ASME B31.4-2009
(Revision of ASME B31.4-2006)

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

ASME SETTING THE STANDARD

INTENTIONALLY LEFT BLANK

ASME B31.4-2009

(Revision of ASME B31.4-2006)

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

ASME SETTING THE STANDARD

Date of Issuance: March 24, 2010

The next Edition of this Code is scheduled for publication in 2013. There will be no addenda issued to this edition.

ASME issues written replies to inquiries concerning interpretations of technical aspects of the Code. Periodically certain actions of the ASME B31 Committee may be published as Code Cases. Code Cases and interpretations are published on the ASME Web site under the Committee Pages at http://cstools.asme.org as they are issued.

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

CONTENTS

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

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

The 2009 Edition of B31.4 contains major revisions to the definitions section; Chapter II, Design; and Chapter VIII, Corrosion Control. The materials standards Table 423.1 and references have been revised and updated. The 2009 Edition was approved by the American National Standards Institute on September 14, 2009, and designated as ASME B31.4-2009.

ASME CODE FOR PRESSURE PIPING, B31

(The following is the roster of the Committee at the time of approval of this Code.)

OFFICERS

M. L. Nayyar, *Chair*
K. C. Bodenhamer, *Vice Chair*
N. Lobo, *Secretary*

COMMITTEE PERSONNEL

R. J. Appleby, ExxonMobil Upstream Research Co.
C. Becht IV, Becht Engineering Co.
A. E. Beyer, Fluor Enterprises
K. C. Bodenhammer, EPCO, Inc.
C. J. Campbell, Air Liquide
J. S. Chin, Transcanada Pipeline U.S.
D. D. Christian, Victaulic
D. L. Coym, Worley Parsons
R. P. Deubler, Fronek Power Systems LLC
J. A. Drake, Spectra Energy Transmission
P. D. Flenner, Flenner Engineering Services
J. W. Frey, Stress Engineering Services, Inc.
D. R. Frikken, Becht Engineering Co.
R. A. Grichuk, Fluor Corp.
R. W. Haupt, Consultant
L. E. Hayden, Jr., Consultant
B. P. Holbrook, Babcock Power, Inc.
G. A. Jolly, Vogt Valves Flowserve Corp.
N. Lobo, The American Society of Mechanical Engineers
W. J. Mauro, American Electric Power
J. E. Meyer, Louis Perry & Associates, Inc.
M. L Nayyar, Bechtel Power Corp.
R. G. Payne, Alstom Power, Inc.
J. T. Powers, Worley Parsons
E. H. Rinaca, Dominion Resources, Inc.
M. J. Rosenfeld, Kiefner & Associates, Inc.
R. J. Silvia, Process Engineers and Constructors, Inc.
W. J. Sperko, Sperko Engineering Services, Inc.
F. W. Tatar, FM Global
K. A. Vilminot, Black & Veatch
K. H. Wooten, ConocoPhillips Pipe Line Co.
A. Soni, *Delegate,* Engineers India Ltd.
W. J. Koves, *Ex-Officio Member,* Consultant
W. B. McGehee, *Ex-Officio Member,* Consultant
A. P. Rangus, *Ex-Officio Member,* Consultant

B31.4/11 LIQUID AND SLURRY PIPING TRANSPORTATION SYSTEMS SECTION COMMITTEE

K. H. Wooten, *Chair,* ConocoPhillips Pipe Line Co.
G. R. Petru, *Vice Chair,* Epco, Inc.
A. P. Maslowski, *Secretary,* The American Society of Mechanical Engineers
A. E. Beyer, Fluor Enterprises, Inc.
K. C. Bodenhammer, EPCO, Inc.
W. M. Cauthen, Tiger Energy Services, Inc.
K. S. Chu, Washington Utility and Transportation Commission
J. A. Cox, Lieberman Consulting
B. L. Flanders, U.S. Department of Transportation
R. J. Hall, U.S. Chemical Safety Board
D. B. Kadakia, TD Williamson, Inc.
P. W. Klein, Nassau Engineering Co.
C. E. Kolovich, Kiefner & Associates, Inc.
R. D. Lewis, H. Rosen USA, Inc.
P. T. Lidiak, American Petroleum Institute
W. M. Olson, Worley-Parsons
S. R. Peterson, Enbridge Energy
M. B. Pickell, Willbros Engineering, Inc.
J. T. Powers, Worley-Parsons
D. Raghu, Shell Global Solutions, Inc.
W. L. Trimble, Fluor Enterprises
P. H. Vieth, CC Technologies, Inc. (A DNV Co.)
T. A. Wicklund, BP Pipelines N.A.
C. Zimmerman, U.S. Department of Transportation
S. C. Gupta, *Delegate,* Bharat Petroleum Corp. Ltd.
A. Soni, *Delegate,* Engineers India Ltd.

B31 FABRICATION AND EXAMINATION COMMITTEE

A. P. Rangus, *Chair,* Bechtel Power Corp.
R. J. Horvath, Jr., *Secretary,* The American Society of Mechanical Engineers
W. G. Scruggs, E. I. du Pont de Nemours & Co.
R. I. Seals, Consultant
R. J. Silvia, Process Engineering & Constructors, Inc.
W. J. Sperko, Sperko Engineering Services, Inc.

B31 MATERIALS TECHNICAL COMMITTEE

M. L. Nayyar, *Chair,* Bechtel Power Corp.
N. Lobo, *Secretary,* The American Society of Mechanical Engineers
J. P. Ellenberger, Consultant
R. J. Ferguson, Consultant
D. J. Fetzner, BP Exploration Alaska, Inc.
P. D. Flenner, Flenner Engineering Services
J. W. Frey, Stress Engineering Services, Inc.
W. W. Lewis, E. I. du Pont de Nemours & Co.
S. P. Licud, Weirich Consulting Services, Inc.
T. Monday, Team Industries, Inc.
A. D. Nalbandian, Thielsch Engineering, Inc.
R. I. Seals, Consultant
R. J. Silvia, Process Engineers & Constructors, Inc.
W. J. Sperko, Sperko Engineering Services, Inc.
E. F. Summers, Jr., Babcock & Wilcox Construction Co.
P. L. Vaughan, Oneok Partners

B31 MECHANICAL DESIGN TECHNICAL COMMITTEE

W. J. Koves, *Chair,* Consultant
G. A. Antaki, *Vice Chair,* Becht Engineering Co.
C. E. O'Brien, *Secretary,* The American Society of Mechanical Engineers
C. Becht IV, Becht Engineering Co.
J. P. Breen, Becht Engineering Co.
N. F. Consumo, Sr., GE Energy (IGCC) NPI
J. P. Ellenberger, Consultant
D. J. Fetzner, BP Exploration Alaska, Inc.
J. A. Graziano, Tennessee Valley Authority
R. W. Haupt, Consultant
B. P. Holbrook, Babcock Power, Inc.
R. A. Leishear, Savannah River National Laboratory
G. D. Mayers, Alton Science & Technology
T. Q. McCawley, Zachry Engineering Corp.
R. J. Medvick, Swagelok
J. C. Minichiello, Bechtel National, Inc.
A. W. Paulin, Paulin Research Group
R. A. Robleto, Consultant
M. J. Rosenfeld, Kiefner & Associates, Inc.
G. Stevick, Berkeley Engineering & Research, Inc.
E. A. Wais, Wais and Associates, Inc.
H. Kosasayama, JGC Corp.
E. C. Rodabaugh, *Honorary Member,* Consultant

B31 CONFERENCE GROUP

T. A. Bell, Bonneville Power Administration
R. A. Coomes, State of Kentucky, Dept. of Housing/Boiler Section
D. H. Hanrath, Consultant
C. J. Harvey, Alabama Public Service Commission
D. T. Jagger, Ohio Department of Commerce
M. Kotb, Regie du Batiment du Quebec
K. T. Lau, Alberta Boilers Safety Association
R. G. Marini, New Hampshire Public Utilities Commission
I. W. Mault, Manitoba Department of Labour
A. W. Meiring, Fire and Building Boiler and Pressure Vessel Division
R. F. Mullaney, Boiler and Pressure Vessel Safety Branch
P. Sher, State of Connecticut
M. E. Skarda, Department of Labor
D. A. Starr, Nebraska Department of Labor
D. J. Stursma, Iowa Utilities Board
R. P. Sullivan, The National Board of Boiler and Pressure Vessel Inspectors
J. E. Troppman, Division of Labor/State of Colorado Boiler Inspections
W. A. West, Lighthouse Assistance, Inc.
T. F. Wickham, Rhode Island Department of Labor

B31 NATIONAL INTEREST REVIEW GROUP

American Pipe Fitting Association — H. Thielsch
American Society of Heating, Refrigeration, and Air Conditioning Engineers — H. R. Kornblum
Chemical Manufacturers Association — D. R. Frikken
Copper Development Association — A. Cohen
Ductile Iron Pipe Research Association — T. F. Stroud
Edison Electric Institute — R. L. Williams
International District Heating Association — G. M. Von Bargen
Manufacturers Standardization Society of the Valve and Fittings Industry — R. A. Schmidt
National Association of Plumbing-Heating-Cooling Contractors — R. E. White
National Certified Pipe Welding Bureau — D. Nikpourfard
National Fire Protection Association — T. C. Lemoff
National Fluid Power Association — H. G. Anderson
Valve Manufacturers Association — R. A. Handschumacher

INTRODUCTION

The ASME B31 Code for Pressure Piping consists of a number of individually published Sections, each an American National Standard. Rules for each Section reflect the kinds of piping installations considered during its development as follows:

B31.1, Power Piping: piping typically found in electric power generating stations, industrial and institutional plants, geothermal heating systems, and central and district heating and cooling systems.

B31.3, Process Piping: piping typically found in petroleum refineries; chemical, pharmaceutical, textile, paper, semiconductor, and cryogenic plants; and related processing plants and terminals.

B31.4, Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids: piping transporting products that are predominately liquid between facilities, plants, and terminals, and within terminals, pumping, regulating, and metering stations.

B31.5, Refrigeration Piping and Heat Transfer Components: piping for refrigerants and secondary coolants.

B31.8, Gas Transportation and Distribution Piping Systems: piping transporting products that are predominately gas between sources and terminals, including compressor, regulating, and metering stations, and gas gathering piplines.

B31.9, Building Services Piping: piping typically found in industrial, institutional, commercial, and public buildings, and in multi-unit residences, that does not require the range of sizes, pressures, and temperatures covered in B31.1.

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

This is the B31.4, Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids Code Section. 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.

It is the user's responsibility to select the Code Section, that most nearly applies to a proposed piping installation. Factors to be considered include limitations of the Code Section, jurisdictional requirements, and the applicability of other codes and standards. All applicable requirements of the selected Code Section shall be met. For some installations, more than one Code Section may apply to different parts of the installation. Certain piping within a facility may be subject to other national or industry codes and standards. The user is also responsible for imposing requirements supplementary to those of the Code if necessary to ensure safe piping for the proposed installation.

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 ensure 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 that 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 Nonmandatory Appendix A 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://cstools.asme.org.

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.