ASME B31.4-2006

(Revision of ASME B31.4-2002)

Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids

ASME Code for Pressure Piping, B31

AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

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Three Park Avenue • New York, NY 10016

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The next Edition of this Code is scheduled for publication in 2009. There will be no addenda issued to this edition.

ASME issues written replies to inquiries concerning interpretations of technical aspects of the Code. Interpretations are published on the ASME Web site under the Committee Pages at http://www.asme.org/codes/ as they are issued.

The user of the Code will note that metric equivalents of U.S. Customary units appear in many places in this Code. The values stated in U.S. Customary units are to be regarded as the standard, unless otherwise agreed between the contracting parties.

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

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FOREWORD

The need for a national code for pressure piping became increasingly evident from 1915 to 1925. To meet this need the American Engineering Standards Committee (later changed to the American Standards Association) initiated Project B31 in March 1926 at the request of The American Society of Mechanical Engineers, and with that society as sole sponsor. After several years' work by Sectional Committee B31 and its subcommittees, a first edition was published in 1935 as an American Tentative Standard Code for Pressure Piping.

A revision of the original tentative standard was begun in 1937. Several more years' effort was given to securing uniformity between sections and to eliminating divergent requirements and discrepancies, as well as to keeping the code abreast of current developments in welding technique, stress computations, and references to new dimensional and material standards. During this period a new section was added on refrigeration piping, prepared in cooperation with The American Society of Refrigeration Engineers and complementing the American Standard Code for Mechanical Refrigeration. This work culminated in the 1942 American Standard Code for Pressure Piping.

Supplements 1 and 2 of the 1942 code, which appeared in 1944 and 1947, respectively, introduced new dimensional and material standards, a new formula for pipe wall thickness, and more comprehensive requirements for instrument and control piping. Shortly after the 1942 code was issued, procedures were established for handling inquiries that require explanation or interpretation of code requirements, and for publishing such inquiries and answers in *Mechanical Engineering* for the information of all concerned.

Continuing increases in the severity of service conditions, with concurrent developments of new materials and designs equal to meeting these higher requirements, had pointed to the need by 1948 for more extensive changes in the code than could be provided by supplements alone. The decision was reached by the American Standards Association and the sponsor to reorganize the Sectional Committee and its several subcommittees, and to invite the various interested bodies to reaffirm their representatives or to designate new ones. Following its reorganization, Sectional Committee B31 made an intensive review of the 1942 code, and a revised code was approved and published in February 1951 with the designation ASA B31.1-1951, which included:

(a) a general revision and extension of requirements to agree with practices current at the time;

(b) revision of references to existing dimensional standards and material specifications, and the addition of references to new ones; and

(c) clarification of ambiguous or conflicting requirements.

Supplement No. 1 to B31.1 was approved and published in 1953 as ASA B31.1a-1953. This Supplement and other approved revisions were included in a new edition of B31.1 published in 1955 with the designation ASA B31.1-1955.

A review by B31 Executive and Sectional Committees in 1955 resulted in a decision to develop and publish industry sections as separate code documents of the American Standard B31 Code for Pressure Piping. ASA B31.4-1959 was the first separate code document for Oil Transportation Piping Systems and superseded that part of Section 3 of the B31.1-1955 code covering Oil Transportation Piping Systems. In 1966 B31.4 was revised to expand coverage on welding, inspection, and testing, and to add new chapters covering construction requirements and operation and maintenance procedures affecting the safety of the piping systems. This revision was published with the designation USAS B31.4-1966, Liquid Petroleum Transportation Piping Systems, since the American Standards Association was reconstituted as the United States of America Standards Institute in 1966.

The United States of America Standards Institute, Inc., changed its name, effective October 6, 1969, to the American National Standards Institute, Inc., and USAS B31.4-1966 was redesignated as ANSI B31.4-1966. The B31 Sectional Committee was redesignated as American National Standards Committee B31 Code for Pressure Piping, and, because of the wide field involved, more than 40 different engineering societies, government bureaus, trade associations, institutes, and the like

had one or more representatives on Standards Committee B31, plus a few "Individual Members" to represent general interests. Code activities were subdivided according to the scope of the several sections, and general direction of Code activities rested with Standards Committee B31 officers and an Executive Committee whose membership consisted principally of Standards Committee officers and chairmen of the Section and Technical Specialists Committees.

The ANSI B31.4-1966 Code was revised and published in 1971 with the designation ANSI B31.4-1971.

The ANSI B31.4-1971 Code was revised and published in 1974 with the designation ANSI B31.4-1974.

In December 1978, American National Standards Committee B31 was converted to an ASME Committee with procedures accredited by ANSI. The 1979 revision was approved by ASME and subsequently by ANSI on November 1, 1979, with the designation ANSI/ASME B31.4-1979.

Following publication of the 1979 Edition, the B31.4 Section Committee began work on expanding the scope of the code to cover requirements for the transportation of liquid alcohols. References to existing dimensional standards and material specifications were revised, and new references were added. Other clarifying and editorial revisions were made in order to improve the text. These revisions led to the publication of two addenda to B31.4. Addenda "b" to B31.4 was approved and published in 1981 as ANSI/ASME B31.4b-1981. Addenda "c" to B31.4 was approved and published in 1986 as ANSI/ASME B31.4c-1986.

The 1986 Edition of B31.4 was an inclusion of the two previously published addenda into the 1979 Edition.

Following publication of the 1986 Edition, clarifying and editorial revisions were made to improve the text. Additionally, references to existing standards and material specifications were revised, and new references were added. These revisions led to the publication of an addenda to B31.4, which was approved and published in 1987 as ASME/ANSI B31.4a-1987.

The 1989 Edition of B31.4 was an inclusion of the previously published addenda into the 1986 Edition.

Following publication of the 1989 Edition, clarifying revisions were made to improve the text. Additionally, references to existing standards and material specifications were revised and updated. These revisions led to the publication of an addenda to B31.4, which was approved and published in 1991 as ASME B31.4a-1991.

The 1992 Edition of B31.4 was an inclusion of the previously published addenda into the 1989 Edition and a revision to valve maintenance. The 1992 Edition was approved by the American National Standards Institute on December 15, 1992, and designated as ASME B31.4-1992 Edition.

The 1998 Edition of B31.4 was an inclusion of the previously published addenda into the 1992 Edition. Also included in this Edition were other revisions and the addition of Chapter IX, Offshore Liquid Pipeline Systems. The 1998 Edition was approved by the American National Standards Institute on November 11, 1998, and designated as ASME B31.4-1998 Edition.

The 2002 Edition of B31.4 was an inclusion of the previously published addenda into the 1998 Edition along with revisions to the maintenance section and updated references. The 2002 Edition was approved by the American National Standards Institute on August 5, 2002, and designated as ASME B31.4-2002.

The 2006 Edition of B31.4 contains a new repair section, along with revisions to the definitions section, expansion of material standards Table 423.1, dimensional standards Table 426.1, and updated references. This 2006 Edition was approved by the American National Standards Institute on January 5, 2006, and designated as ASME B31.4-2006.

ASME CODE FOR PRESSURE PIPING, B31

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INTRODUCTION

The ASME B31 Code for Pressure Piping consists of a number of individually published Sections, each an American National Standard. Hereafter, in this Introduction and in the text of this Code Section B31.4, where the word "Code" is used without specific identification, it means this Code Section.

The Code sets forth engineering requirements deemed necessary for safe design and construction of pressure piping. While safety is the basic consideration, this factor alone will not necessarily govern the final specifications for any piping system. The designer is cautioned that the Code is not a design handbook; it does not do away with the need for the designer or for competent engineering judgment.

To the greatest possible extent, Code requirements for design are stated in terms of basic design principles and formulas. These are supplemented as necessary with specific requirements to assure uniform application of principles and to guide selection and application of piping elements. The Code prohibits designs and practices known to be unsafe and contains warnings where caution, but not prohibition, is warranted.

This Code Section includes

(a) references to acceptable material specifications and component standards, including dimensional requirements and pressure-temperature ratings

(b) requirements for design of components and assemblies, including pipe supports

(c) requirements and data for evaluation and limitation of stresses, reactions, and movements associated with pressure, temperature changes, and other forces

(d) guidance and limitations on the selection and application of materials, components, and joining methods

(e) requirements for the fabrication, assembly, and erection of piping

(f) requirements for examination, inspection, and testing of piping

(g) procedures for operation and maintenance that are essential to public safety

(h) provisions for protecting pipelines from external corrosion and internal corrosion/erosion

It is intended that this Edition of Code Section B31.4 and any subsequent Addenda not be retroactive. Unless agreement is specifically made between contracting parties to use another issue, or the regulatory body having jurisdiction imposes the use of another issue, the latest Edition and Addenda issued at least 6 months prior to the original contract date for the first phase of activity covering a piping system or systems shall be the governing document for all design, materials, fabrication, erection, examination, and testing for the piping until the completion of the work and initial operation.

Users of this Code are cautioned against making use of Code revisions without assurance that they are acceptable to the proper authorities in the jurisdiction where the piping is to be installed.

Code users will note that paragraphs in the Code are not necessarily numbered consecutively. Such discontinuities result from following a common outline, insofar as practicable, for all Code Sections. In this way, corresponding material is correspondingly numbered in most Code Sections, thus facilitating reference by those who have occasion to use more than one Section.

The Code is under the direction of ASME Committee B31, Code for Pressure Piping, which is organized and operates under procedures of The American Society of Mechanical Engineers which have been accredited by the American National Standards Institute. The Committee is a continuing one and keeps all Code Sections current with new developments in materials, construction, and industrial practice. Addenda are issued periodically. New editions are published at intervals of 3 to 5 years.

When no Section of the ASME Code for Pressure Piping specifically covers a piping system, at his discretion the user may select any Section determined to be generally applicable. However, it is cautioned that supplementary requirements to the Section chosen may be necessary to provide for a safe piping system for the intended application. Technical limitations of the various Sections, legal requirements, and possible applicability of other codes or standards are some of the factors

to be considered by the user in determining the applicability of any Section of this Code.

The Committee has established an orderly procedure to consider requests for interpretation and revision of Code requirements. To receive consideration, inquiries must be in writing and must give full particulars (see Mandatory Appendix covering preparation of technical inquiries).

The approved reply to an inquiry will be sent directly to the inquirer. In addition, the question and reply will be published as part of an Interpretation Supplement issued to the applicable Code Section.

A Case is the prescribed form of reply to an inquiry when study indicates that the Code wording needs clarification or when the reply modifies existing requirements of the Code or grants permission to use new materials or alternative constructions. Proposed Cases are published in *Mechanical Engineering* for public review. In addition, the Case will be published on the B31.4 web site at http://www.asme.org/codes/.

A Case is normally issued for a limited period, after which it may be renewed, incorporated in the Code, or allowed to expire if there is no indication of further need for the requirements covered by the Case. However, the provisions of a Case may be used after its expiration or withdrawal, providing the Case was effective on the original contract date or was adopted before completion of the work, and the contracting parties agree to its use.

Materials are listed in the stress tables only when sufficient usage in piping within the scope of the Code has been shown. Materials may be covered by a Case. Requests for listing shall include evidence of satisfactory usage and specific data to permit establishment of allowable stresses, maximum and minimum temperature limits, and other restrictions. Additional criteria can be found in the guidelines for addition of new materials in the ASME Boiler and Pressure Vessel Code, Section II and Section VIII, Division 1, Appendix B. (To develop usage and gain experience, unlisted materials may be used in accordance with para. 423.1.)

Requests for interpretation and suggestions for revision should be addressed to the Secretary, ASME B31 Committee, Three Park Avenue, New York, NY 10016.

ASME B31.4-2006
SUMMARY OF CHANGES

Following approval by the B31 Committee and ASME, and after public review, ASME B31.4-2006 was approved by the American National Standards Institute on January 5, 2006.

ASME B31.4-2006 includes editorial changes, revisions, and corrections identified by a margin note, **(06),** placed next to the affected area.

Page	*Location*	*Change*
4–6	400.2	Definitions for *employer, in-line inspection tools, mainline pipelines,* and *return interval* added
8–12	402.3.1	Equations and nomenclature for *S* revised
	Table 402.3.1(a)	Allowable Stress Value *S* for ASTM A 333 corrected by errata
	402.3.1(h)	Added
	402.6	Added
13	404.1.1(b)	Nomenclature for *t* revised
22	406.1.1(d)	Added
	406.2.1(d)	Added
	406.2.2	Last sentence added
	406.2.3(b)	Revised
	406.5	Last sentence added
23	407.1(d)	Added
30	422.2	Added
	422.6.1	Revised
	422.7	Added
31	423.1(b)	Revised
	423.2.3	Revised
32, 33	Table 423.1	Revised
36	Table 426.1	Revised
37	434.2	(1) Title revised (2) Revised in its entirety
	434.4	Revised
38	434.7.1(e)	Added
39	Table 434.6(a)	Revised in its entirety
	434.8.3(b)	Revised in its entirety
40, 41	484.8.3(e)	Revised

Page	*Location*	*Change*
	434.8.3(g)	Last sentence added
	434.8.5(a)(3)	Revised
43, 44	Fig. 434.8.6(a)-(2)	Notes added by errata
47	434.13.5	Added
48	434.17.4	Added
52	436.5.2(d)	Added
53	437.1.4(b)	Reference in first sentence corrected by errata
	437.1.5	Added
57–65	450.2(l)	Added
	451.4	Revised in its entirety
	451.5(a)	Second sentence revised
	451.6	Revised in its entirety
	Fig. 451.6.2(a)(2)(d)(1)	Added
	Fig. 451.6.2(a)(2)(d)(2)	Added
	Table 451.6.2(b)-1	Added
	Table 451.6.2(b)-2	Added
66	451.11	Added
	452.1(b)	Revised in its entirety
71	461.1.2(f)	First sentence revised
	461.1.2(i)	Added
75, 76	A400.2	Definition of *return interval* deleted
84	A434.4	Deleted
91, 92	Nonmandatory Appendix A	API RP 1130 added
96	Nonmandatory Appendix C	Added

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 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 Figs. 400.1.1 and 400.1.2.)

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

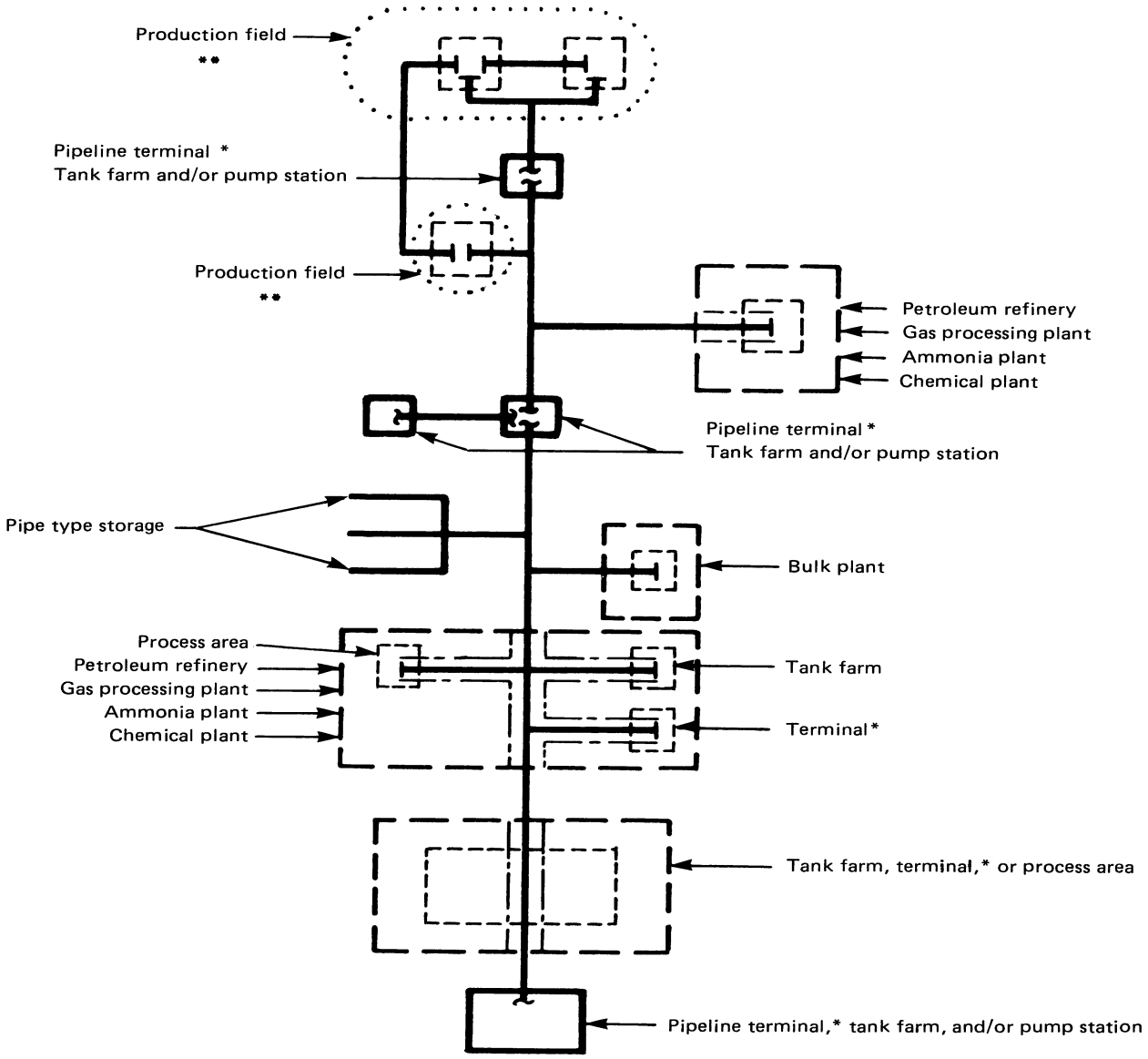
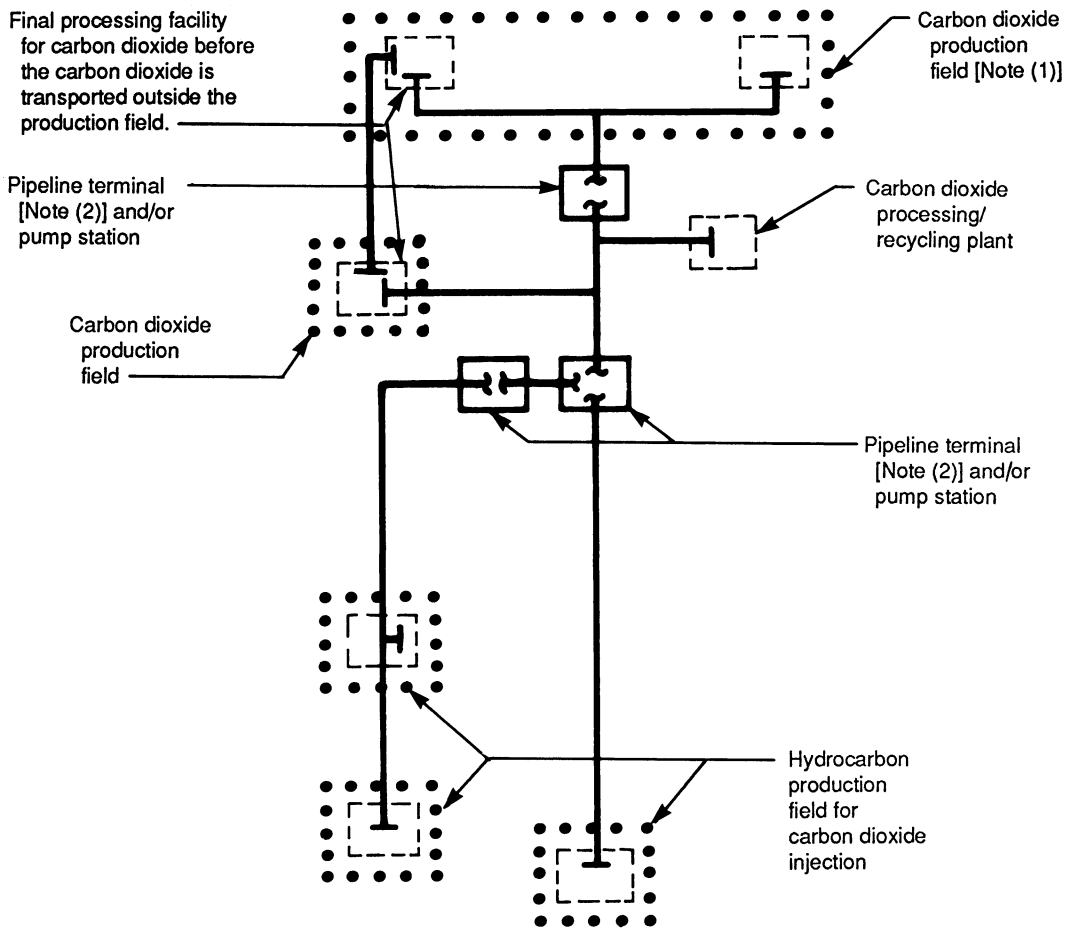


Fig. 400.1.1 Diagram Showing Scope of ASME B31.4 Excluding Carbon Dioxide Pipeline Systems (See Fig. 400.1.2)



NOTES:

(1) Onshore or offshore.

(2) Marine, rail, or truck (all loading or unloading).

Fig. 400.1.2 Diagram Showing Scope of ASME B31.4 for Carbon Dioxide Pipeline Systems

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)]

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)

(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 (06)

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.

blunt imperfection: an imperfection characterized by smoothly contoured variations in wall thickness.[2]

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.

design life: a period of time used in design calculations, selected for the purpose of verifying that a replaceable or permanent component is suitable for the anticipated period of service. Design life does not pertain to the life of the pipeline system because a properly maintained and protected pipeline system can provide liquid transportation service indefinitely.

employer: the owner, manufacturer, fabricator, contractor, assembler, or installer responsible for the welding, brazing, and NDE performed by his organization, including procedure and performance qualifications.

engineering design: detailed design developed from operating requirements and conforming to Code requirements, including all necessary drawings and specifications, governing a piping installation.

general corrosion: uniform or gradually varying loss of wall thickness over an area.

[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.

[2] Sharp imperfections may be rendered blunt by grinding, but the absence of a sharp imperfection must be verified by visual and nondestructive examination.