall also include the location of anodes and buckle arrestors (if used) by pipe joint installation sequence. Subsea valve, tie-in, and other special assembly locations shall be recorded by coordinates.

A450 OPERATION AND MAINTENANCE PROCEDURES AFFECTING THE SAFETY OF LIQUID AND SLURRY TRANSPORTATION PIPING SYSTEMS

A450.2 Operation and Maintenance Plans and Procedures

The provisions of paras. 450.2(d), (e), and (i) are superseded by the following:

(d) Have a plan for reviewing conditions affecting the integrity and safety of the pipeline system, including provisions for periodic patrolling and reporting of construction activity and changes in conditions.
(e) Establish and maintain liaisons with local offshore authorities who issue permits in order to prevent accidents caused by new construction. Establish and maintain liaisons with available offshore firefighting and pollution control entities.

(i) In establishing plans and procedures, give particular attention to those portions of the system presenting the greatest hazard to the public and to the environment in the event of emergencies or because of construction or extraordinary maintenance requirements.

**A451 PIPELINE OPERATION AND MAINTENANCE**

**A451.1 Operating Pressure**

(a) If a component is installed during the repair that has a maximum pressure rating less than the allowable operating pressure of the pipeline, the pipeline shall be derated to the pressure rating of the component, Analyzed in accordance with para. 451.1(a).

**A451.3 Line Markers and Signs**

The provisions of para. 451.3 do not apply to offshore pipeline systems.

**A451.4 Right-of-Way Maintenance**

The provisions of para. 451.4 do not apply to offshore pipeline systems.

**A451.5 Patrolling**

(a) The provisions of paras. 451.5(a) and (b) are superseded by the following. Each offshore pipeline system operator shall maintain a periodic pipeline patrol program to observe surface conditions on, and adjacent to, the pipeline right-of-way, indication of leaks, construction activity other than that performed by the operator, and any other factors affecting the safety and operation of the pipeline. Consideration should be given to increased patrols in areas more susceptible to damage by outside forces. Such areas are listed in para. A451.11.

**A451.6 Pipeline Integrity Assessment and Repairs**

As a means of maintaining the integrity of its pipeline system, each operating company shall establish and implement procedures for continuing surveillance of its facilities. Studies shall be initiated and appropriate action taken when unusual operating and maintenance conditions occur, such as failures, leakage history, unexplained changes in flow or pressure, or substantial changes in cathodic protection requirements.

Consideration should be given to inspection of pipelines and pipeline protection measures in areas most susceptible to damage by outside forces. Such areas may include shore crossings, areas near platforms, shipping fairways, pipeline crossings, span rectifications, subsea assemblies, and shallow water areas. If the operating company discovers that the cover or other conditions do not meet the original design, it shall determine whether the existing conditions are unacceptable. If unacceptable, the operating company shall provide additional protection by replacing cover, lowering the line, installing temporary or permanent warning markers or buoys, or using other suitable means.

When such studies indicate the facility is in an unsatisfactory condition, a planned program shall be initiated to abandon, replace, or repair. If such a facility cannot be
repaired or abandoned, the maximum operating pressure shall be reduced commensurate with the requirements described in paras. 451.1(a) and A451.1(a).

Offshore pipeline risers shall be visually inspected annually for physical damage and corrosion in the splash zone and above. Consideration should also be given to periodic visual inspection of the submerged zone of the riser. The extent of any observed damage shall be determined, and if the serviceability of the riser is affected, the riser shall be repaired or replaced.

Consideration should be given to the periodic use of internal or external inspection tools to monitor internal and external pipeline corrosion and to detect other unsafe conditions.

**A451.6.1 General.**

Additional requirements for repairs to offshore pipeline systems are as follows:

(a) Repair operations shall not result in imposed deformations that would impair the integrity of the pipe materials, and weight or protective coating.

(b) Subsea equipment used in the repair of offshore pipeline systems shall be carefully controlled and monitored to avoid damaging the pipeline, external coating, or cathodic protection system.

(c) When lifting or supporting pipe during repairs, the curvature of a pipe sag bend and overbend shall be controlled to prevent overstressing, denting, or buckling the pipe or damaging the coating. Lifting equipment shall be selected to comply with this requirement.

(d) Wave and current loads shall be considered in determining total imposed stresses and cyclical loadings in both surface and subsurface repairs.

(e) When pipe is repaired, damaged coating shall be repaired.

(f) Replacement pipe and components shall be protected from corrosion.

Consideration should be given to obtaining pipe-to-water potentials during the repair operations to verify conformance to cathodic protection requirements.

**A451.6.2 Limits and Disposition of Imperfections and Anomalies**

**Disposition of Defects**

**A451.6.2.9 Permanent Repairs**

(b) Allowable Pipeline Repairs

(4) Patches shall not be used on offshore pipeline systems.

(6) Partial encirclement half soles shall not be used on offshore pipeline systems.

(c) Repair Methods

(5) Patches shall not be used on offshore pipeline systems.

(9) Welded fittings allowed by para. 451.6.2.9(h) to cover defects shall not be used in offshore pipeline systems.

(13) Half soles for repairs in offshore pipeline systems are prohibited.

Commented [STM55]: Text deleted in this paragraph was removed because 451.6.2.9(i) does not allow patches of half soles.
A451.4 Repair of Flexible Pipe

(a) Major Structural Damage. If the serviceability of the flexible pipe is impaired, the damaged pipe section shall be replaced.

(b) Surface Cuts. In the event of surface cuts and abrasions that do not expose the load-carrying members to potential corrosion, the repair shall be performed in a manner recommended by the manufacturer.

A451.8 Valve Maintenance

Provisions of para. 451.8 do not apply to offshore pipeline systems. Pipeline block valves that would be required by the emergency plan (see sections 454 and A454) to be operated during an emergency shall be inspected periodically, and fully or partially operated at least once a year.

A451.9 Railroads and Highways Crossing Existing Pipelines

The provisions of para. 451.9 do not apply to offshore pipeline systems.

A451.10 Offshore Pipeline Risers Inland Waters Platform Risers

The provisions of para. 451.10 do not apply to offshore pipeline systems.

A452 PUMP STATION, TERMINAL, AND STORAGE FACILITIES OPERATION AND MAINTENANCE

A452.5 Fencing

Fencing is not applicable for offshore facilities.

A452.7 Prevention of Accidental Ignition

Smoking shall be prohibited in all areas of offshore facilities in which the possible leakage or presence of vapor constitutes a fire or explosion hazard.

A454 EMERGENCY PLAN

(d) The provisions of para. 454(d) do not apply to offshore pipeline systems.

(e)(5) The provisions of para. 454(e)(5) do not apply to offshore pipeline systems. To minimize public exposure to injury and to prevent accidental ignition, provisions for halting or diverting marine vessel traffic shall be included in the emergency plan.

A460 GENERAL

(a) In addition to the provisions of para. 460(a), special considerations shall be given to corrosion control of offshore pipeline systems because they cannot easily be inspected after installation and there is the possibility of damage to the coating system. Special attention shall be given to the selection, design, and application of corrosion control coatings, the cathodic protection system, and other corrosion design elements.

(c) NACE SP 0115 / ISO 15589-2RP 0675 provides a guide for procedures to implement requirements herein and to monitor and maintain cathodic protection systems for offshore pipeline systems.

A461 EXTERNAL CORROSION CONTROL FOR OFFSHORE-BURIED OR SUBMERGED PIPELINES
A461.1 New Installations

A461.1.1 General

(ac) In addition to the provisions of para. 461.1, a minimum clearance of 12 in. (300 mm) shall be maintained between the outside of any offshore pipeline and any other structure that may affect the cathodic protection of the offshore pipeline, except where impractical (e.g., bundled pipelines) and where adequate provisions for corrosion control have been made.

A461.1.2 Protective Coating Requirements

(f) In addition to the provisions of paras. 461.1.2 and 461.2.8, consideration should be given to insulating the carrier pipe from the casing pipe when the carrier pipe is pulled into pull-tube risers. Consideration should also be given to preventing oxygen replenishment in the water in the annulus between carrier pipe and casing by sealing at least one end of pull-tube risers or other measures to prevent corrosion.

A461.1.3 Cathodic Protection Requirements System

(a) In addition to the provisions of para. 461.1.3, where impressed current systems are used, the system shall be designed to minimize outages. The design formula for galvanic anode systems shall include the percentage of exposed pipe, current output of the anodes, design life of the system, anode material, and utilization efficiency. Anodes should be compatible with the operating temperature of the pipeline and the marine environment. Consideration should be given to the effects on cathodic protection of variations in oxygen content, temperature, and water/soil resistivity of the particular offshore environment in which the pipeline is installed.

For installations containing flexible pipe, consideration shall be given to the need for galvanic anodes or impressed current at the end connections. A cathodic protection system shall be installed at the time of pipeline installation or as soon as practical after pipeline installation. Owners of other offshore pipelines or facilities that may be affected by installation of a cathodic protection system shall be notified of said installation.

A461.1.4 Electrical Isolation

(a) In addition to the provisions of para. 461.1.4, consideration shall be given to electrically isolating supporting devices, such as clamps and pipe supports, from the riser on platforms. Wiring and piping connections to an electrically isolated pipeline shall also be insulated from devices grounded to the platform.

A461.1.5 Electrical Connections and Monitoring Points Test Leads

(a) It is considered impractical to locate test leads on submerged portions of offshore pipeline systems. Consideration should be given to installing test leads on platform risers, platform piping, and pipeline shore crossings.

A461.1.6 Electrical Interference

(c) When new pipeline are laid in the vicinity of existing lines, measures shall be taken to minimize electrical interference.

A461.3 Monitoring
Evidence of adequate level of cathodic protection shall be by one or more of the criteria listed in NACE SP 0115 / ISO 15589-2 RP 0675.

If repairs are made to offshore pipelines below water, inspection for evidence of external corrosion or coating deterioration shall be made, and necessary corrective action shall be taken to maintain the corrosion protection of the pipeline.

When an offshore pipeline is lifted above water for maintenance or repair purpose, the operating company shall visually inspect for evidence of coating deterioration, external corrosion, and where possible, the condition of any exposed anode. If excessive corrosion is present, remedial action shall be taken as necessary.

Consideration should be given to the periodic use of internal inspection tools to monitor external pipeline corrosion.

A463 EXTERNAL CORROSION CONTROL FOR PIPELINES EXPOSED TO ATMOSPHERE

A463.1 New Offshore Installations

(a) The option of demonstrating “by test, investigation, or experience in area of application that a corrosive atmosphere does not exist,” does not apply to offshore pipeline systems. The type of protective coating selected shall be resistant to the environment existing in offshore locations. The surface preparation and coating application shall be performed in accordance with established specifications and the manufacturer’s recommendations. The selected coating should have the following characteristics:

1. low water absorption
2. resistance to water action
3. compatibility with system operating temperature
4. resistance to atmospheric deterioration
5. resistance to mechanical damage
6. ease of repair

(b) The splash zone area of the offshore pipeline system shall be designed with additional protection against corrosion. This shall be accomplished by one or more of the following:

1. special coating
2. special protective systems and techniques
3. other suitable measures, including selection of pipe material
451.6.2.6 Anomalies Created by Manufacturing Processes.
An anomaly created during the manufacture of the steel or the pipe that exists in a pipeline that has been subjected to a hydrostatic test to a minimum level of 1.25 times its maximum operating pressure in accordance with para. 437.4.1 shall not be considered a defect unless the operator has reason to suspect that the anomaly has been enlarged by pressure-cycle-induced fatigue. If it is established that the anomaly has become or is likely to become enlarged by pressure-cycle induced fatigue, the anomaly shall be removed or repaired.

451.6.2.6 Anomalies Created by Manufacturing Processes.
An anomaly created during the manufacture of the steel or the pipe that exists in a pipeline that has been subjected to a hydrostatic test to a minimum level of 1.25 times its maximum operating pressure in accordance with para. 437.4.1 shall not be considered a defect unless the operator has reason to suspect that the anomaly has been enlarged by pressure-cycle-induced fatigue. If it is established that the anomaly has become or is likely to become enlarged by pressure-cycle induced fatigue, the anomaly shall be removed or repaired. Unless an engineering evaluation indicates that the anomaly will not affect integrity before the next planned inspection.
437.6.4 Determination of Weld Joint Factor.
If the type of longitudinal or helical seam weld joint is known, the corresponding weld joint factor (Table 403.2.1-1) may be used. Otherwise, as noted in Table 403.2.1-1, the factor $E$ shall not exceed 0.60 for pipe NPS 4 and smaller, or 0.80 for pipe over NPS 4.
# RATIONALE

The purpose of this change is to add a reference to ASME B31J in the B31.4 Code. B31J was recently revised based on extensive research by Tony Paulin. It contains stress intensification and flexibility factors of higher accuracy and increased scope compared to B31.4. There is movement amongst all B31 code books to allow their users to utilize B31J for stress intensification factors and flexibility factors.

This item will be used to add a reference to ASME B31J in the B31.4 Code so that stress intensification and flexibility factors calculated utilizing information within B31.4 or ASME B31J can be used.

## REIRCULATION BALLOT CHANGE:

Two comments on ballots requested a change of wording from “per 402.1” to “in accordance with para. 402.1”. The revised proposal incorporates the request.

<table>
<thead>
<tr>
<th>PRESENT TEXT</th>
<th>PROPOSED CHANGES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>402.1 General</strong></td>
<td><strong>402.1 General</strong></td>
</tr>
<tr>
<td>Calculations shall take into account stress intensification factors found to exist in components other than plain straight pipe. Credit may be taken for extra flexibility of such components. In the absence of more directly applicable data, the flexibility factors and stress intensification factors shown in Table 402.1-1 may be used.</td>
<td>Calculations shall take into account stress intensification factors found to exist in components other than plain straight pipe. Credit may be taken for extra flexibility of such components. In the absence of more directly applicable data, the flexibility factors and stress intensification factors shown in Table 402.1-1 or ASME B31J may be used.</td>
</tr>
</tbody>
</table>

NOTES: (1) Underline and blue indicates revised and new text.
(2) Strikethrough and red indicates deleted text.
(3) Informational note is shown in green.
## 402.5.2 Unrestrained Pipe.

Calculations shall take into account flexibility and stress intensification factors of piping components.

The stress range resulting from thermal expansion in pipe, fittings, and components in unrestrained pipeline is calculated as follows, using the modulus of elasticity at the installed temperature:

\[ S_E = \sqrt{S_b^2 + 4S_t^2} \]

where

- \( S_b \) = resultant bending stress, psi (MPa)
- \( S_t \) = torsional stress, psi (MPa)

**NOTE:** Thermal stress shall be calculated for the range of minimum and maximum operating temperatures

The resultant bending stress, \( S_b \), is calculated as follows:

\[ S_b = \sqrt{(i_i M_i)^2 + (i_o M_o)^2} / Z \]

where

- \( i_i \) = in-plane stress intensification factor from Table 402.1-1. Note that \( i_i \) is 1 for pipe.
- \( i_o \) = out-of-plane stress intensification factor from Table 402.1-1. Note that \( i_o \) is 1 for pipe
- \( M_i \) = in-plane bending moment, in.-lb (N • m)
- \( M_o \) = out-of-plane bending moment, in.-lb (N • m)
- \( Z \) = section modulus of the pipe or of the fitting outlet, as applicable, in. \( ^3 \) (cm \( ^3 \))
### A402.3.5 Strength Criteria During Operations

*(2) Longitudinal Stress.* For offshore pipeline systems, the longitudinal stress shall not exceed values found from

\[ |S_L| \leq F_2(S_\gamma) \]

where
- \( A \) = cross-sectional area of pipe material, in.\(^2\) (mm\(^2\))
- \( F_2 \) = longitudinal stress design factor from Table A402.3.5-1
- \( F_a \) = axial force, lb (N)
- \( i_i \) = in-plane stress intensification factor from Table 402.1-1
- \( i_o \) = out-of-plane stress intensification factor from Table 402.1-1

*(3) Combined Stress.* For offshore pipeline systems, the combined stress shall not exceed the value given by the Maximum Shear Stress Equation (Tresca Combined Stress)

\[
2 \left[ \sqrt{ \left( \frac{S_L - S_h}{2} \right)^2 + S_i^2 } \right] \leq F_3(S_\gamma)
\]

where
- \( A \) = pipe cross-sectional area, in.\(^2\) (mm\(^2\))
- \( F_3 \) = combined stress design factor from Table A402.3.5-1
- \( F_a \) = axial force, lb (N)
- \( i_i \) = in-plane stress intensification factor from Table 402.1-1
- \( i_o \) = out-of-plane stress intensification factor from Table 402.1-1

### ASME CODE FOR PRESSURE PIPING, B31

Standard Test Method for Determining Stress Intensification Factors (i-Factors) for Metallic Piping Components…..B31J-2008 (R2013)

Metodo de prueba estandar para determinar factores de itensificacion de esfuerzo (Facotres i) para componentes de tuberia metalicas….. B31J-2008 (R2013)
<table>
<thead>
<tr>
<th>Current Language</th>
<th>Proposal</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>434.8.9 Stress Relieving</strong>&lt;br&gt;(a) Welds shall be stress relieved when the effective weld throat (see Fig. 434.8.6-2) exceeds 1(\frac{1}{4}) in. (32 mm), unless it can be demonstrated by welding procedure qualification tests, using materials of the same specification, type, and grade with an effective weld throat that is equal to or greater than the production weld, that stress relieving is not necessary. Welds in carbon steels having an effective weld throat larger than 1(\frac{1}{4}) in. (32 mm) and not larger than 1(\frac{1}{2}) in. (38 mm) may be exempted from stress relieving if a minimum preheating temperature of 200°F (93°C) is used. The welding procedure specification shall specify when stress relieving and/or heat treatment are required due to composition, thickness, welding process, restraint of the weld joint, or service conditions. When required, the welding procedure qualification test shall include stress relieving and/or heat treatment of the completed test joint. The postweld stress-relieving and heat treatment requirements in ASME B31.3 or Section VIII, Division 1 or Division 2 of the ASME Boiler and Pressure Vessel Code may be used as a guide for minimum stress relieving and heat treating requirements. The thickness to be used to determine the stress-relieving requirements of branch connections or slip-on flanges shall be the thickness of the pipe or header. The thickness to be used to determine the stress-relieving requirements of branch connections or slip-on flanges shall be the thickness of the pipe or header.</td>
<td><strong>434.8.9 Stress Relieving</strong>&lt;br&gt;(a) Welds shall be stress relieved when the effective weld throat (see Fig. 434.8.6-2) exceeds 1(\frac{1}{4}) in. (32 mm), unless it can be demonstrated by welding procedure qualification tests, using materials of the same specification, type, and grade with an effective weld throat that is equal to or greater than the production weld, that stress relieving is not necessary. Welds in carbon steels having an effective weld throat larger than 1(\frac{1}{4}) in. (32 mm) and not larger than 1(\frac{1}{2}) in. (38 mm) may be exempted from stress relieving if a minimum preheating temperature of 200°F (93°C) is used. The welding procedure specification shall specify when stress relieving and/or heat treatment are required due to composition, thickness, welding process, restraint of the weld joint, or service conditions. When required, the welding procedure qualification test shall include stress relieving and/or heat treatment of the completed test joint. The postweld stress-relieving and heat treatment requirements in ASME B31.3 or Section VIII, Division 1 or Division 2 of the ASME Boiler and Pressure Vessel Code may be used as a guide for minimum stress relieving and heat treating requirements. The thickness to be used to determine the stress-relieving requirements of branch connections or slip-on flanges shall be the thickness of the pipe or header. The thickness to be used to determine the stress-relieving requirements of branch connections or slip-on flanges shall be the thickness of the pipe or header.</td>
</tr>
</tbody>
</table>
ISSUE:
Pipe metal area is included within the equations for longitudinal stress in sections 402.6.1 and 402.6.2. The variable “A” is defined as “metal area of nominal pipe cross section, in² (cm²)”.

The use of cm² for variable “A” within the SI equations results in inconsistent units. The SI unit within the variable definition must be modified to “mm²” within each section.

Proposed changes are highlighted on the following slides.
402.6.1 Longitudinal Stress

(16) 402.6.1 Restrained Pipe. Longitudinal stress in restrained pipe is calculated as

\[ S_L = S_E + \nu S_H + \frac{M}{Z} + \frac{F_a}{A} \]

where

- \( A \) = metal area of nominal pipe cross section, in.\(^2\) (cm\(^2\))
- \( F_a \) = axial force, such as weight on a riser, lb (N)
- \( M \) = bending moment, in.-lb (N\(\cdot\)m)
- \( S_E \) = thermal expansion stress, psi (MPa)
- \( S_H \) = circumferential (hoop) stress due to internal pressure, psi (MPa)
- \( Z \) = section modulus of the pipe, in.\(^3\) (cm\(^3\))
- \( \nu \) = Poisson’s ratio

\[ A = \text{metal area of nominal pipe cross section, in.}^2 (\text{mm}^2) \]
402.6.2 Unrestrained Pipe. The longitudinal stress from pressure and external loadings in unrestrained pipe is calculated as

(U.S. Customary Units)

\[ S_L = \frac{PD}{4t} + \frac{iM}{Z} + \frac{F_a}{A} \]

(SI Units)

\[ S_L = \frac{PD}{40t} + \frac{iM}{Z} + \frac{F_a}{A} \]

where

- \( A \) = metal area of nominal pipe cross section, in.\(^2\) (cm\(^2\))
- \( D \) = outside diameter of pipe, in. (mm)
- \( F_a \) = axial force, such as weight on a riser, lb (N)
- \( i \) = component stress intensification in plane of loading (see Table 402.1-1), limited by \( 0.75i \geq 1 \). For straight pipe, \( i = 1.0 \).
- \( M \) = bending moment across the nominal pipe cross section due to weight or seismic inertia loading, in.-lb (Nm)
- \( P_i \) = internal design gage pressure, psi (bar)
- \( t \) = wall thickness of pipe, in. (mm)
- \( Z \) = section modulus of the pipe or of the fitting outlet, as applicable, in.\(^3\) (cm\(^3\))

\[ A = \text{metal area of nominal pipe cross section, in.}^2 \text{ (mm}^2\text{)} \]
In 404.2.3 for Induction Bends, the very last “word” in section refers to “para. 403.12”. The correct reference should be to “para. 403.11”, which has to do with limitations on use of cold worked pipe in making bends.

**Current Text**

404.2.3 Induction Bends. Induction bends are made by … When hot bends are made in pipe that has been cold worked in order to meet the specified minimum yield strength, wall thickness shall be determined by using the lower stress values in accordance with para. 403.12.

**Proposed Text**

404.2.3 Induction Bends. Induction bends are made by … When hot bends are made in pipe that has been cold worked in order to meet the specified minimum yield strength, wall thickness shall be determined by using the lower stress values in accordance with para. 403.11.

**References**

16. **403.11 Criteria for Cold Worked Pipe**

The allowable stress for pipe that has been cold worked to meet the specified minimum yield strength and is subsequently heated to 600°F (300°C) or higher (welding excepted) shall be derated to 75% of the allowable stress value as defined in para. 403.2.1.

403.12 Criteria for Shear and Bearing Stresses

Allowable stress values in shear shall not exceed 45% of the specified minimum yield strength of the pipe, and allowable stress values in bearing shall not exceed 90% of the specified minimum yield strength of the pipe.
434.15.2 Mainline Valves

(a) Mainline block valves shall be installed on the upstream side of major river crossings and public water supply reservoirs. Either a block or check valve shall be installed on the downstream side of major river crossings and public water supply reservoirs.

(b) A mainline block valve shall be installed at mainline pump stations, and a block or check valve (where applicable to minimize pipeline backflow) shall be installed at other locations appropriate for the terrain features. In industrial, commercial, and residential areas where construction activities pose a particular risk of external damage to the pipeline, provisions shall be made for the appropriate spacing and location of mainline valves consistent with the type of liquids and slurries being transported. An analysis that examines the potential hazards and areas impacted by an inadvertent release of product shall be completed to assist in determining valve spacing and locations.

(c) A remotely operated mainline block valve shall be provided at remotely controlled pipeline facilities to isolate segments of the pipeline.

(d) On piping systems transporting LPG or liquid anhydrous ammonia, check valves shall be installed where applicable with each block valve to provide automatic blockage of reverse flow in the piping system.

(e) In order to facilitate operational control, limit the duration of an outage, and expedite repairs, mainline block valves shall be installed at 7.5 mile (12 km) maximum spacing on piping systems transporting LPG or liquid anhydrous ammonia in industrial, commercial, and residential areas.

(f) Mainline block valve locations shall be confirmed by an analysis of the potential hazards and impacts resulting from an inadvertent release of product.

Commented [BO1]: This opening phrase sets the context for what follows: i.e. risk of damage from 3rd party construction.
In Chapter XI: para C400.2 the conversion from 60,000 psi to MPa is incorrect and should be approx. 414 MPa. This corresponds to the lesser Tensile Strength value in MPa of the “Ductile Iron” materials, ASTM A395 and ASTM A536, listed in Table 423.1-1. viz.: 60,000 Psi [414 MPa]

<table>
<thead>
<tr>
<th>Current Text</th>
<th>Proposed Text</th>
<th>References / Justification</th>
</tr>
</thead>
<tbody>
<tr>
<td>C400.2 Definitions (Applicable to This Chapter Only)</td>
<td>C400.2 Definitions (Applicable to This Chapter Only)</td>
<td>from ASTM A395</td>
</tr>
<tr>
<td>Some of the more common terms relating to slurry pipelines are defined below. ... ductile iron: a gray iron base metal ... A minimum tensile strength of 60,000 psi (207 MPa) is required.</td>
<td>Some of the more common terms relating to slurry pipelines are defined below. ... ductile iron: a gray iron base metal ... A minimum tensile strength of 60,000 psi (414 MPa) is required.</td>
<td>from ASTM A536</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TABLE 1 Mechanical Property Require</th>
</tr>
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<tbody>
<tr>
<td>Property</td>
</tr>
<tr>
<td>Tensile Strength Minimum, Psi [MPa]</td>
</tr>
<tr>
<td>Yield Strength Minimum, Psi [MPa]</td>
</tr>
<tr>
<td>Elongation in 2 in. Minimum, %</td>
</tr>
<tr>
<td>Hardness HB, 3000 Kgf Load</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TABLE 1</th>
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<tbody>
<tr>
<td>Grade 60-40-18</td>
</tr>
<tr>
<td>Tensile strength, min. psi</td>
</tr>
<tr>
<td>Tensile strength, min. MPa</td>
</tr>
<tr>
<td>Yield strength, min. psi</td>
</tr>
<tr>
<td>Yield strength, min. MPa</td>
</tr>
<tr>
<td>Elongation in 2 in. or 50 mm, min. %</td>
</tr>
</tbody>
</table>
In 404.4 Flanges, the opening sentence should read (additions are underlined): “The design of flanges manufactured in accordance with para. 404.4 and standards or specifications listed in Tables 423.1-1 and 426.1-1 shall be considered suitable for use....”

<table>
<thead>
<tr>
<th>Current Text</th>
<th>Proposed Text</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>404.4.1 General.</strong> The design of flanges manufactured in accordance with para. 404.4 and standards listed in Table 426.1-1 shall be considered suitable for use at the pressure–temperature ratings as set forth in para. 404.1.2. When steel flanged fittings are used, they shall comply with ASME B16.5</td>
<td><strong>404.4.1 General.</strong> The design of flanges manufactured in accordance with para. 404.4 and standards or specifications listed in Table 423.1-1 and Table 426.1-1 shall be considered suitable for use at the pressure–temperature ratings as set forth in para. 404.1.2. When steel flanged fittings are used, they shall comply with ASME B16.5</td>
<td></td>
</tr>
</tbody>
</table>
The same changes apply to Chapter XI: C404.4 Flanges, except that Table C426.1-1 DOES NOT EXIST. The tables referenced in 404.4.1 apply to slurry piping system with the addition of Table C423.1-1, but subject to excluded standards listed in Tables C423.1-2 and Table C426.1-2.

<table>
<thead>
<tr>
<th>Current Text</th>
<th>Proposed Text</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>C404.4.1 General.</strong> The design of flanges manufactured in accordance with this paragraph and standards listed in Table C426.1-1 shall be considered suitable for use at the pressure–temperature ratings as set forth in para. 404.1.2</td>
<td><strong>C404.4.1 General.</strong> The design of flanges manufactured in accordance with this paragraph and standards or specifications listed in para. 404.4.1 and in Table C423.1-1 subject to exclusions in Table C423.1-2 and Table C426.1-2 shall be considered suitable for use at the pressure temperature ratings as set forth in para. 404.1.2</td>
</tr>
</tbody>
</table>

**References**

Table C423.1-2 Material Standards Not Applicable for Slurry Piping Systems From Table 426.1-1

<table>
<thead>
<tr>
<th>Standard or Specification</th>
<th>Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fittings, Valves, and Flanges</td>
<td>ASME B16.36</td>
</tr>
<tr>
<td>Orifice Flanges</td>
<td></td>
</tr>
</tbody>
</table>
B31.4 New Ballot Item 02-20-2018

Description:
Ballot identifying editorial changes [only] to better identify intent of use of a NOTE in the body text of the document

Ballot Document

402.5.2 Unrestrained Pipe. Calculations shall take into account flexibility and stress intensification factors of piping components.

The stress range resulting from thermal expansion in pipe, fittings, and components in unrestrained pipeline is calculated as follows, using the modulus of elasticity at the installed temperature:

\[ \text{original equation retained, no changes} \]

where

- \( S_b \): resultant bending stress, psi (MPa)
- \( S_t \): torsional stress, psi (MPa)

**NOTE:** Thermal stress shall be calculated for the range of minimum and maximum operating temperatures.

402.6.2 Unrestrained Pipe. The longitudinal stress from pressure and external loadings in unrestrained pipe is calculated as

\[ \text{original equation retained, no changes} \]

**Note that:** Longitudinal stress from pressure in an unrestrained line shall include consideration of bending stress or axial stress that may be caused by elongation of the pipe due to internal pressure and result in stress at bends and at connections and produce additional loads on equipment and on supports.

403.9.1 Unrestrained Pipelines. Pipelines shall be designed to have sufficient flexibility to prevent expansion or contraction from causing stresses in the pipe material or pipeline components that exceed the allowables specified herein, including joints, connections, anchor points, or guide points. **Note that:** Allowable forces and moments on equipment may be less than for the connected pipe.

Analysis of adequate flexibility of unrestrained pipe is not required for a pipeline that

(a) has been previously analyzed
(b) is of uniform size, has no more than two anchor
points and no intermediate restraints, and falls within the limitations of the following empirical formula:
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thicknesses, fig 434.8.6-1
Acceptable butt welded joint design for unequal wall
thicknesses, fig 434.8.6-2
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Acceptable pipeline repair methods for dents,
buckles, ripples, wrinkles, leaking, couplings
and defective prior repairs, table 451.6.2.9-2
Acceptable pipeline repair methods, table 451.6.2.9-1
Allowable values for pipeline system stresses, table
403.3.1-1
Anomalies created by manufacturing processes,
451.6.2.6
Application of loads, 401.2
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Process Piping .................................................................. B31.3-2014
Tubieras de Proceso ....................................................... B31.3-2014
Pipeline Transportation Systems for Liquids and Slurries. ........................................ B31.4-2016
Refrigeration Piping and Heat Transfer Components .................................................. B31.5-2013
Gas Transmission and Distribution Piping Systems ............................................. B31.8-2014
Managing System Integrity of Gas Pipelines ..................................................... B31.8S-2014
Gestión de Integridad de Sistemas de Gasoductos ............................................ B31.8S-2010
Building Services Piping ............................................................................... B31.9-2014
Hydrogen Piping and Pipelines ................................................................. B31.12-2014
Standard for the Seismic Design and Retrofit of Above-Ground Piping Systems .................. B31E-2008
Manual para la determinación de la resistencia remanente de tuberías corroídas ................. B31G-2012
Standard Test Method for Determining Stress Intensification Factors (i-Factors) for Metallic Piping Components ........................................ B31J-2008 (R2013)
Méthode de prueba estándar para determinar factores de intensificación de esfuerzo (Factores i) para componentes de tuberías metálicas .......... B31J-2008 (R2013)
Pipeline Personnel Qualification ..................................................................... B31Q-2014
Calificación del personal de líneas de tuberías ........................................... B31Q-2010
Standard Toughness Requirements for Piping .................................................. B31T-2010

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The changes proposed below are to add API RP 5LT. API RP 5LT covers transportation of pipe by truck. The changes affect Section 434.4, Appendix I, and the Index.

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<td><strong>434.4 Handling, Hauling, Stringing, and Storing</strong></td>
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<td>Care shall be exercised in the handling or storing of pipe, casing,</td>
<td>Care shall be exercised in the handling or storing of pipe, casing,</td>
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<td>coating materials, valves, fittings, and other materials to prevent</td>
<td>coating materials, valves, fittings, and other materials to prevent</td>
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<td>damage. Transportation by truck or other road vehicles, rail cars, and</td>
<td>damage. Transportation by truck or other road vehicles, rail cars, and</td>
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<tr>
<td>marine vessels shall be performed in such a manner as to avoid damage to</td>
<td>marine vessels shall be performed in such a manner as to avoid damage to</td>
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<td>the pipe and any pre-applied coatings. Transportation of line pipe</td>
<td>the pipe and any pre-applied coatings. Transportation of line pipe</td>
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<td>shall conform to the requirements of API RP 5LW and API RP 5L1, as</td>
<td>shall conform to the requirements of API RP 5LW, API RP 5LT, and API RP</td>
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<td>applicable. In the event pipe is yard coated or mill coated, adequate</td>
<td>5L1, as applicable. In the event pipe is yard coated or mill coated,</td>
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<td>precautions shall be taken to prevent damage to the coating when</td>
<td>adequate precautions shall be taken to prevent damage to the coating</td>
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<td>hauling, lifting, and placing on the right of way. Pipe shall not be</td>
<td>when hauling, lifting, and placing on the right of way. Pipe shall not</td>
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<td>allowed to drop and strike objects that will distort, dent, flatten,</td>
<td>be allowed to drop and strike objects that will distort, dent, flatten,</td>
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<td>gouge, or notch the pipe or damage the coating, but shall be lifted or</td>
<td>gouge, or notch the pipe or damage the coating, but shall be lifted or</td>
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<tr>
<td>lowered by suitable and safe equipment.</td>
<td>lowered by suitable and safe equipment.</td>
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Proposed changes to Appendix I:

**MANDATORY APPENDIX I**

**REFERENCED STANDARDS**

Specific editions of standards incorporated in this Code by reference, and the names and addresses of the sponsoring organizations, are shown in this Mandatory Appendix. It is not practical to refer to a specific edition of each standard throughout the Code text; instead, the specific edition reference dates are shown here. Mandatory Appendix I will be revised at intervals as needed. An asterisk (*) is used to indicate those standards that have been accepted as American National Standards by the American National Standards Institute (ANSI). For ASME codes and standards, the latest published edition in effect at the time this Code is specified is the specific edition referenced by this Code unless otherwise specified in the design.

**API Standards and Other Publications**

- Spec. 58, 15th Ed., 2008
- Spec. 5L, 44th Ed., 2007 & Em. 3-2006, Add. 1-2009
- Spec. C52
- RP 5L, 6th Ed., 1996
- RP 5L8, 2nd Ed., 1994
- (Incorporates 5L1, 5L1, and SPL)
- Spec. 6A, 19th Ed., 2000 & Em. 3-2004, Em. 2-2001

**API Standards and Other Publications (Cont’d)**

- RP 1102, 7th Ed., 2007 & Em. 1-2008
- RP 1105, 3rd Ed., 2003
- *RP 1110, 6th Ed., 2007
- RP 1111, 3rd Ed., 1999
- RP 1112, 3rd Ed., 2008 & Em. 1-2008
- RP 1120, 1st Ed., 2007
- Std. 2015, 6th Ed., 2008
- RP 2200, 3rd Ed., 1996

**ASME Codes and Standards (Cont’d)**

- *B110
- *B117
- *B16.1508
- *B16.198
- *A131
- ASTMD specifiers
- A53/A53M-06
- A106/A106M-07
- A233/A233M-05
- A136/A136M-08
- AN/A198-02

Commented [KV1]: Note to Editor: Keep comma

Commented [KV2]: Note to Editor: Delete * before RP 5LT
GENERAL NOTE: The issue date shown immediately following the number of the standard (e.g., ASME/SP-1 and SP-4-2007) is the effective date of issue (edition) of the standard.

NOTES:
1. Use of bell and spigot line pipe not permitted.
2. Limited as set forth in para. 433.3.1.
3. Approved only if mill hydrostatic test is performed.
4. API/ASME Code VIII-9 is not suitable for ammonia ammonia due to copper content.

Table of standards and specifications listed above that are referenced in the text but do not appear in Table 433.1-1 —
Material Standards or Table 476.1-1 — Dimensional Standards are as follows:

APISL Manual of Petroleum Measurement Standards
API 5A/WSO Recommended Practice for Planning, Designing, and Constructing Fixed Offshore Platforms — Working Stress Design
API 5L1 Recommended Practice for Railroad Transportation of Line Pipe
API 54S Recommended Practice for Transportation of Line Pipe on Barges and Marine Vessels
API 12B Specification for Beaded Tees for Storage of Production Liquids
API 12C Specification for Field Welded Tees for Storage of Production Liquids
API 12F Specification for Shop Welded Tanks for Storage of Production Liquids
API 17B Recommended Practice for Flexible Pipe
API 509 Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Division 1 and Divisions 2
API 630 Design and Construction of Large, Welded, Low-Pressure Storage Tanks
API 650 Welded Tanks for Oil Storage
API 1103 Steel Pipelines Crossing Railroads and Highways
API 1104 Welding of Pipelines and Related Facilities
API 1109 Marking Liquid Petroleum Pipeline Facilities
API 1110 Pressure Testing of Steel Pipelines for the Transportation of Gas, Petroleum Gas, Hazardous Liquids, Highly Volatile Liquids, or Chemicals
API 1111 Design, Construction, Operation, and Maintenance of Offshore Hydrantation Pipelines (Limit State Design)
API 1130 Computational Pipeline Monitoring for Liquids
API 2001 Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks
API 2002 Repairing Crude Oil, Liquefied Petroleum Gas, and Product Pipelines
API 2024 Safe Hot Tapping Practices in the Petroleum and Petrochemical Industries
ASME . . . Boiler and Pressure Vessel Code, Section VIII Division 1 Pressure Vessels, Section VIII Division 2 Alternative Rules for Pressure Vessels, and Section IX Welding, Brazing, and Brazing Qualifications

API SLT Recommended Practice for Truck Transportation of Line Pipe

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