ASME CODE FOR PRESSURE PIPING, B31
AN AMERICAN NATIONAL STANDARD

ASME B31.4a-2001

ADDENDA

to

ASME B31.4-1998 EDITION
PIPELINE TRANSPORTATION SYSTEMS FOR LIQUID HYDROCARBONS AND OTHER LIQUIDS

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
Three Park Avenue • New York, NY 10016

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The American Society of Mechanical Engineers
Three Park Avenue, New York, NY 10016-5990

SUMMARY OF CHANGES

Addenda to the 1998 Edition of the Code are issued in the form of replacement pages. Revisions, additions, or deletions are incorporated directly into the affected pages. It is advisable, however, that all replaced pages be retained for reference.

Replace or insert the pages listed. Changes given below are identified on the pages by a margin note, **A01**, placed next to the affected area. Revisions to the 1998 Edition are indicated by **98**. For the listing below, the *Page* references the affected area. A margin note, **A01**, placed next to the heading indicates *Location*. Revisions are listed under *Change*.

Page	*Location*	*Change*
xiii–xvi	Roster	Revised
2	400.1.2(d)	Revised
12, 13	Table 402.3.1(a)	(1) API 5LU deleted (2) API 5L, Grade X80 added
15	Table 402.4.3	API 5LU deleted
33	421.1(d)	Revised
35	423.2.6	Revised
36	Table 423.1	API 5LU deleted
40	Table 426.1	API 5LU deleted
53	435.3.3	Last line corrected by errata
60, 61	451.6.1(a)	API RP 1107 revised to read API Standard 1104
	451.6.2(a)(2)(c)	First line corrected by errata
64	451.9(a)	Last two sentences revised
93–95	Appendix A	Revised
107	B31 List	Revised

NOTES:

(1) The interpretations to ASME B31.4 issued between January 1, 1998 through December 31, 2000, follow the last page of this Addenda as a separate supplement, Interpretations No. 6.

(2) After the Interpretations, a separate supplement, Cases No. 4, follows.

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CHAPTER I

SCOPE AND DEFINITIONS

400 GENERAL STATEMENTS

(a) This Liquid Transportation Systems Code is one of several sections of the ASME Code for Pressure Piping, B31. This Section is published as a separate document for convenience. This Code applies to hydrocarbons, liquid petroleum gas, anhydrous ammonia, alcohols, and carbon dioxide. Throughout this Code these systems will be referred to as Liquid Pipeline Systems.

(b) The requirements of this Code are adequate for safety under conditions normally encountered in the operation of liquid pipeline systems. Requirements for all abnormal or unusual conditions are not specifically provided for, nor are all details of engineering and construction prescribed. All work performed within the Scope of this Code shall comply with the safety standards expressed or implied.

(c) The primary purpose of this Code is to establish requirements for safe design, construction, inspection, testing, operation, and maintenance of liquid pipeline systems for protection of the general public and operating company personnel as well as for reasonable protection of the piping system against vandalism and accidental damage by others and reasonable protection of the environment.

(d) This Code is concerned with employee safety to the extent that it is affected by basic design, quality of materials and workmanship, and requirements for construction, inspection, testing, operation, and maintenance of liquid pipeline systems. Existing industrial safety regulations pertaining to work areas, safe work practices, and safety devices are not intended to be supplanted by this Code.

(e) The designer is cautioned that the Code is not a design handbook. The Code does not do away with the need for the engineer or competent engineering judgment. The specific design requirements of the Code usually revolve around a simplified engineering approach to a subject. It is intended that a designer capable of applying more complete and rigorous analysis to special or unusual problems shall have latitude in the development of such designs and the evaluation of complex or combined stresses. In such cases the designer is responsible for demonstrating the validity of his approach.

(f) This Code shall not be retroactive or construed as applying to piping systems installed before date of issuance shown on document title page insofar as design, materials, construction, assembly, inspection, and testing are concerned. It is intended, however, that the provisions of this Code shall be applicable within 6 months after date of issuance to the relocation, replacement, and uprating or otherwise changing existing piping systems; and to the operation, maintenance, and corrosion control of new or existing piping systems. After Code revisions are approved by ASME and ANSI, they may be used by agreement between contracting parties beginning with the date of issuance. Revisions become mandatory or minimum requirements for new installations 6 months after date of issuance except for piping installations or components contracted for or under construction prior to the end of the 6 month period.

(g) The users of this Code are advised that in some areas legislation may establish governmental jurisdiction over the subject matter covered by this Code and are cautioned against making use of revisions that are less restrictive than former requirements without having assurance that they have been accepted by the proper authorities in the jurisdiction where the piping is to be installed. The Department of Transportation, United States of America, rules governing the transportation by pipeline in interstate and foreign commerce of petroleum, petroleum products, and liquids such as anhydrous ammonia or carbon dioxide are prescribed under Part 195 — Transportation of Hazardous Liquids by Pipeline, Title 49 — Transportation, Code of Federal Regulations.

400.1 Scope

400.1.1 This Code prescribes requirements for the design, materials, construction, assembly, inspection, and testing of piping transporting liquids such as crude (98)

oil, condensate, natural gasoline, natural gas liquids, liquefied petroleum gas, carbon dioxide, liquid alcohol, liquid anhydrous ammonia, and liquid petroleum products between producers' lease facilities, tank farms, natural gas processing plants, refineries, stations, ammonia plants, terminals (marine, rail, and truck), and other delivery and receiving points. (See Fig. 400.1.1.)

Piping consists of pipe, flanges, bolting, gaskets, valves, relief devices, fittings, and the pressure containing parts of other piping components. It also includes hangers and supports, and other equipment items necessary to prevent overstressing the pressure containing parts. It does not include support structures such as frames of buildings, stanchions, or foundations, or any equipment such as defined in para. 400.1.2(b).

Requirements for offshore pipelines are found in Chapter IX.

Also included within the scope of this Code are:

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

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

(c) liquid petroleum and liquid anhydrous ammonia piping located on property which has been set aside for such piping within petroleum refinery, natural gasoline, gas processing, ammonia, and bulk plants;

(d) those aspects of operation and maintenance of Liquid 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)].

(98) **400.1.2** This Code does not apply to:

(a) auxiliary piping, such as water, air, steam, lubricating oil, gas, and fuel;

(b) pressure vessels, heat exchangers, pumps, meters, and other such equipment including internal piping and connections for piping except as limited by para. 423.2.4(b);

(c) piping designed for internal pressures:

(1) at or below 15 psi (1 bar) gage pressure regardless of temperature;

(2) above 15 psi (1 bar) gage pressure if design temperature is below minus 20°F (−30°C) or above 250°F (120°C);

A01 *(d)* casing, tubing, or pipe used in oil wells, wellhead assemblies, oil and gas separators, crude oil production tanks, and other producing facilities;

(e) petroleum refinery, natural gasoline, gas processing, ammonia, carbon dioxide processing, and bulk plant piping, except as covered under para. 400.1.1(c);

(f) gas transmission and distribution piping;

(g) the design and fabrication of proprietary items of equipment, apparatus, or instruments, except as limited by para. 423.2.4(b);

(h) ammonia refrigeration piping systems provided for in ASME B31.5, Refrigeration Piping Code;

(i) carbon dioxide gathering and field distribution system.

400.2 Definitions (98)

Some of the more common terms relating to piping are defined below.[1]

accidental loads: any unplanned load or combination of unplanned loads caused by human intervention or natural phenomena.

breakaway coupling: a component installed in the pipeline to allow the pipeline to separate when a predetermined axial load is applied to the coupling.

buckle: a condition where the pipeline has undergone sufficient plastic deformation to cause permanent wrinkling in the pipe wall or excessive cross-sectional deformation caused by loads acting alone or in combination with hydrostatic pressure.

carbon dioxide: a fluid consisting predominantly of carbon dioxide compressed above its critical pressure and, for the purpose of this Code, shall be considered to be a liquid.

cold springing: deliberate deflection of piping, within its yield strength, to compensate for anticipated thermal expansion.

column buckling: buckling of a beam or pipe under compressive axial load in which loads cause unstable lateral deflection, also referred to as upheaval buckling.

connectors: component, except flanges, used for the purpose of mechanically joining two sections of pipe.

defect: an imperfection of sufficient magnitude to warrant rejection.

[1] Welding terms which agree with AWS Standard A3.0 are marked with an asterisk (*). For welding terms used in this Code but not shown here, definitions in accordance with AWS A3.0 apply.

402.3 Allowable Stresses and Other Stress Limits

402.3.1 Allowable Stress Values

(a) The allowable stress value S to be used for design calculations in para. 404.1.2 for new pipe of known specification shall be established as follows:

S = 0.72 × E × specified minimum yield strength of the pipe, psi (MPa)

where

0.72 = design factor based on nominal wall thickness. 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.

E = weld joint factor (see para. 402.4.3 and Table 402.4.3)

Table 402.3.1(a) is a tabulation of examples of allowable stresses for reference use in transportation piping systems within the scope of this Code.

(b) The allowable stress value S to be used for design calculations in para. 404.1.2 for used (reclaimed) pipe of known specification shall be in accordance with (a) above and limitations in para. 405.2.1(b).

(c) The allowable stress value S to be used for design calculations in para. 404.1.2 for new or used (reclaimed) pipe of unknown or ASTM A 120 specification shall be established in accordance with the following and limitations in para. 405.2.1(c).

S = 0.72 × E × minimum yield strength of the pipe, psi (MPa) [24,000 psi (165 MPa)] or yield strength determined in accordance with paras. 437.6.6 and 437.6.7]

where

0.72 = design factor based on nominal wall thickness. 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.

E = weld joint factor (see Table 402.4.3)

(d) The allowable stress value S to be used for design calculations in para. 404.1.2 for pipe which has been cold worked in order to meet the specified minimum yield strength and is subsequently heated to 600°F (300°C) or higher (welding expected) shall be 75% of the applicable allowable stress value as determined by para. 402.3.1(a), (b), or (c).

(e) 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.

(f) Allowable tensile and compressive stress values for materials used in structural supports and restraints shall not exceed 66% of the specified minimum yield strength. Allowable stress values in shear and bearing shall not exceed 45% and 90% of the specified minimum yield strength, respectively. Steel materials of unknown specifications may be used for structural supports and restraints, provided a yield strength of 24,000 psi (165 MPa) or less is used.

(g) In no case where the Code refers to the specified minimum value of a physical property shall a higher value of the property be used in establishing the allowable stress value.

402.3.2 Limits of Calculated Stresses Due to Sustained Loads and Thermal Expansion (98)

(a) Internal Pressure Stresses. The calculated stresses due to internal pressure shall not exceed the applicable allowable stress value S determined by para. 402.3.1 (a), (b), (c), or (d) except as permitted by other subparagraphs of para. 402.3.

(b) External Pressure Stresses. Stresses due to external pressure shall be considered safe when the wall thickness of the piping components meets the requirements of paras. 403 and 404.

(c) Allowable Expansion Stresses. The allowable stress values for the equivalent tensile stress in para. 419.6.4(b) for restrained lines shall not exceed 90% of the specified minimum yield strength of the pipe. The allowable stress range S_A in para. 419.6.4(c) for unrestrained lines shall not exceed 72% of the specified minimum yield strength of the pipe.

(d) Additive Longitudinal Stresses. The sum of the longitudinal stresses due to pressure, weight, and other sustained external loadings [see para. 419.6.4(c)] shall not exceed 75% of the allowable stress value specified for S_A in (c) above.

402.3.3 Limits of Calculated Stresses Due to Occasional Loads

(a) Operation. The sum of the longitudinal stresses produced by pressure, live and dead loads, and those produced by occasional loads, such as wind or earthquake, shall not exceed 80% of the specified minimum

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TABLE 402.3.1(a)
TABULATION OF EXAMPLES OF ALLOWABLE STRESSES FOR REFERENCE USE IN PIPING SYSTEMS WITHIN THE SCOPE OF THIS CODE

Specification	Grade	Specified Min. Yield Strength, psi (MPa)	Weld Joint Factor *E*	Allowable Stress Value *S*, −20°F to 250°F (−30°C to 120°C), psi (MPa)
Seamless				
API 5L	A25	25,000 (172)	1.00	18,000 (124)
API 5L, ASTM A 53, ASTM A 106	A	30,000 (207)	1.00	21,600 (149)
API 5L, ASTM A 53, ASTM A 106	B	35,000 (241)	1.00	25,200 (174)
API 5L	X42	42,000 (289)	1.00	30,250 (208)
API 5L	X46	46,000 (317)	1.00	33,100 (228)
API 5L	X52	52,000 (358)	1.00	37,450 (258)
API 5L	X56	56,000 (386)	1.00	40,300 (278)
API 5L	X60	60,000 (413)	1.00	43,200 (298)
API 5L	X65	65,000 (448)	1.00	46,800 (323)
API 5L	X70	70,000 (482)	1.00	50,400 (347)
API 5L	X80	80,000 (551)	1.00	57,600 (397)
ASTM A 106	C	40,000 (278)	1.00	28,800 (199)
ASTM A 333	6	35,000 (241)	1.00	25,000 (174)
ASTM A 524	I	35,000 (241)	1.00	25,200 (174)
ASTM A 524	H	30,000 (207)	1.00	21,600 (149)
Furnace Butt Welded, Continuous Welded				
ASTM A 53	...	25,000 (172)	0.60	10,800 (74)
API 5L Classes I and II	A25	25,000 (172)	0.60	10,800 (74)
Electric Resistance Welded and Electric Flash Welded				
API 5L	A25	25,000 (172)	1.00	18,000 (124)
API 5L, ASTM A 53, ASTM A 135	A	30,000 (207)	1.00	21,600 (149)
API 5L, ASTM A 53, ASTM A 135	B	35,000 (241)	1.00	25,200 (174)
API 5L	X42	42,000 (289)	1.00	30,250 (208)
API 5L	X46	46,000 (317)	1.00	33,100 (228)
API 5L	X52	52,000 (358)	1.00	37,450 (258)
API 5L	X56	56,000 (386)	1.00	40,300 (279)
API 5L	X60	60,000 (413)	1.00	43,200 (297)
API 5L	X65	65,000 (448)	1.00	46,800 (323)
API 5L	X70	70,000 (482)	1.00	50,400 (347)
API 5L	X80	80,000 (551)	1.00	57,600 (397)
ASTM A 333	6	35,000 (241)	1.00	25,000 (174)

TABLE 402.3.1(a) (CONT'D) A01
TABULATION OF EXAMPLES OF ALLOWABLE STRESSES FOR REFERENCE USE IN PIPING SYSTEMS WITHIN THE SCOPE OF THIS CODE

Specification	Grade	Specified Min. Yield Strength, psi (MPa)	Weld Joint Factor E	Allowable Stress Value S, −20°F to 250°F (−30°C to 120°C), psi (MPa)
Electric Fusion Welded				
ASTM A 134	...	...	0.80	...
ASTM A 139	A	30,000 (207)	0.80	17,300 (119)
ASTM A 139	B	35,000 (241)	0.80	20,150 (139)
ASTM A 671	...	Note (1)	1.00 [Notes (2), (3)]	...
ASTM A 671	...	Note (1)	0.70 [Note (4)]	...
ASTM A 672	...	Note (1)	1.00 [Notes (2), (3)]	...
ASTM A 672	...	Note (1)	0.80 [Note (4)]	...
Submerged Arc Welded				
API 5L	A	30,000 (207)	1.00	21,600 (149)
API 5L	B	35,000 (241)	1.00	25,200 (174)
API 5L	X42	42,000 (289)	1.00	30,250 (208)
API 5L	X46	46,000 (317)	1.00	33,100 (228)
API 5L	X52	52,000 (358)	1.00	37,450 (258)
API 5L	X56	56,000 (386)	1.00	40,300 (278)
API 5L	X60	60,000 (413)	1.00	43,200 (298)
API 5L	X65	65,000 (448)	1.00	46,800 (323)
API 5L	X70	70,000 (482)	1.00	50,400 (347)
API 5L	X80	80,000 (551)	1.00	57,600 (397)
ASTM A 381	Y35	35,000 (241)	1.00	25,200 (174)
ASTM A 381	Y42	42,000 (290)	1.00	30,250 (209)
ASTM A 381	Y46	46,000 (317)	1.00	33,100 (228)
ASTM A 381	Y48	48,000 (331)	1.00	34,550 (238)
ASTM A 381	Y50	50,000 (345)	1.00	36,000 (248)
ASTM A 381	Y52	52,000 (358)	1.00	37,450 (258)
ASTM A 381	Y60	60,000 (413)	1.00	43,200 (298)
ASTM A 381	Y65	65,000 (448)	1.00	46,800 (323)

GENERAL NOTES:
(a) Allowable stress values S shown in this Table are equal to $0.72E$ (weld joint factor) × specified minimum yield strength of the pipe.
(b) Allowable stress values shown are for new pipe of known specification. Allowble stress values for new pipe of unknown specification, ASTM A 120 specification, or used (reclaimed) pipe shall be determined in accordance with para. 402.3.1.
(c) For some Code computations, particularly with regard to branch connections [see para. 404.3.1(d)(3)] and expansion, flexibility, structural attachments, supports, and restraints (Chapter II, Part 5), the weld joint factor E need not be considered.
(d) For specified minimum yield strength of other grades in approved specifications, refer to that particular specification.
(e) Allowable stress value for cold worked pipe subsequently heated to 600°F (300°C) or higher (welding excepted) shall be 75% of the value listed in Table.
(f) Definitions for the various types of pipe are given in para. 400.2.
(g) Metric stress levels are given in MPa (1 megapascal = 1 million pascals).

NOTES:
(1) See applicable plate specification for yield point and refer to para. 402.3.1 for calculation of S.
(2) Factor applies for Classes 12, 22, 32, 42, and 52 only.
(3) Radiography must be performed after heat treatment.
(4) Factor applies for Classes 13, 23, 33, 43, and 53 only.

yield strength of the pipe. It is not necessary to consider wind and earthquake as occurring concurrently.

(b) Test. Stresses due to test conditions are not subject to the limitations of para. 402.3. It is not necessary to consider other occasional loads, such as wind and earthquake, as occurring concurrently with the live, dead, and test loads existing at the time of test.

402.4 Allowances

402.4.1 Corrosion. A wall thickness allowance for corrosion is not required if pipe and components are protected against corrosion in accordance with the requirements and procedures prescribed in Chapter VIII.

402.4.2 Threading and Grooving. An allowance for thread or groove depth in inches (mm) shall be included in A of the equation under para. 404.1.1 when threaded or grooved pipe is allowed by this Code (see para. 414).

402.4.3 Weld Joint Factors. Longitudinal or spiral weld joint factors E for various types of pipe are listed in Table 402.4.3.

402.4.5 Wall Thickness and Defect Tolerances. Wall thickness tolerances and defect tolerances for pipe shall be as specified in applicable pipe specifications or dimensional standards included in this Code by reference in Appendix A.

402.5 Fracture Propagation in Carbon Dioxide Pipelines

402.5.1 Design Considerations. The possibility of brittle and ductile propagating fractures shall be considered in the design of carbon dioxide pipelines. The design engineer shall provide reasonable protection to limit the occurrence and the length of fractures throughout the pipeline with special consideration at river crossings, road crossings, and other appropriate areas or intervals.

402.5.2 Brittle Fractures. Brittle fracture propagation shall be prevented by selection of a pipe steel which fractures in a ductile manner at operating temperatures. API 5L supplementary requirements or similar specifications shall be used for testing requirements to ensure the proper pipe steel selection.

402.5.3 Ductile Fractures. Ductile fracture propagation shall be minimized by the selection of a pipe steel with appropriate fracture toughness and/or by the installation of suitable fracture arrestors. Design consideration shall include pipe diameter, wall thickness, fracture toughness, yield strength, operating pressure, operating temperature, and the decompression characteristics of carbon dioxide and its associated impurities.

PART 2
PRESSURE DESIGN OF PIPING COMPONENTS

403 CRITERIA FOR PRESSURE DESIGN OF PIPING COMPONENTS

The design of piping components, considering the effects of pressure, shall be in accordance with para. 404. In addition, the design shall provide for dynamic and weight effects included in para. 401 and design criteria in para. 402.

404 PRESSURE DESIGN OF COMPONENTS

404.1 Straight Pipe

404.1.1 General (98)

(a) 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.

$$t_n = t + A$$

(b) The notations described below are used in the equations for the pressure design for straight pipe.

t_n = nominal wall thickness satisfying requirements for pressure and allowances

t = pressure design wall thickness as calculated in inches (mm) in accordance with para. 404.1.2 for internal pressure. As noted under para. 402.3.1 or para. A402.3.5, as applicable, 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.

A = sum of allowances for threading and grooving as required under para. 402.4.2, corrosion as required under para. 402.4.1, and increase in wall thickness if used as protective measure under para. 402.1.

P_i = internal design gage pressure (see para. 401.2.2), psi (bar)

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

S = applicable allowable stress value, psi (MPa), in accordance with para. 402.3.1(a), (b), (c), or (d)

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TABLE 402.4.3
WELD JOINT FACTOR *E*

Specification No.	Pipe Type [Note (1)]	Weld Joint Factor *E*
ASTM A 53	Seamless	1.00
	Electric resistance welded	1.00
	Furnace butt welded	0.60
ASTM A 106	Seamless	1.00
ASTM A 134	Electric fusion (arc) welded	0.80
ASTM A 135	Electric resistance welded	1.00
ASTM A 139	Electric fusion (arc) welded	0.80
ASTM A 333	Seamless	1.00
	Electric resistance weld	1.00
ASTM A 381	Double submerged arc welded	1.00
ASTM A 671	Electric fusion welded	1.00 [Notes (2), (3)] 0.80 [Note (4)]
ASTM A 672	Electric fusion welded	1.00 [Notes (2), (3)] 0.80 [Note (4)]
API 5L	Seamless	1.00
	Electric resistance welded	1.00
	Electric induction welded	1.00
	Submerged arc welded	1.00
	Furnace butt welded, continuous welded	0.60
Known	Known	Note (5)
Unknown	Seamless	1.00 [Note (6)]
Unknown	Electric resistance welded	1.00 [Note (6)]
Unknown	Electric Fusion welded	0.80 [Note (6)]
Unknown	Over NPS 4	0.80 [Note (7)]
Unknown	NPS 4 and smaller	0.60 [Note (8)]

NOTES:
(1) Definitions for the various pipe types (weld joints) are given in para. 400.2.
(2) Factor applies for Classes 12, 22, 32, 42, and 52 only.
(3) Radiography must be performed after heat treatment.
(4) Factor applies for Classes 13, 23, 33, 43, and 53 only.
(5) Factors shown above apply for new or used (reclaimed) pipe if pipe specification and pipe type are known.
(6) Factor applies for new or used pipe of unknown specification and ASTM A 120 if type of weld joint is known.
(7) Factor applies for new or used pipe of unknown specification and ASTM A 120 or for pipe over NPS 4 if type of jont is unknown.
(8) Factor applies for new or used pipe of unknown specification and ASTM A 120 or for pipe NPS 4 and smaller if type of joint is unknown.

404.1.2 Straight Pipe Under Internal Pressure. The internal pressure design wall thickness t of steel pipe shall be calculated by the following equation.

$$t = \frac{P_i D}{2S} \qquad \left(t = \frac{P_i D}{20S} \right)$$

404.1.3 Straight Pipe Under External Pressure. Pipelines within the scope of this Code may be subject to conditions during construction and operation where the external pressure exceeds the internal pressure (vacuum within the pipe or pressure outside the pipe when submerged). The pipe wall selected shall provide adequate strength to prevent collapse, taking into consideration mechanical properties, variations in wall thickness permitted by material specifications, ellipticity (out-of-roundness), bending stresses, and external loads (see para. 401.2.2).

404.2 Curved Segments of Pipe

Changes in direction may be made by bending the pipe in accordance with para. 406.2.1 or installing factory made bends or elbows, in accordance with para. 406.2.3.

404.2.1 Pipe Bends. The wall thickness of pipe before bending shall be determined as for straight pipe in accordance with para. 404.1. Bends shall meet the flattening limitations of para. 434.7.1.

(98) **404.2.2 Elbows**

(a) The minimum metal thickness of flanged or threaded elbows shall not be less than specified for the pressures and temperatures in the applicable American National Standard or the MSS Standard Practice.

(b) Steel butt welding elbows shall comply with ASME B16.9, ASME B16.28, or MSS SP-75 and shall have pressure and temperature ratings based on the same stress values as were used in establishing the pressure and temperature limitations for pipe of the same or equivalent materials.

404.3 Intersections

(98) **404.3.1 Branch Connections.** Branch connections may be made by means of tees, crosses, integrally reinforced extruded outlet headers, or welded connections, and shall be designed in accordance with the following requirements.

(a) Tees and Crosses

(1) The minimum metal thickness of flanged or threaded tees and crosses shall not be less than specified for the pressures and temperatures in the applicable American National Standard or the MSS Standard Practice.

(2) Steel butt welding tees and crosses shall comply with ASME B16.9 or MSS SP-75 and shall have pressure and temperature ratings based on the same stress values as were used in establishing the pressure and temperature limitations for pipe of the same or equivalent material.

(3) Steel butt welding tees and crosses may be used for all ratios of branch diameter to header diameter and all ratios of design hoop stress to specified minimum yield strength of the adjoining header and branch pipe, provided they comply with (2) above.

(b) Integrally Reinforced Extruded Outlet Headers

(1) Integrally reinforced extruded outlet headers may be used for all ratios of branch diameter to header diameter and all ratios of design hoop stress to specified minimum yield strength of the joining header and branch pipe, provided they comply with (2) through (8) immediately following.

(2) When the design meets the limitations on geometry contained herein, the rules established are valid and meet the intent of the Code. These rules cover minimum requirements and are selected to assure satisfactory performance of extruded headers subjected to pressure. In addition, however, forces and moments are usually applied to the branch by such agencies as thermal expansion and contraction, by vibration, by dead weight of piping, valves and fittings, covering and contents, and by earth settlement. Consideration shall be given to the design of extruded header to withstand these forces and moments.

(3) Definition

(a) An *extruded outlet header* is defined as a header in which the extruded lip at the outlet has a height above the surface of the header which is equal to or greater than the radius of curvature of the external contoured portion of the outlet, i.e., $h_o \geq r_o$. See nomenclature and Fig. 404.3.1(b)(3).

(b) These rules do not apply to any nozzle in which additional nonintegral material is applied in the form of rings, pads, or saddles.

(c) These rules apply only to cases where the axis of the outlet intersects and is perpendicular to the axis of the header.

(4) Notation. The notation used herein is illustrated in Fig. 404.3.1(b)(3). All dimensions are in inches (mm).

d = outside diameter of branch pipe
d_c = internal diameter of branch pipe

(11) Radius of curvature of external contoured portion of outlet measured in the plane containing the axes of the run and branch. This is subject to the following limitations:
(a) minimum radius r_o: the lesser of $0.05d$ or 38 mm (1.5 in.);
(b) maximum radius r_o shall not exceed:
(1) for branches DN200 (NPS 8) and larger, $0.10d + 13$ mm (0.50 in);
(2) for branches less than DN200 (NPS 8), 32 mm (1.25 in.);
(c) when the external contour contains more than one radius, the radius on any arc sector of approximately 45 deg. shall meet the requirements of (a) and (b) above;
(d) machining shall not be employed in order to meet the above requirements.

(98) FIG. 419.6.4(c) FLEXIBILITY FACTOR k AND STRESS INTENSIFICATION FACTOR i (CONT'D)

420 LOADS ON PIPE SUPPORTING ELEMENTS

420.1 General

The forces and moments transmitted to connected equipment, such as valves, strainers, tanks, pressure vessels, and pumping machinery, shall be kept within safe limits.

421 DESIGN OF PIPE SUPPORTING ELEMENTS

421.1 Supports, Braces, and Anchors

(a) Supports shall be designed to support the pipe without causing excessive local stresses in the pipe and without imposing excessive axial or lateral friction forces that might prevent the desired freedom of movement.

(b) Braces and damping devices may occasionally be required to prevent vibration of piping.

(c) All attachments to the pipe shall be designed to minimize the added stresses in the pipe wall because of the attachment. Nonintegral attachments, such as pipe clamps and ring girders, are preferred where they will fulfill the supporting or anchoring functions.

A01 *(d)* If pipe is designed to operate above 20% SMYS, all attachments welded to the pipe shall be made to a separate cylindrical member that completely encircles the pipe, and this encircling member shall be welded to the pipe by continuous circumferential welds.

(e) The applicable sections of MSS SP-58 for materials and design of pipe hangers and supports and of MSS SP-69 for their selection and application may be used.

PART 6
AUXILIARY AND OTHER SPECIFIC PIPING

422 DESIGN REQUIREMENTS

422.3 Instrument and Other Auxiliary Liquid Petroleum or Liquid Anhydrous Ammonia Piping

All instrument and other auxiliary piping connected to primary piping and which operates at a gage pressure exceeding 15 psi (1 bar) shall be constructed in accordance with the provisions of this Code.

422.6 Pressure Disposal Piping

Pressure disposal or relief piping between pressure origin point and relief device shall be in accordance with this Code.

422.6.1 A full area stop valve may be installed between origin point and relief device providing such valve can be locked or sealed in the open position.

422.6.2 Disposal piping from relief device shall be connected to a proper disposal facility, which may be a flare stack, suitable pit, sump, or tank. This disposal piping shall have no valve between relief device and disposal facility unless such valve can be locked or sealed in the open position.

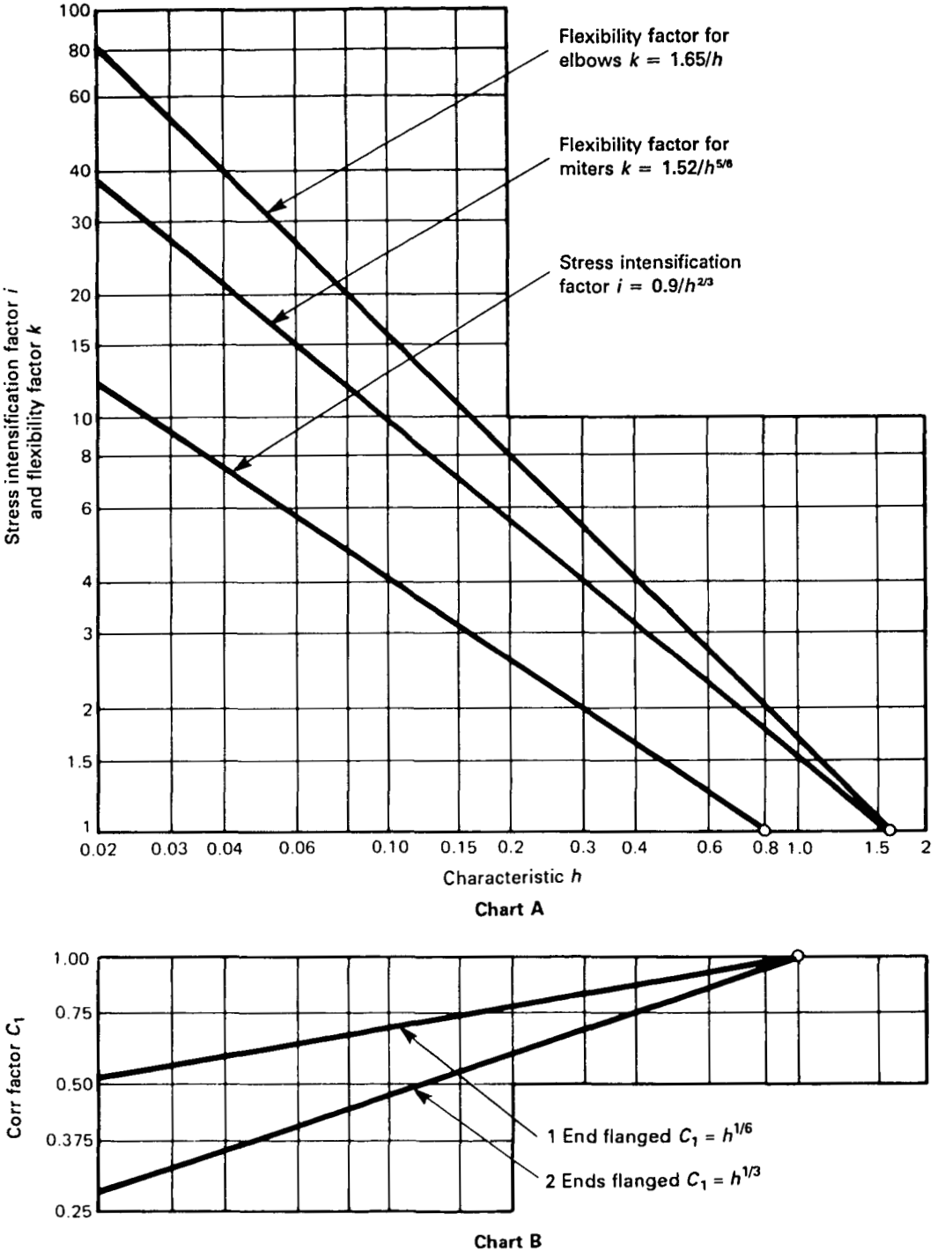

FIG. 419.6.4(c) FLEXIBILITY FACTOR k AND STRESS INTENSIFICATION FACTOR i (CONT'D)

CHAPTER III
MATERIALS

423 MATERIALS — GENERAL REQUIREMENTS

423.1 Acceptable Materials and Specifications

(a) The materials used shall conform to the specifications listed in Table 423.1 or shall meet the requirements of this Code for materials not listed. Specific editions of standards incorporated in this Code by reference, and the names and addresses of the sponsoring organizations, are shown in Appendix A, since it is not practical to refer to a specific edition of each standard in Table 423.1 and throughout the Code text. Appendix A will be revised at intervals, as needed, and issued in Addenda to the Code. Materials and components conforming to a specification or standard previously listed in Table 423.1, or to a superseded edition of a listed specification or standard, may be used.

(b) Except as otherwise provided for in this Code, materials which do not conform to a listed specification or standard shall be qualified for use by petitioning the Code Committee for approval. Complete information shall be supplied to the Code Committee and the Code Committee approval shall be obtained before the material may be used.

423.2 Limitations on Materials

423.2.1 General

(a) The designer shall give consideration to the significance of temperature on the performance of the material.

(b) Selection of material to resist deterioration in service is not within the scope of this Code. It is the designer's responsibility to select materials suitable for the fluid service under the intended operating conditions. An example of a source of information on materials performance in corrosive environments is the *Corrosion Data Survey* published by the National Association of Corrosion Engineers.

423.2.3 Steel. Steels for pipe are shown in Table 423.1 (except as noted in para. 423.2.5).

423.2.4 Cast, Malleable, and Wrought Iron

(a) Cast, malleable, and wrought iron shall not be used for pressure containing parts except as provided in paras. 407.1(a), 407.1(b), and 423.2.4(b).

(b) Cast, malleable, and wrought iron are acceptable in pressure vessels and other equipment noted in para. 400.1.2(b) and in 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. Only steel conforming to specifications listed in Appendix A shall be used for pressure containing piping components and equipment in liquid anhydrous ammonia pipeline systems. However, internal parts of such piping components and equipment may be made of other materials suitable for the service.

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

Cold formed fittings shall be normalized after fabrication.

Except for the quantities permitted in steels by individual specifications for steels listed in Appendix A, the use of copper, zinc, or alloys of these metals is prohibited for all pressure piping components subject to a liquid anhydrous ammonia environment.

423.2.6 Materials for Carbon Dioxide Piping Systems. Blow down and bypass piping in carbon dioxide pipelines shall be of a material suitable for the low temperatures expected. A01

425 MATERIALS APPLIED TO MISCELLANEOUS PARTS

425.3 Gaskets

Limitations on gasket materials are covered in para. 408.4.

425.4 Bolting

Limitations on bolting materials are covered in para. 408.5.

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TABLE 423.1
MATERIAL STANDARDS

Standard or Specification	Designation
Pipe	
Pipe, Steel, Black & Hot-Dipped, Zinc-Coated Welded & Seamless	ASTM A 53
Seamless Carbon Steel Pipe for High-Temperature Service	ASTM A 106
Pipe, Steel, Electric-Fusion (Arc)-Welded (Sizes NPS 16 and Over)	ASTM A 134
Electric-Resistance-Welded Steel Pipe	ASTM A 135
Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over)	ASTM A 139
Seamless and Welded Steel Pipe for Low Temperature Service	ASTM A 333
Metal-Arc-Welded Steel Pipe for Use with High-Pressure Transmission Systems	ASTM A 381
Seamless Carbon Steel Pipe for Atmospheric and Lower Temperatures	ASTM A 524
General Requirements for Specialized Carbon and Alloy Steel Pipe	ASTM A 530
Electric-Fusion-Welded Steel Pipe for Atmospheric and Lower Temperatures	ASTM A 671
Electric-Fusion-Welded Steel Pipe for High-Pressure Service at Moderate Temperatures	ASTM A 672
Line Pipe	API 5L
Fittings, Valves, and Flanges	
Pipe Flanges and Flanged Fittings	ASME B16.5
Forgings, Carbon Steel, for Piping Components	ASTM A 105
Gray Iron Castings for Valves, Flanges, and Pipe Fittings	ASTM A 126
Forgings, Carbon Steel, for General-Purpose Piping	ASTM A 181
Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service	ASTM A 182
Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service	ASTM A 216
Steel Castings, Martensitic Stainless and Alloy, for Pressure Containing Parts, Suitable for High-Temperature Service	ASTM A 217
Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures	ASTM A 234
Forgings, Carbon and Low-Alloy Steel, Requiring Notch Toughness Testing for Piping Components	ASTM A 350
Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures	ASTM A 395
Piping Fittings of Wrought Carbon Steel and Alloy Steel for Low Temperature Service [Note (1)]	ASTM A 420
Steel Castings Suitable for Pressure Service	ASTM A 487
Forgings, Carbon and Alloy Steel, for Pipe Flanges, Fittings, Valves, and Parts for High-Pressure Transmission Service	ASTM A 694
Wellhead Equipment	API 6A
Pipeline Valves, End Closures, Connectors and Swivels	API 6D
Steel Gate Valves, Flanged and Buttwelding Ends	API 600
Compact Carbon Steel Gate Valves	API 602
Class 150, Corrosion Resistant Gate Valves	API 603
Quality Standard for Steel Castings for Valves, Flanges and Fittings and Other Piping Components	MSS SP-55
Specification For High Test Wrought Welding Fittings	MSS SP-75
Bolting	
Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service	ASTM A 193
Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service	ASTM A 194
Carbon Steel Externally Threaded Standard Fasteners	ASTM A 307
Alloy Steel Bolting Materials for Low-Temperature Service	ASTM A 320
High-Strength Bolts for Structural Steel Joints	ASTM A 325
Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners	ASTM A 354
Quenched and Tempered Steel Bolts and Studs	ASTM A 449

CHAPTER IV
DIMENSIONAL REQUIREMENTS

426 DIMENSIONAL REQUIREMENTS FOR STANDARD AND NONSTANDARD PIPING COMPONENTS

426.1 Standard Piping Components

Dimensional standards for piping components are listed in Table 426.1. Also, certain material specifications listed in Table 423.1 contain dimensional requirements which are requirements of para. 426. Dimensions of piping components shall comply with these standards and specifications unless the provisions of para. 426.2 are met.

426.2 Nonstandard Piping Components

The dimensions for nonstandard piping components shall be such as to provide strength and performance equivalent to standard components or as provided under para. 404. Wherever practical, these dimensions shall conform to those of comparable standard components.

426.3 Threads

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 (see para. 414.1).

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TABLE 426.1
DIMENSIONAL STANDARDS

Standard or Specification	Designation
Pipe	
Welded and Seamless Wrought Steel Pipe	ASME B36.10M
Stainless Steel Pipe	ASME B36.19M
Line Pipe (*Combination of former API Spec. 5L, 5LS, and 5LX*)	API 5L
Fittings, Valves, and Flanges	
Pipe Flanges and Flanged Fittings	ASME B16.5
Factory-Made Wrought Steel Buttwelding Fittings	ASME B16.9
Face-to-Face and End-to-End Dimensions of Valves	ASME B16.10
Metallic Gaskets for Pipe Flanges — Ring Joint, Spiral-Wound, and Jacketed	ASME B16.20
Nonmetallic Flat Gaskets for Pipe Flanges	ASME B16.21
Buttwelding Ends	ASME B16.25
Wrought Steel Buttwelding Short Radius Elbows and Returns	ASME B16.28
Wellhead Equipment	API 6A
Pipeline Valves, End Closures, Connectors and Swivels	API 6D
Steel Gate Valves, Flanged and Buttwelding Ends	API 600
Compact Carbon Steel Gate Valves	API 602
Class 150, Corrosion Resistant Gate Valves	API 603
Standard Finishes for Contact Faces of Pipe Flanges and Connecting-End Flanges of Valves and Fittings	MSS SP-6
Standard Marking System for Valves, Fittings, Flanges and Unions	MSS SP-25
Steel Pipe Line Flanges	MSS SP-44
Pressure Testing of Steel Valves	MSS SP-61
Butterfly Valves	MSS SP-67
Cast Iron Gate Valves, Flanged and Threaded Ends	MSS SP-70
Cast Iron Swing Check Valves, Flanged and Threaded Ends	MSS SP-71
Specification for High Test Wrought Welding Fittings	MSS SP-75
Cast Iron Plug Valves, Flanged and Threaded Ends	MSS SP-78
Miscellaneous	
Unified Inch Screw Threads (UN and UNR Thread Form)	ASME B1.1
Pipe Threads, General Purpose (Inch)	ASME B1.20.1
Dry Seal Pipe Threads (Inch)	ASME B1.20.3
Threading, Gaging, and Thread Inspection of Casing, Tubing, and Line Pipe Threads	API 5B
Pipe Hangers and Supports—Selection and Application	MSS SP-69

GENERAL NOTE: Specific editions of standards incorporated in this Code by reference, and the names and addresses of the sponsoring organizations, are shown in Appendix A, since it is not practical to refer to a specific edition of each standard in Table 426.1 and throughout the Code text. Appendix A will be revised at intervals as needed, and issued in Addenda to the Code.

434.24.3 The filtering medium should be of such retention size and capacity as to fully protect the facilities against the intrusion of harmful foreign substances.

434.24.4 Assembly of strainers or filters and their components shall be in accordance with para. 435.

435 ASSEMBLY OF PIPING COMPONENTS

435.1 General

The assembly of the various piping components, whether done in a shop or as a field erection, shall be done so that the completely erected piping conforms with the requirements of this Code and with the specific requirements of the engineering design.

435.2 Bolting Procedure

435.2.1 All flanged joints shall be fitted up so that the gasket contact faces bear uniformly on the gasket, and made up with uniform bolt stress.

435.2.2 In bolting gasketed flanged joints, the gasket shall be properly compressed in accordance with the design principles applicable to the type of gasket used.

435.2.3 All bolts or studs shall extend completely through their nuts.

435.3 Pumping Unit Piping

435.3.1 Piping to main pumping units shall be so designed and supported that when assembled to the pump flanges and valves it should be relatively free of stress and should not add stress or load to the pump frame.

435.3.2 The design and assembly shall take into account the forces of expansion and contraction to minimize their effect within the assembly.

A01 **435.3.3** All valves and fittings on pumping units shall carry the same pressure ratings as required for line operating pressures.

435.3.4 Welding shall be in accordance with para. 434.8 of the Code.

435.3.5 Bolting shall be in accordance with para. 435.2.

435.4 Manifolds

435.4.1 All components within a manifold assembly, including valves, flanges, fittings, headers, and special assemblies, shall withstand the operating pressures and specified loadings for the specific service piping to which it is connected.

435.4.2 Meter banks, prover loops, and scraper traps shall be subject to the same assembly requirements as manifolds.

435.4.3 Manifold headers with multiple outlets shall have outlets designed as covered in paras. 404.3.1(b) and 404.3.1(e) and illustrated in Figs. 404.3.1(b)(3) and 404.3.1(d)(2), respectively. Assembly may be with the use of jigs to assure alignment of outlets and flanges with other components. The fabricated unit shall be stress relieved before removal from the jig.

435.4.4 Manifold headers assembled from wrought tees, fittings, and flanges may be assembled with jigs to assure alignment of components. Stress relieving should be considered.

435.4.5 All welding on manifolds and headers shall conform to para. 434.8.

435.4.6 Final assembly of all components shall minimize locked-in stresses. The entire assembly shall be adequately supported to provide minimum unbalance and vibration.

435.5 Auxiliary Liquid Petroleum, Carbon Dioxide, Liquid Anhydrous Ammonia, or Liquid Alcohol Piping

435.5.1 All auxiliary piping between main units and auxiliary components shall be assembled in a workmanlike manner and in accordance with the applicable code.

435.5.2 All welded auxiliary lines shall be assembled in accordance with the requirements of this Code with special provisions as required for assembly to minimize locked-in stress, and for adequate support or restraint to minimize vibration.

CHAPTER VII
OPERATION AND MAINTENANCE PROCEDURES

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

450.1 General

(a) It is not possible to prescribe in this Code a detailed set of operating and maintenance procedures that will encompass all cases. It is possible, however, for each operating company to develop operating and maintenance procedures based on the provisions of this Code, and the company's experience and knowledge of its facilities and conditions under which they are operated, which will be adequate from the standpoint of public safety.

(b) The methods and procedures set forth herein serve as a general guide, but do not relieve the individual or operating company from the responsibility for prudent action that current particular circumstances make advisable.

(c) It must be recognized that local conditions (such as the effects of temperature, characteristics of the line contents, and topography) will have considerable bearing on the approach to any particular maintenance and repair job.

(d) Suitable safety equipment shall be available for personnel use at all work areas and operating facilities where liquid anhydrous ammonia is transported. Such safety equipment shall include at least the following:

(1) full face gas mask with anhydrous ammonia refill canisters;

(2) independently supplied air mask;

(3) tight-fitting goggles or full face shield;

(4) protective gloves;

(5) protective boots;

(6) protective slicker and/or protective pants and jacket;

(7) easily accessible shower and/or at least 50 gal (190 liters) of clean water in an open top container.

Personnel shall be instructed in effective use of masks and limited shelf life of refill canisters. Protective clothing shall be of rubber fabric or other ammonia impervious material.

450.2 Operation and Maintenance Plans and Procedures

Each operating company having a transportation piping system within the scope of this Code shall:

(a) have written detailed plans and training programs for employees covering operating and maintenance procedures for the transportation piping system during normal operations and maintenance in accordance with the purpose of this Code; essential features recommended for inclusion in the plans for specific portions of the system are given in paras. 451 and 452.

(b) have a plan for external and internal corrosion control of new and existing piping systems, including requirements and procedures prescribed in para. 453 and Chapter VIII;

(c) have a written Emergency Plan as indicated in para. 454 for implementation in the event of system failures, accidents, or other emergencies; train appropriate operating and maintenance employees with regard to applicable portions of the plan, and establish liaison with appropriate public officials with respect to the plan;

(d) have a plan for reviewing changes in conditions affecting the integrity and safety of the piping system, including provisions for periodic patrolling and reporting of construction activity and changes in conditions, especially in industrial, commercial, and residential areas and at river, railroad, and highway crossings, in order to consider the possibility of providing additional protection to prevent damage to the pipeline in accordance with para. 402.1;

(e) establish liaison with local authorities who issue construction permits in urban areas to prevent accidents caused by excavators;

(f) establish procedures to analyze all failures and accidents for the purpose of determining the cause and to minimize the possibility of recurrence;

(g) maintain necessary maps and records to properly administer the plans and procedures, including records listed in para. 455;

(h) have procedures for abandoning piping systems, including the requirements in para. 457;

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

(j) operate and maintain its piping system in conformance with these plans and procedures;

(k) modify the plans and procedures from time to time as experience dictates and as exposure of the system to the public and changes in operating conditions require.

451 PIPELINE OPERATION AND MAINTENANCE

451.1 Operating Pressure

(a) Care shall be exercised to assure 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. 402.2.3, 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. 402.2.4.

(b) A piping system shall be qualified for a higher operating pressure when the higher operating pressure will produce a hoop stress of more than 20% of the specified minimum yield strength of the pipe in accordance with para. 456.

(c) If a piping system is derated to a lower operating pressure in lieu of repair or replacement, the new maximum steady state operating pressure shall be determined in accordance with para. 451.7.

(d) For existing systems utilizing materials produced under discontinued or superseded standards or specifications, the internal design pressure shall be determined using the allowable stress and design criteria listed in the issue of the applicable code or specification in effect at the time of the original construction.

451.2 Communications

A communications facility shall be maintained to assure safe pipeline operations under both normal and emergency conditions.

451.3 Markers

(a) Markers shall be installed over each line on each side of road, highway, railroad, and stream crossings to properly locate and identify the system. Markers are not required for pipelines offshore.

(b) Pipeline markers at crossings, aerial markers when used, and other signs shall be maintained so as to indicate the location of the line. These markers shall show the name of the operating company, and, where possible, an emergency telephone contact. Additional pipeline markers shall be installed along the line in areas of development and growth to protect the system from encroachment. API RP 1109 shall be used for guidance.

451.4 Right of Way Maintenance

(a) The right of way should be maintained so as to have clear visibility and to give reasonable access to maintenance crews.

(b) Access shall be maintained to valve locations.

(c) Diversion ditches or dikes shall be maintained where needed to protect against washouts of the line and erosion of the landowner's property.

451.5 Patrolling

(a) Each operating company 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 company, and any other factors affecting the safety and operation of the pipeline. Special attention shall be given to such activities as road building, ditch cleanouts, excavations, and like encroachments to the pipeline system. Patrols shall be made at intervals not exceeding 2 weeks, except that piping systems transporting LPG or liquid anhydrous ammonia shall be patrolled at intervals not exceeding 1 week in industrial, commercial, or residential areas.

(b) Underwater crossings shall be inspected periodically for sufficiency of cover, accumulation of debris, or for any other condition affecting the safety and security of the crossings, and at any time it is felt that the crossings are in danger as a result of floods, storms, or suspected mechanical damage.

451.6 Pipeline Repairs

451.6.1 General (98) A01

(a) Repairs shall be covered by a maintenance plan [see para. 450.2(a)] and shall be performed under

qualified supervision by trained personnel aware of and familiar with the hazards to public safety, utilizing strategically located equipment and repair materials. The maintenance plan shall consider the appropriate information contained in API Publ. 2200, API Pub. 2201, API Standard 1104, and API RP 1111. It is essential that all personnel working on pipeline repairs understand the need for careful planning of the job, be briefed as to the procedure to be followed in accomplishing the repairs, and follow precautionary measures and procedures outlined in API Publ. 2200. Personnel working on repairs to pipelines handling LPG, carbon dioxide, liquid alcohol, or liquid anhydrous ammonia shall also be informed on the specific properties, characteristics, and potential hazards associated with those liquids, precautions to be taken following detection of a leak, and safety repair procedures set forth for LPG pipelines in API Publ. 2200. Approvals, procedures, and special considerations described in API Publ. 2201 shall be observed for welding, as well as making hot taps on pipelines, vessels, or tanks which are under pressure. Piping in the vicinity of any repair shall be adequately supported during and after the repair.

(b) If an inert fluid is used to temporarily displace the liquid in a pipeline system for the purpose of a repair, a detailed written procedure shall be required. Because the potential energy of a gas presents special concerns, this procedure shall address, as a minimum, the factors related to the use of an inert gas:

(1) maximum flow rate;
(2) pressure;
(3) injection temperature;
(4) inert gas disposal;
(5) safety procedures.

The procedure shall be followed under the supervision required in para. 451.6.1(a).

(98) **451.6.2 Disposition of Defects**

(a) Limits and Dispositions of Imperfections

(1) Gouges and grooves having a depth greater than 12½% of the nominal wall thickness shall be removed or repaired.

(2) Dents meeting any of the following conditions shall be removed or repaired:

(a) dents which affect the pipe curvature at the pipe seam or at any girth weld;

(b) dents containing a scratch, gouge, or groove; or

A01 *(c)* dents exceeding a depth of ¼ in. (6 mm) in pipe NPS 4 and smaller, or 6% of the nominal pipe diameter in sizes greater than NPS 4.

(3) All arc burns shall be removed or repaired.

(4) All cracks shall be removed or repaired.

(5) All welds found to have defects as set forth in para. 434.8.5(b) or in the appropriate pipe specification shall be removed or repaired.

(6) General Corrosion. Pipe shall be replaced, or repaired if the area is small, or operated at a reduced pressure (see para. 451.7) if general corrosion has reduced the 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.

(7) Localized Corrosion Pitting. Pipe shall be repaired, replaced, or operated at a reduced pressure (see para. 451.7) if localized corrosion pitting has reduced the 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. This applies if the length of the pitted area is greater than permitted by the equation shown below. The following method applies only when the depth of the corrosion pit is less than 80% of the nominal wall thickness of the pipe. This method shall not be used to evaluate corrosion concentrated in electric resistance welded seams (ERW), electric induction welded seams or electric flash-welded seams, nor shall it be used to evaluate corrosion-caused metal loss which is circumferentially oriented along or in a girth weld or its heat-affected zone. The method may be used, however, to evaluate the longitudinal profile of corrosion-caused metal loss which crosses a girth weld or impinges on a submerged arc welded seam. The corroded area must be clean to bare metal. Care shall be taken in cleaning corroded areas of a pressurized pipeline when the degree of corrosion is significant.

$$L = 1.12B\sqrt{Dt_n}$$

where

$$B = \sqrt{\left(\frac{c/t_n}{1.1c/t_n - 0.15}\right)^2 - 1}$$

L = maximum allowable longitudinal extent of the corroded area as shown in Fig. 451.6.2(a)(7), in. (mm)
B = a value not to exceed 4.0 which may be determined from the above equation or Fig. 451.6.2(a)(7)
D = nominal outside diameter of the pipe, in. (mm)
t_n = nominal wall thickness of the pipe, in. (mm)
c = maximum depth of the corroded area, in. (mm)

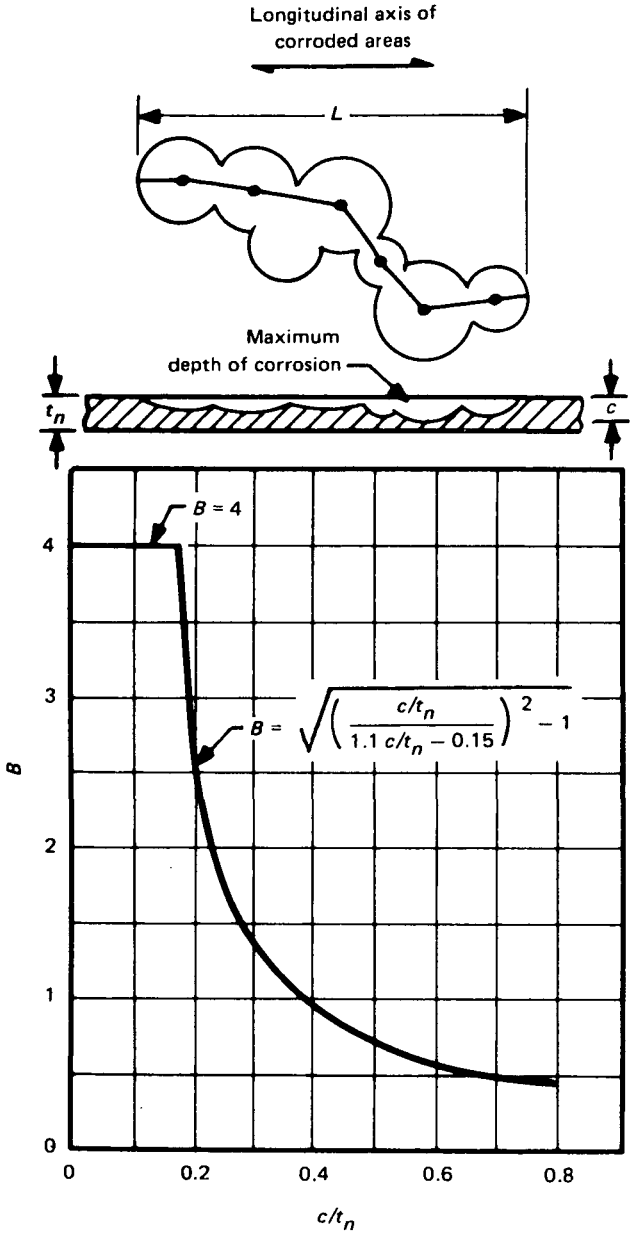

FIG. 451.6.2(a)(7) PARAMETERS USED IN ANALYSIS OF THE STRENGTH OF CORRODED AREAS

(8) Areas where grinding has reduced 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, may be analyzed the same as localized corrosion pitting [see para. 451.6.2(a)(7)] to determine if ground areas need to be replaced, repaired, or the operating pressure reduced (see para. 451.7). ASME B31G may be used for guidance.

(9) All pipe containing leaks shall be removed or repaired.

(b) Allowable Pipeline Repairs

(1) If practical, the pipeline should be taken out of service and repaired by cutting out a cylindrical piece of pipe containing the defect and replacing the same with pipe meeting the requirements of para. 401.2.2 and having a length of not less than one-half diameter.

(2) If not practical to take the pipeline out of service, repairs may be made by the installation of a full encirclement welded or mechanically applied split sleeve in accordance with para. 451.6.2(c).

(a) For repairs of dents, either a hardenable filler material such as epoxy shall be used to fill the void between the sleeve and the pipe to restore the original contour of the pipe, or the carrier pipe shall be tapped through the sleeve or other means provided to equalize the internal pressures of the carrier pipe and the sleeve.

(b) For repairs to nonleaking cracks in materials that might be expected to behave in a brittle manner (e.g., a seam defect in a low-frequency welded ERW seam), an appropriately-designed fitting shall be installed on the sleeve through which the sleeve and carrier pipe will be tapped to equalize the internal pressures of the carrier pipe and the sleeve.

(3) If not practical to take the pipeline out of service, defects may be removed by grinding or hot tapping. When grinding, the ground areas shall be smoothly contoured and be in accordance with para. 451.6.2(a)(8). When hot tapping, the portion of piping containing the defect shall be completely removed.

(4) If not practical to take the pipeline out of service, minor leaks and small corroded areas, except for cracks, may be repaired by the installation of a patch or welded fitting in accordance with paras. 451.6.2(c)(5) and (8). Pipe containing arc burns, grooves, and gouges may be repaired with patches or welded fitting if the arc burn or notch is removed by grinding.

(5) If not practical to take the pipeline out of service, defects in welds produced with a filler metal, small corroded areas, gouges, grooves, and arc burns may be repaired by depositing weld metal in accordance with para. 451.6.2(c)(9). Weld imperfections, arc burns, gouges, and grooves shall be removed by grinding prior to depositing the weld filler metal.

(6) If not practical to take the pipeline out of

service, nonleaking corroded areas may be repaired by installation of a fully welded, partial encirclement half sole in accordance with para. 451.6.2(c)(13).

(7) If not practical to take the pipeline out of service, nonleaking corroded areas may be repaired by installation of a mechanically applied composite material wrap used to reinforce the pipeline in accordance with para. 451.6.2(c)(14).

(c) Repair Methods

(1) All repair weld procedures and all welders performing repair work shall be qualified in accordance with para. 434.8.3 or API RP 1107. The welders shall also be familiar with safety precautions and other problems associated with cutting and welding on pipe that contains or has contained liquids within the scope of this Code. Cutting and welding shall commence only after compliance with para. 434.8.1(c).

(2) The qualification test for welding procedures to be used on pipe containing a liquid shall consider 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.

(3) Materials used for pipeline repair shall be in accordance with at least one of the specifications or standards listed in Table 423.1, or as otherwise required by this Code.

(4) Temporary repairs may be necessitated for operating purposes and shall be made in a safe manner. Such temporary repairs shall be made permanent or replaced in a permanent manner as described herein as soon as practical.

(5) Welded patches shall have rounded corners and a maximum dimension of 6 in. (150 mm) along the pipe axis. The patch material shall be of a similar or higher grade with a wall thickness similar to the pipe being repaired. Patches shall be limited to pipe sizes NPS 12 and less and conforming to API 5L, Grade X42 and lower. Patches shall be attached by fillet welds. Insert patching is prohibited. Special consideration shall be given to minimize stress concentrations resulting from the repair.

(6) Full encirclement welded split sleeves installed to repair leaks or otherwise to contain internal pressure shall have a design pressure of not less than the pipe being repaired and shall be fully welded, both circumferentially and longitudinally. Length of full encirclement split sleeves shall not be less than 4 in. (100 mm). If the sleeve is thicker than the pipe being repaired, the circumferential ends shall be chamfered (at approximately 45 deg.) down to the thickness of the pipe. For full encirclement split sleeves installed for repair by reinforcement only and not internal pressure containment, circumferential welding is optional. Special consideration shall be given to minimize stress concentrations resulting from the repair.

(7) Mechanically applied full encirclement repair fittings shall meet the design requirements of paras. 401.2 and 418.

(8) Welded fittings used to cover pipeline defects shall not exceed NPS 3 and shall have a design pressure of not less than the pipe being repaired.

(9) For repairs involving only deposition of a weld filler metal, welding processes shall be in accordance with the requirements of the appropriate pipe specification for the grade and type being repaired. Welding procedure qualifications shall be in accordance with para. 451.6.2(c)(2).

(10) Where repairs are made to a coated pipe, all damaged coating shall be removed and new coating applied in accordance with para. 461.1.2. Replacement pieces of pipe, welded patches, and full encirclement welded split sleeves used in making repairs shall also be coated when installed in a coated line.

(11) Pipe containing liquid shall be examined to determine that the material is sound and of adequate thickness in the areas to be affected by grinding, welding, cutting, or hot tapping operations.

(12) If the pipeline is not taken out of service, the operating pressure shall be reduced to a level which will provide safety during the repair operations.

(13) Fully welded partial encirclement half soles may be used to repair corroded areas only on pipe and shall not be used to repair leaks, gouges, dents, or other defects. The use of half soles shall be limited to pipe sizes NPS 12 or less and may only be used on pipe made prior to 1942 with a specified minimum yield strength not exceeding 40,000 psi (276 MPa). The half sole material shall be of a similar or higher grade with a wall thickness not less than 87.5% or more than 125% of that of the pipe being repaired. Half soles shall have rounded corners and a maximum length of 10 ft (3 m) along the pipe axis. Half soles shall not be used across girth welds and the minimum clearance between the end of half soles or the ends of half soles and girth welds shall be 2 in. Combinations of a half sole and patches shall not be used in parallel around a given circumference. To ensure optimum performance of half soles, the annular space between the corroded pipe and the half sole may be filled with a hardenable filler material such as epoxy. Special consideration shall be given to ensuring a close fit

between the edges of the half sole and the pipe being repaired and to minimizing stress concentrations resulting from the repair.

(14) Mechanically applied composite material wrap may be used to reinforce the pipeline provided that design and installation methods are proven for the intended service prior to application. The user is cautioned that a qualified written procedure performed by trained personnel is a requirement and records shall be retained in accordance with para. 455.

451.6.3 Testing Repairs to Pipelines Operating at a Hoop Stress of More Than 20% of the Specified Minimum Yield Strength of the Pipe

(a) Testing of Replacement Pipe Sections. When a scheduled repair to a pipeline is made by cutting out a section of the pipe as a cylinder and replacing it with another section of pipe, the replacement section of pipe shall be subjected to a pressure test. The replacement section of pipe shall be tested as required for a new pipeline in accordance with para. 437.4.1. The tests may be made on the pipe prior to installation provided radiographic or other acceptable nondestructive tests (visual inspection excepted) are made on all tie-in butt welds after installation.

(b) Examination of Repair Welds. Welds made during pipeline repairs shall be examined by accepted non-destructive methods or visually examined by a qualified inspector.

451.7 Derating a Pipeline to a Lower Operating Pressure

(a) Corroded pipe or pipe containing areas repaired by grinding may be derated to a lower operating pressure in lieu of replacement or repair or further repair. Except as provided in para. 451.7(b), the lower operating pressure shall be based on para. 404.1.2 and the actual remaining wall thickness of the pipe at the point of deepest corrosion or grinding.

(b) For pipe containing localized corrosion pitting or areas repaired by grinding where the remaining material in the pipe does not meet the depth and length limits in para. 451.6.2(a)(7), the lower operating pressure may be determined by the following equation, provided the corrosion or grinding is not in the girth or longitudinal weld or related heat affected zones.

$$P_d = 1.1P_i \left[\frac{1 - 0.67\left(\frac{c}{t_n}\right)}{1 - \frac{0.67c}{t_n\sqrt{G^2 + 1}}} \right]$$

where

$G = 0.893\, L/\sqrt{Dt_n}$
$= $ a value not to exceed 4.0 in the above analysis and which may be determined from the above equation
$P_d =$ derated internal design gage pressure, psi (bar)
$P_i =$ original internal design gage pressure, based on specified nominal wall thickness of the pipe (see para. 404.1), psi (bar)
$L =$ longitudinal extent of the corroded area as shown in Fig. 451.6.2(a)(7), in. (mm)

For t_n, c, and D, see para. 451.6.2(a)(7).

For values of G greater than 4.0,

$$P_d = 1.1P_i\,(1 - c/t_n)$$

except p_d shall not exceed p_i.

451.8 Valve Maintenance

Pipeline block valves shall be inspected, serviced where necessary, and partially operated at least once each year to assure proper operating conditions.

451.9 Railroads and Highways Crossing Existing Pipelines (98)

(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 both live and dead loads) exceeds 0.90 SMYS (specified minimum yield strength), the operating company shall install mechanical reinforcement, structural protection, or suitable pipe to reduce the stress to 0.90 SMYS 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 failure. A01

(b) Installation of uncased carrier pipe is preferred. Adjustments of existing pipelines in service at a proposed railroad or highway crossing shall conform to details contained in API RP 1102. As specified in para.

APPENDIX A
REFERENCED STANDARDS[1]

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Specific editions of standards incorporated in this Code by reference, and the names and addresses of the sponsoring organizations, are shown in this 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. Appendix A will be revised at intervals as needed, and issued in Addenda to this Code. An asterisk (*) is used to indicate those standards that have been accepted as American National Standards by the American National Standards Institute (ANSI).

ASTM Specifications

A 6/A 6M-99b
A 20/A 20M-99a
A 29/A 29M-99
A 36/A 36M-00

A 53-99b

A 105/A 105M-98
A 106-99e1 [Note (2)]
A 126-95e1
A 134-96
A 135-97c [Note (2)]
A 139-96e1

A 181/A 181M-95b
A 182/A 182M-99
A 193/A 193M-99a
A 194/A 194M-99

A 216/A 216M-93 (1998)
A 217/A 217M-99
A 225/A 225M-93 (1999)
A 234/A 234M-99
A 242/A 242M-00

A 283/A 283M-00
A 285/A 285M-90e1 (1996)

A 307-97
A 320/A 320M-99
A 325-97
A 333/A 333M-99
A 350/A 350M-99

A 354-98
A 381-96
A 395-99

A 420/A 420M-99 [Note (5)]

A 449-93

A 487/A 487M-93 (1998)
A 490-97/A 490M-93

ASTM Specifications (Cont'd)

A 505-00
A 506-93 (1998)
A 507-93 (1998)
A 514/A 514M-00
A 515/A 515M-92 (1997)
A 516/A 516M-90e1 (1996)
A 517/A 517M-93 (1999)
A 524-96 [Note (2)]
A 530/A 530M-99

A 572/A 572M-00
A 573/A 573M-93a (1998)
A 575-96
A 576-90b e1 (1995)

A 633/A 633M-00

A 663/A 663M-89e1 (1994)
A 671-96
A 672-96
A 675/A 675M-90a e1 (1995)
A 694/A 694M-00

NFPA Codes

*30-1996
*70-1999

AWS Standards

*A3.0-1994
*D3.6M-1999

NACE Standards and Other Publications

MR-01-75 (2000 Rev.)
RP-01-69 (1996 Rev.)
RP-01-75
RP-01-77 (1995 Rev.)
RP-06-75
Corrosion Data Survey — Metals Section, 6th Ed., 1985

MSS Standard Practices

SP-6-1996
SP-25-1998
SP-44-1996
SP-55-1996
*SP-58-1993
SP-61-1992
SP-67-1995
SP-69-1996
SP-70-1998
SP-71-1997
SP-75-1998
SP-78-1998

API Standards and Other Publications

RP 2A-WSD, 20th Ed., 1993 & Supp. 1-1996

*Spec. 5B, 14th Ed., 1996
*Spec. 5L, 42nd Ed., 2000 [Note (3)]
*RP 5L1, 5th Ed., 1996
*RP 5LW, 2nd Ed., 1996 (Incorporates 5L1, 5L5, and 5L6)
*Spec. 6A, 18th Ed., 1999
Spec. 6D, 21st Ed., 1994
*Spec. 12B, 14th Ed., 1995
*Spec. 12D, 10th Ed., 1994
*Spec. 12F, 11th Ed., 1994

RP 17B, 2nd Ed., 1998
*RP 500, 2nd Ed., 1997

Std. 600, 10th Ed., 1997

Std. 602, 7th Ed., 1998
*Std. 603, 5th Ed., 1991
*Std. 620, 9th Ed., 1996
Std. 650, 10th Ed., 1998

RP 1102, 6th Ed., 1993
*Std. 1104, 19th Ed., 1999
RP 1109, 2nd Ed., 1993

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REFERENCED STANDARDS[1] (CONT'D)

API Standards and Other Publications (Cont'd)	ASME Codes and Standards	ASME Codes and Standards (Cont'd)
	*ASME Boiler and Pressure Vessel Code, 1998 Ed. and 1999 Addenda	*B16.20-1998 & Addenda 2000
RP 1110, 4th Ed., 1997		*B16.21-1992
RP 1111, 3rd Ed., 1999		*B16.25-1997
RP 1117, 2nd Ed., 1996		*B16.28-1994
	*B1.1-1998	*B31G-1991
Publ. 2015, 5th Ed., 1994	*B1.20.1-1983 (R1992)	*B31.5-1992 & Addenda-1994
Publ. 2200, 3rd Ed., 1994	*B1.20.3-1976 (R1998)	*B36.10M-1996
Publ. 2201, 4th Ed., 1995		*B36.19M-1985 (R1994)
	*B16.5-1996 [Note (4)]	
API Manual of Petroleum Measurement Standards	*B16.9-1993	
	*B16.10-1992	

NOTES:
(1) The issue date shown immediately following the number of the standard (e.g., A 53-96, B1.1-1998, and SP-6-1996 is the effective date of issue (edition) of the standard.
(2) Approved only if mill hydrostatic test is performed.
(3) Use of bell and spigot line pipe not permitted.
(4) Limited as set forth in para. 402.2.1.
(5) A 420/A 420M Grade WPL9 is not suitable for anhydrous ammonia due to copper content.

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

API	. . .	Manual of Petroleum Measurement Standards
API	2A-WSD	Recommended Practice for Planning, Designing, and Constructing Fixed Platforms — Working Stress Design
API	5L1	Recommended Practice for Railroad Transportation of Line Pipe
API	5LW	Recommended Practice for Tansportation of Line Pipe on Barges and Marine Vessels
API	12B	Specification for Bolted Tanks for Storage of Production Liquids
API	12D	Specification for Field Welded Tanks 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	500	Classification of Locations for Electrical Installations at Petroleum Facilities
API	620	Design and Construction of Large, Welded, Low-Pressure Storage Tanks
API	650	Welded Steel Tanks for Oil Storage
API	1102	Recommended Practice for Liquid Petroleum Pipelines Crossing Railroads and Highways
API	1104	Standard for Welding Pipelines and Related Facilities
API	1109	Recommended Practice for Marking Liquid Petroleum Pipeline Facilities
API	1110	Recommended Practice for Pressure Testing of Liquid Petroleum Pipelines
API	1111	Recommended Practice for Design, Construction, Operation and Maintenance of Offshore Hydrocarbon Pipelines
API	2015	Cleaning Petroleum Storage Tanks
API	2200	Repairing Crude Oil, Liquefied Petroleum Gas, and Product Pipelines
API	2201	Procedures for Welding or Hot Tapping on Equipment in Service
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 and Brazing Qualifications
ASME	B31G	Manual for Determining the Remaining Strength of Corroded Pipelines: A Supplement to B31, Code for Pressure Piping
ASME	B31.5	Refrigeration Piping
AWS	A3.0	Welding Terms and Definitions
AWS	D3.6	Specification for Underwater Welding
NACE	. . .	Corrosion Data Survey — Metals Section
NACE	MR-01-75	Sulfide Stress Cracking Resistant Metallic Materials for Oil Field Equipment
NACE	RP-01-69	Recommended Practice — Control of External Corrosion on Underground or Submerged Metallic Piping Systems
NACE	RP-01-75	Recommended Practice: Control of Internal Corrosion in Steel Pipelines Systems
NACE	RP-01-77	Mitigation of Alternating Current and Lightning Effects on Metallic Structures and Corrosion Control Systems
NACE	RP-06-75	Recommended Practice: Control of Corrosion on Offshore Steel Pipelines

REFERENCED STANDARDS[1] (CONT'D)

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NFPA	30	Flammable and Combustible Liquids Code
NFPA	70	National Electrical Code

Specifications and standads of the following organizations appear in Appendix A:

ANSI American National Standards Institute, Inc.
11 West 42nd Street
New York, NY 10036
212 642-4900

API American Petroleum Institute
Order Desk
1220 L Street, N.W.
Washington, DC 20005-4070
202 682-8375

ASME *The American Society of Mechanical Engineers*
Three Park Avenue
New York, NY 10016-5990
212 591-8500

ASME Order Department
22 Law Drive
Box 2900
Fairfield, NJ 07007-2900
800 843-2763
201 882-1167

ASTM American Society for Testing and Materials
100 Bar Harbor Drive
West Conshohocken, PA 19428-2959
610 832-9500

AWS American Welding Society
P.O. Box 351040
550 N.W. LeJeune Road
Miami, FL 33126
305 443-9353

MSS Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.
127 Park Street, N.E.
Vienna, VA 22180
703 281-6613

NACE National Association of Corrosion Engineers
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ASME CODE FOR PRESSURE PIPING, B31

A01

B31.1	Power Piping	1998	
B31.2[1]	Fuel Gas Piping	1968	
B31.3	Process Piping	1999	
B31.4	Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids	1998	
B31.5	Refrigeration Piping	1992	
B31.8	Gas Transmission and Distribution Piping Systems	1999	
B31.9	Building Services Piping	1996	
B31.11	Slurry Transportation Piping Systems	1989	(R1998)
B31G	Manual for Determining the Remaining Strength of Corroded Pipelines: A Supplement to ASME B31 Code for Pressure Piping	1991	

NOTE:
(1) USAS B31.2-1968 was withdrawn as an American National Standard on February 18, 1988. ASME will continue to make available USAS B31.2-1968 as an historical document for a period of time.

ASME B31.4

INTERPRETATIONS NO. 6

Replies to Technical Inquiries
January 1, 1998 Through December 31, 2000

It has been agreed to publish intepretations issued by the B31 Committee concerning B31.4 as part of the update service to the Code. The interpretations have been asssigned numbers in chronological order. Each interpretation applies either to the latest Edition or Addenda at the time of issuance of the interpretation or the Edition or Addenda stated in the reply. Subsequent revisions to the Code may have superseded the reply.

These replies are taken verbatim from the original letters, except for a few typographical and editorial corrections made for the purpose of improved clarity. In some instances, a review of the interpretation revealed a need for corrections of a technical nature. In these cases, a revised reply bearing the original interpretation number with the suffix R is presented. In the case where an interpretation is corrected by Errata, the original interpretation number with the suffix E is used.

ASME procedures provide for reconsideration of these interpretations when or if additional information is available which the inquirer believes might affect the interpretation. Further, persons aggrieved by an interpretation may appeal to the cognizant ASME committee or subcommittee. As stated in the Statement of Policy in the Code documents, ASME does not "approve," "certify," "rate," or "endorse" any item, construction, proprietary device, or activity.

For detailed instructions on preparations of technical inquiries to the B31 Committee, refer to Appendix B.

Interpretations No. 1 was included with ANSI/ASME B31.4c-1986. Interpretations No. 2 was included with ASME B31.4a-1987. Interpretations No. 3 was included with ASME B31.4a-1991. Interpretations No. 4 was included with ASME B31.4a-1994. Interpretations No. 5 was included with ASME B31.4-1998.

B31.4

Interpretation: 4-68

Subject: ASME B31.4-1998 Edition, Para. 406.2, Bends, Miters, and Elbows

Date Issued: February 15, 2000

File: B31-00-058

Question (1): Are single joint miter bends of an angle up to 12.5 deg permissible in systems to be operated at a hoop stress between 10% and 20% of the specified minimum yield strength of the pipe?

Reply (1): Yes.

Question (2): Does the requirement "and the minimum distance between miters measured at the crotch shall not be less than one pipe diameter" imply that a miter bend should be made up of a minimum of two joints even when the miter bend angle is within 12.5 deg?

Reply (2): No.

Question (3): Is the "angle of miter bend" referred to in ASME B31.4, para. 406.2.2 the same as the angle θ shown in ASME B31.4, Fig. 419.6.4(c)?

Reply (3): Yes.

Interpretation: 4-69

Subject: ASME B31.4-1998 Edition, Para. 400.1.1(c), Scope; and Fig. 400.1.1, Diagram Showing Scope of ASME B31.4 Excluding Carbon Dioxide Pipeline Systems

Date Issued: February 15, 2000

File: B31-00-059

Question: Does B31.4 specify minimum required width or other limitations for corridors referred to in Fig. 400.1.1?

Reply: No.

Interpretation: 4-70

Subject: ASME B31.4-1998 Edition, Para. 423.1, Acceptable Materials; and Table 423.1, Material Standards

Date Issued: February 22, 2000

File: B31-00-060

Question: Is it permissible to use API 5L Grade X80 pipe in pipeline systems designed in accordance with ASME B31.4?

Reply: Yes.

Interpretation: 4-71

Subject: ASME B31.4-1998 Edition, Para. 437.4.3; Leak Testing

Date Issued: February 23, 2000

File: B31-00-061

Question: Do the limitations on hydrostatic test media for proof testing in para. 437.4.1(c) apply to leak testing, para. 437.4.3?

Reply: Yes.

Interpretation: 4-72

Subject: ASME B31.4-1998 Edition, Fig. 434.8.6(a)-(2), Acceptable Butt Welded Joint Design for Unequal Wall Thickness

Date Issued: November 13, 2000

File: B31-00-062

Question (1): Does General Note (a) of Fig. 434.8.6(a)-(2), which states that "the sketches in Fig. 434.8.6(a)-(2) illustrate acceptable preparations for joining pipe ends having unequal wall thicknesses and/or materials of unequal specified minimum yield strength by butt welding," mean that the examples are acceptable preparations for joining pipe ends having unequal specified minimum yield strength by butt welding.

Reply (1): Yes.

Question (2): Does General Note (b) of Fig. 434.8.6(a)-(2), requiring that the thickness of the pipes to be joined, beyond the joint design area, comply with the design requirements of the Code, also apply to the tapered portion of the pipe within the joint design area?

Reply (2): No.

Question (3): Is it permissible to weld a 12.75 O.D. × 0.500 w.t. API 5L X46 pipe directly to a 12.75 in. O.D. w.t. API 5L X60 pipe, without a transition nipple, per detail (b) of Fig. 434.8.6(a)-(2)?

Reply (3): Yes.

B31.4 — Cases No. 4

A Case is the official method of handling a reply to an inquiry when study indicates that the Code wording needs clarification, or when the reply modifies the existing requirements of the Code, or grants permission to use new materials or alternative constructions.

ASME has agreed to publish Cases issued by the B31 Committee concerning B31.4 as part of the update service to B31.4. The text of proposed new and revised Cases and reaffirmations of current Cases appear in *Mechanical Engineering* for public review. A notice also appears in *Mechanical Engineering* when new and revised Cases are approved. New and revised Cases, as well as announcements of reaffirmed Cases and annulments, then appear in the next update. All Cases currently in effect at the time of publication of a new Edition of the Code are included with it as a supplement.

The page numbers for the Cases supplements included with updates to the 1998 Edition start with C-1 and continue consecutively through the last Cases supplement to this Edition.

The Case affected by this supplement is as follows:

Page	*Location*	*Change*
C-1	Case 167	Annulled

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