INTRODUCTION

B31.11 Slurry Transportation Piping Systems: piping transporting aqueous slurries between facilities, plants, and terminals, and within terminals and pumping and regulating stations.

Incorporated into B31.4-2012.

400.2 Definitions

double submerged arc welded pipe: pipe having a longitudinal or spiral-helical seam butt joint produced by at least two passes, one of which is on the inside of the pipe. Coalescence is produced by heating with an electric arc or arcs between the bare metal electrode or electrodes and the work. The welding is shielded by a blanket of granular, fusible material on the work. Pressure is not used and filler metal for the inside and outside welds is obtained from the electrode or electrodes.

electric fusion welded pipe: pipe having a longitudinal or spiral-helical seam butt joint wherein coalescence is produced in the preformed tube by manual or automatic electric arc welding. The weld may be single or double and may be made with or without the use of filler metal. SpiralHelical seam welded pipe is also made by the electric fusion welded process with either a lap joint or a lock-seam joint.

electric induction welded pipe: pipe produced in individual lengths or in continuous lengths from coiled skelp having a longitudinal or spiral helical seam butt joint wherein coalescence is produced by the heat obtained from resistance of the pipe to induced electric current, and by application of pressure.

electric resistance welded pipe: pipe produced in individual lengths or in continuous lengths from coiled skelp, having a longitudinal or spiral-helical seam butt joint wherein coalescence is produced by the heat obtained from resistance of the pipe to the flow of electric current in a circuit of which the pipe is a part, and by the application of pressure.

internal design pressure: internal pressure used in calculations or analysis for pressure design of a piping component (see para. 401.2.2).

specified minimum yield strength (SMYS)(Sy): expressed in pounds per square inch (psi) or in megapascals (MPa), minimum yield strength prescribed by the specification under which the pipe was manufactured.

Fig. 404.3.4-1 NOTES:
(2) Provide hole in reinforcement to reveal leakage in buried welds and to provide venting during welding and heat treatment [see para. 404.3.1(d)(8)404.3.5(h)]. Not required for tee type.

Fig. 404.3.4-2
GENERAL NOTES:
(c) A hole shall be provided in reinforcement to reveal leakage in buried welds and to provide venting during welding and heat treatment [see para. 404.3.1(d)(8)404.3.5(h)].

404.3.5 Reinforcement of Single Openings

th design header wall thickness required by para. 403.1.2. For welded pipe, when the branch does not intersect the longitudinal or spiral-helical seam weld of the header, the allowable stress value for seamless pipe of comparable grade may be used in determining th for the purpose of reinforcement calculations only. When the branch does intersect the longitudinal or spiral-helical seam weld of the header, the allowable stress value S of the header shall be used in the calculation. The allowable stress value S of the branch shall be used in calculating tb.

423.2.3
(a) For all grades with an SMYS-Sy equal to or greater than 42,000 psi (289 MPa), the required minimum average (set of three specimens) absorbed energy for each heat based on full-sized 0.394 in x 0.394 in (10 mm x 10 mm) specimens shall be 20 lb-ft (27 J) for transverse specimens or 30 lb-ft (41 J) for longitudinal samples.

423.2.4
(b) Cast, malleable, and wrought iron are acceptable in pressure vessels and other equipment noted in para. 400.1.2(b) and proprietary items [see para. 400.1.2(g)], except that pressure-containing parts shall be limited to pressures not exceeding 250 psi (17 bar).
423.2.5 Materials for Liquid Anhydrous Ammonia Pipeline Systems

The longitudinal or spiral-helical seam weld of electric resistance welded and electric induction welded pipe shall be normalized.

424 Dual or multiple marking is acceptable, as long as provided the material so marked meets all of the requirements of all the specifications, grades, classes, and types with of which it is marked.

434.8 Welding

434.8.1 General

(a) Scope. Welding herein applies to the arc and gas welding of pipe in both wrought and cast steel materials as applied in pipelines and connections to apparatus or equipment. This includes butt joints in the installation of pipe, valves, flanges, fittings, and other equipment, and fillet welded joints in pipe branches, slip-on flanges, etc. It does not apply to the welding of longitudinal or spiral-helical seam joints in the manufacture of pipe, fittings, and valves, or to pressure vessels or assemblies manufactured in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 or 2.

434.8.2 For alloy steels, the nominal chemical analysis of the weld metal shall be the same as the nominal chemical analysis of the base metal. If base metals of different chemical analysis are being joined, the weld metal shall be the same as either base metal, or of intermediate composition. Where austenitic steels are joined to ferritic steels, the weld metal shall have an austenitic structure except as specified below.

(a) When austenitic steels are joined to ferritic steels, the weld metal shall have an austenitic structure.

434.13.1 Water Crossings

(a) Underwater Construction. Plans and specifications for underground construction shall describe the position of the line, showing relationship of the pipeline to the natural bottom and the depth below mean low water level when applicable. To meet the conditions set out in para. 434.13.1, heavier wall pipe may be specified. Approach and position of the line in the banks is important, as is the position of the line across the bottom. Special consideration shall be given to depth of cover and other means of protecting the pipeline in the surf zone. Special consideration shall be given to protective coating and the use of concrete jacketing or the application of river weights. Complete inspection shall be provided. Precautions shall be taken during construction to limit stress below the level that would produce buckling or collapse due to out-of-roundness of the completed pipeline.

434.18 Line Markers

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, must be in letters at least one inch (25.4 mm) high with an approximate stroke of one-quarter inch (6.4 mm).

435.4.3 Manifold headers with multiple outlets shall have outlets designed as covered in paras. 404.3.1(b) 404.3 and 404.3.1(e) 404.3.3, and illustrated in Figs. 404.3.1-1 and 404.3.5-1, respectively. 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.

437.6.4 Determination of Weld Joint Factor. If the type of longitudinal or spiral-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.

451.1 Operating Pressure

(a) Care shall be exercised to ensure that at any point in the piping system the maximum steady state operating pressure and static head pressure with the line in a static condition do not exceed at that point the internal design pressure and pressure ratings for the components used as specified in para. 402.2.2.4.01.2.2.2, and that the level of pressure rise due to surges and other variations from normal operation does not exceed the internal design pressure at any point in the piping system and equipment by more than 10% as specified in para. 403.3.4.01.2.4.

451.6.2.2 Corrosion

(b) External Corrosion. Externally corroded areas exposed for examination must be cleaned to bare metal. In general, areas of corrosion with a maximum depth of 20% or less of the thickness required for design (t) need not be repaired.
451.6.2.9 Permanent Repairs.

(g) Hot Tapping. Defects may be removed by hot tapping. When hot tapping is used as a means of repair, the portion of piping containing the defect shall be completely removed. Hot tap fittings larger than 2 in. (50 mm) that have integral material sufficient to satisfy the area replacement requirements of para. 404.3.4(d)5 may not have adequate resistance to external forces and moments if used without full-encirclement reinforcement.

454 EMERGENCY PLAN

(b) The plan shall provide for acquainting and training of personnel responsible for the prompt execution of emergency action.

465.1 General

Special consideration must be given to the corrosion control requirements of pipelines and other facilities in high temperature service (above 150°F (66°C)).

465.3.2 Galvanic Anodes.

Some anode materials may become more noble than steel at temperatures above 140°F (60°C) in certain electrolytes. Zinc anodes containing aluminum are also susceptible to intergranular corrosion above 120°F (49°C).

A402 DESIGN CRITERIA Calculation of Stresses

A402.3 Stress from Internal Pressure Allowable Stresses and Other Stress Limits

The calculations of stresses allowable stresses and other stress limits given in para. 402.3 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.

A404 PRESSURE DESIGN OF COMPONENTS CRITERIA FOR PIPELINES

A404.1 Straight Pipe A403.2 Criteria for Pipe Wall Thickness and Allowances

A404.1.1 General A403.2.1 Criteria

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

\[ S = \frac{p}{F_1}\left(\frac{S_y}{1000}\right) \]

Where

- \( F_1 \) = hoop stress design factor from Table A402.3.5-1 and
- \( S_y \) = specified minimum yield strength, psi (MPa) are defined in para. A402.3.5.

A404.3.6 Design Criteria for Expansion and Flexibility.

Unburied subsea pipeline systems and platform piping shall be considered as aboveground piping [see para. 403.9.1, and 403.9.3 paras. 419.1(a), (b), and (d)] 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. A402.3.5 in lieu of the calculation of stresses stress calculations allowables listed in para. 402.5.1, and 402.5.2 para. 419.6.4. Equations in paras. 402.5.1, and 402.5.2, 402.5, and 402.6, and 402.7 para. 419.6.4 are valid for calculating the indicated stresses. See paras. A401.10 and A401.11 for loads that must be considered in design. Where appropriate, allowable strain criteria in para. A402.3.5 stress criteria.

A404.1.1 General

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

\[ S = \frac{p}{F_1}\left(\frac{S_y}{1000}\right) \]

where \( F_1 \) and \( S_y \) are defined in para. A402.3.5.

A404.2 Directional Changes A406.2 Bends, Mitered, and Elbows

Mitered bends are prohibited in offshore liquid pipeline systems.

A404.3 Intersections

A404.3.5 Reinforcement of Single Openings

(a)(1) 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 the 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.

**A404.5 Valves**

**A404.7.1** 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**

**A405.2 Metallic Pipe**

**A405.2.1 Steel Pipe**

(a) The provisions of para. A405.2.1(a) are superseded by the following. New pipe of the specifications listed in Table 423.1-1 may be used in accordance with the design equations of para. 403.2.1404.1.2 subject to para A404.1.1 and to the testing requirements of paras. 437.1.4(a)(1), (2), (4), and (5); paras. 437.1.4(b) and (c); and paras. 437.4.1 and A437.1.4.

(c) Paragraph 405.2.1(c) does not apply.

(bd) 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.

**A405.3 Flexible Pipe**

Selection of flexible pipe shall be in accordance with API RP 17B. (See also para. A402.3.11.)

**A406 Fittings, Elbows, Bends, and Intersections**

**A406.1 Pigs and Internal Inspection Tools**

**A406.2 Special Components**

**A407 Valves**

**A407.1 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.

**A408 Flanges, Facings, Gaskets, and Bolting**

**A408.1 Flanges**

**A408.1.1 General**. Paragraph 404.4.3408.4.1(c) does not apply. Cast iron or ductile iron flanges are prohibited for applications in offshore liquid pipeline systems.

**A408.3 Ring joint-type flanges are preferred in offshore liquid pipeline systems.**
A409 USED PIPING COMPONENTS AND EQUIPMENT
Used piping components, such as fittings, elbows, bends, intersections, couplings, reducers, closures, flanges, valves, and equipment, may be reused as noted in section 404, except that the reuse of piping components of unknown specification is prohibited in offshore liquid pipeline systems.

A419 EXPANSION AND FLEXIBILITY
See para. A402.3.6 for additional provisions

A434.8.5 Welding Quality
(a) Inspection Methods
(2) Welds in offshore pipeline systems may also be evaluated on the basis of para. A434.8.5(b).
(43) The requirements of para. 434.8.5(a)(43) are superseded by the following provisions.

A451.6.2 Disposition of Defects
(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.
(8) 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.

A461.1.3 Cathodic Protection System
(a) In addition to the provisions of para. 461.1.3(a), 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.

A463 EXTERNAL CORROSION CONTROL FOR PIPELINES OFFSHORE PIPING SYSTEMS EXPOSED TO ATMOSPHERIC CONDITIONS
A463.12 New Offshore Installations
The selected coating should have the following characteristics:
(1a) low water absorption
(2b) resistance to water action
(3c) compatibility with system operating temperature
(4d) resistance to atmospheric deterioration
(5e) resistance to mechanical damage
(6f) 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:
(1a) special coating
(2b) special protective systems and techniques
(3c) other suitable measures, including selection of pipe material

B454 EMERGENCY PLAN
(b) The plan shall provide for training of personnel responsible for the prompt execution of emergency action.

MANDATORY APPENDIX I
REFERENCED STANDARDS
*ASME Boiler and Pressure Vessel Code, 1998 Ed. and 1999 Addenda