I.12-01-007

PG&E'S REQUEST FOR OFFICIAL NOTICE

EXHIBIT 5

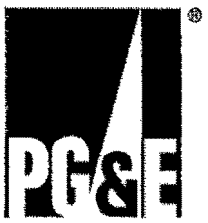
Records Ex. PG&E-47
(ASA B31.1.8 – 1955)

Investigation: 11-02-016
Exhibit No.: PG&E 47
Date: 9/7/12

PACIFIC GAS AND ELECTRIC COMPANY

Reconditioned Pipe Practices / ASA B31.1.8

(PG&E Data Response to Records OII CPUC 003-Q10)



PACIFIC GAS AND ELECTRIC COMPANY
Gas Transmission System Records OII
Investigation 11-02-016
Data Response

PG&E Data Request No.:	CPUC_003-10		
PG&E File Name:	GasTransmissionSystemRecordsOII_DR_CPUC_003-Q10		
Request Date:	July 29, 2011	Requester DR No.:	003
Date Sent:	August 12, 2011	Requesting Party:	California Public Utilities Commission (CPUC)
PG&E Witness:		Requester:	Bob Cagen

QUESTION 10

Identify all PG&E policies and procedures PG&E used in 1956 to determine the integrity of the salvaged 30" pipe used in the construction of segment 180 of L-132 when the pipe was relocated in 1956? Provide a copy of each policy and procedure identified.

ANSWER 10

Initially, the question presumes that salvaged 30" pipe was used in the 1956 construction of Segment 180 on Line 132. Documents from the 1956 construction file can be interpreted as showing that some reconditioned pipe may have been used in the Segment 180 construction. However, to PG&E's knowledge, the information known to date does not conclusively show that to be the case.

PG&E has not yet located internal specifications for reconditioning pipe for the time frame from 1948 to 1956.[1] However, it is generally understood in the industry in order to recondition a piece of pipe, some material must be trimmed from the end of the pipe. Similarly, reconditioning may require the removal of any portion of the pipe that was damaged when removed from the ground. PG&E believes that the practice during this time period would have been to trim several inches from the end of the piece of pipe to be reconditioned, if it were not damaged in some other way. Additionally, the inner wall of the pipe may have been reground during reconditioning to eliminate the bump from the long seam weld and facilitate the use of an internal line up clamp during installation. The 1955 edition of the American Standard Code for Pressure Piping, Section 8 (ASA B31.1.8, which later became ASME B31.8) also contained guidance during this time frame regarding the reuse of pipe. See B31.1.8, § 811.25 of attachment GasTransmissionSystemRecordsOII_DR_CPUC_003-Q10Atch01. PG&E will provide any documentation that it may identify in its continuing records review that is responsive to this request.

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1 Presently, PG&E Utility Standard TD-4125S provides that rehabilitated pipe must meet design and testing requirements set forth in Gas Standard and Specification A-34.

AMERICAN STANDARD

Gas Transmission and Distribution Piping Systems

ASA B31.1.8-1955
UDC 621.64.002.1/.2

SECTION 8 of
American Standard Code for Pressure Piping
(ASA B31.1—1955)

Sponsor

The American Society of Mechanical Engineers

Published by

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
29 West 39th Street, New York 18, N. Y.

Foreword to Second Edition (1955) of American Standard Code for Gas Transmission and Distribution Piping Systems Section 8 of American Standard Code for Pressure Piping

SECTIONAL Committee B31 at its annual meeting, November 29, 1951, authorized the establishment of a section of the Code for Pressure Piping dealing with gas transmission and distribution piping to be complete with the applicable parts of Section 6, Fabrication Details, and Section 7, Materials – Their Specifications and Indentification. The purpose was to provide an integrated document for gas transmission and distribution piping that would not require cross-referencing to other sections of the Code.

This document is the second edition of the American Standard Code for Pressure Piping, Section 8, Gas Transmission and Distribution Piping Systems.

A new Subcommittee No. 8 has been appointed to take over the responsibility for this section of the Code and it is actively working on revisions which will be aimed at clarification and such amplification as is necessary to reflect adequately safe practice in the light of modern materials and methods of construction and operation.

Subcommittee No. 2 is currently redrafting Section 2 to cover requirements of gas and air piping systems in industrial installations only. When this work is completed, the American Standards Association will have provided adequate safety codes dealing with all phases, as follows:

ASA B31 Section 8 – Gas Transmission and Distribution Piping Systems
ASA B31 Section 2 – Gas and Air Piping in Industrial Installations
ASA Z21.30 – Installation of Gas Piping and Gas Appliances in Buildings

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El Paso, Texas

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Pittsburgh 30, Pennsylvania

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Milwaukee, Wisconsin

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Houston, Texas

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United Gas Building
Shreveport 92, Louisiana

E. L. Henderson
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Shreveport 92, Louisiana

E. N. Henderson
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L. W. Kattelle
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60 East 42nd Street
New York 17, N.Y.

J. J. King
Tennessee Gas Transmission Co.
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Houston 1, Texas

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836 S. Michigan Avenue
Chicago 5, Illinois

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Trenton 2, N.J.

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Stanolind Oil & Gas Company
Box 591
Tulsa 2, Oklahoma

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Cowlesville, N.Y.

Giles R. Locke
Republic Steel Corporation
335 Market Street
Youngstown, Ohio

*M. C. Madsen
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2223 Dodge Street
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B. T. Mast
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225 Broadway
New York, N.Y.

Henry W. Nicolson
Public Service Electric and Gas Co.
80 Park Place
Newark 1, N. J.

Paul E. Noll
Consolidated Western Steel Division
United States Steel Corporation
P.O. Box 2015, Terminal Annex
Los Angeles 54, California

Preston Parks
Colorado Interstate Gas Company
P. O. Box 1087
Colorado Springs, Colorado

M. J. Paul
Natural Gas Pipeline Co. of America
20 North Wacker Drive
Chicago 6, Illinois

J. R. Reeves
Dominion Natural Gas Company, Ltd.
220 Delaware Avenue
Buffalo 2, N.Y.

F. G. Sandstrom
Consolidated Edison Co. of N.Y., Inc.
4 Irving Place
New York 3, N.Y.

W. H. Savage
Robert W. Hunt Company
A-2200 Insurance Exchange
Chicago 4, Illinois

C. T. Schweitzer
Southern California Gas Company
P. O. Box 3249, Terminal Annex
Los Angeles 54, California

A. J. Shoup
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P. O. Box 1612
Shreveport 94, Louisiana

J. C. Siegle
Youngstown Sheet & Tube Company
Stambaugh Building
Youngstown, Ohio

D. P. Smith
Michigan-Wisconsin Pipe Line Co.
500 Griswold Street
Detroit 26, Michigan

Roscoe D. Smith
Pacific Gas and Electric Company
245 Market Street
San Francisco 6, California

B. W. Snyder
Canadian Western Natural Gas Co., Ltd.
Calgary, Alberta, Canada

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Iowa State College
Ames, Iowa

F. E. Stanley
Midwestern Constructors, Inc.
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Tulsa, Oklahoma

H. L. Stowers
Texas Gas Transmission Corp.
416 West Third Street
Owensboro, Kentucky

Professor Harry Udin
Mass. Institute of Technology
Cambridge, Massachusetts

J. Thompson Vann
American Cast Iron Pipe Company
Box 2603
Birmingham 2, Alabama

P. K. Wallace
Oklahoma Natural Gas Company
P. O. Box 871
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Professor E. C. Wright
P. O. Box 327
University, Alabama

Consultants

R. J. Love
E. R. Parker
F. H. Deckman

CONTENTS

CONTENTS (Continued)

Note: In Section 8 each chapter is assigned a number in the 800 series ending in a multiple of 10. In most cases all of the whole numbers allocated to a chapter by this system have not been used.

800 SECTION 8 OF AMERICAN STANDARD CODE FOR PRESSURE PIPING (ASA B31.1) GAS TRANSMISSION AND DISTRIBUTION PIPING SYSTEMS

801 PRELIMINARY STATEMENT. THIS GAS TRANSMISSION AND DISTRIBUTION PIPING SYSTEM CODE IS A PART OF THE AMERICAN STANDARD CODE FOR PRESSURE PIPING. MANY OF THE APPLICABLE PROVISIONS OF THE PRESSURE PIPING CODE ARE PUBLISHED HERE AS A SEPARATE DOCUMENT FOR THE CONVENIENCE OF USERS OF THE CODE.

FOREWORD

802 FOREWORD The need for a national code for pressure piping became increasingly evident from 1915 to 1925. To meet this need 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 reference 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 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.

Because of the wide field involved, some 30 to 40 different engineering societies, government bureaus, trade associations, institutes and the like have one or more representatives on the sectional committee, plus a few "members at large" to represent general interests. In addition to active voting members on subcommittees, there are several "corresponding members" who receive mailings and who are urged to comment if they so desire. Code activities are subdivided according to the scope of the several sections and chapters listed on page 1. General direction of code activities rests with the sectional committee officers and an executive committee whose membership consists principally of sectional committee officers and section chairmen. There also is a subcommittee on Coordination (editing and interpretations) and another on Liaison with Other Codes and Standards.

Following its reorganization in 1948, Sectional Committee B31 made an intensive review of the 1942 code which resulted in: (1) a general revision and extension of requirements to agree with present day practice; (2) the revision of references to existing dimensional standards and material specifi-

cations and the addition of references to new ones; and (3) the clarification of ambiguous or conflicting requirements. A revision was prepared which was presented for letter ballot vote of Sectional Committee B31. Following approval by this body, the project was next approved by the sponsor organization and by the American Standards Association. It was finally designated as an American Standard in February, 1951 with the designation B31.1-1951.

Sectional Committee B31 at its annual meeting, November 29, 1951, authorized the separate publication of a section of the Code for Pressure Piping dealing with gas transmission and distribution piping to be complete with the applicable parts of Section 2, Gas and Air Piping Systems, Section 6, Fabrication Details, and Section 7, Materials - Their Specifications and Identification. The purpose was to provide an integrated document for gas transmission and distribution piping that would not require cross-referencing to other sections of the Code.

The first edition of this integrated document known as American Standard Code for Pressure Piping, Section 8, Gas Transmission and Distribution Piping Systems, was published in 1952 and consisted almost entirely of material taken from Sections 2, 6, and 7 of the 1951 Edition of the Pressure Piping Code.

A new subcommittee was organized in 1952 to amplify Section 8 as necessary in the light of modern materials and methods of construction and operation. This 1954 edition is the work of that subcommittee, and constitutes a general revision of the 1951 edition with a considerably expanded scope.

803 INQUIRIES - REVISIONS AND INTERPRETATIONS The Sectional Committee ASA B31 has established an orderly procedure to consider requests for interpretations and revisions of the code rules. In order to receive consideration inquiries shall be in writing and must give full particulars.

Requests for interpretations or for changes in the code for clarification can usually be acted upon promptly. Requests for basic changes in the code or questions that disclose the need for basic changes require more time.

When an approved reply to an inquiry involves a change in the code rules, the ruling is made public through the issuance of a "case." This is published in Mechanical Engineering Other changes are usually handled by issuing revisions to the code once each year. Suggestions for revisions may originate within the committee itself or from anyone outside the committee.

All requests for interpretations or suggestions for revisions should be addressed to the Secretary, ASA Committee B31, 420 Lexington Avenue, New York 17, N.Y., or to that Committee in care of the American Society of Mechanical Engineers, 29 West 39th Street, New York 18, N.Y.

GENERAL PROVISIONS AND DEFINITIONS

804 SCOPE AND INTENT

804.1 This Section 8 covers the design, fabrication, installation, inspection, testing, and the safety aspects of operation and maintenance of gas transmission and distribution systems, including gas pipelines, gas compressor stations, gas metering and regulating stations, gas mains, and gas services up to the outlet of the customer's meter set assembly. Also included within the scope of this section are gas storage equipment of the closed pipe type fabricated or forged from pipe or fabricated from pipe and fittings, and gas storage lines. (See Figure 804-A in Appendix.)

804.2 The requirements of Section 8 also cover the conditions of use of the elements of the piping systems described in 804.1, including, but not limited to, pipe, valves, fittings, flanges, bolting, gaskets, regulators, pressure vessels, pulsation dampeners, and relief valves.

804.3 This Section 8 does not apply to:

(a) Design and fabrication of pressure vessels covered by the ASME code.

(b) Piping with metal temperatures above 450°F. or below minus 20°F. (For temperatures above 450°F., ASA B31.1, Section 3, Division A, shall apply. For low temperatures within the range covered by this section, see 814.)

(c) Piping beyond the outlet of the customer's meter set assembly. (See ASA Z21.30 for such piping.)

(d) Piping in oil refineries or natural gasoline extraction plants, gas treating plant piping other than the main gas stream piping in dehydration and all other processing plants installed as part of a gas transmission system, gas manufacturing plants, industrial plants, or mines. (See other applicable sections of ASA B31.1)

(e) Vent piping to operate at substantially atmospheric pressures for waste gases of any kind.

(f) Wellhead assemblies, including control valves, and flow lines between wellhead and trap or separator, or casing and tubing in gas or oil wells.

(g) Proprietary items of equipment, apparatus, or instruments.

(h) Heat exchangers.

(i) Oil or liquid products pipelines.

(j) Prefabricated units which employ plate and longitudinal welds as contrasted to pipe.

804.4 The requirements of Section 8 are adequate for safety under conditions normally encountered in the gas industry. Requirements for abnormal or unusual conditions are not specifically provided for, nor are all details of engineering and construction prescribed. It is intended that all work performed within the scope of this section shall meet or exceed the safety standards expressed or implied herein.

804.5 This section is concerned with:

(a) Safety of the general public.

(b) Employee safety to the extent that it is affected by basic design, quality of the materials and workmanship, and requirements for testing and maintenance of gas transmission and distribution facilities. Existing industrial safety regulations pertaining to work areas, safety devices, and safe work practices are not intended to be supplanted by this code.

804.6 It is not intended that this code be applied retroactively to existing installations insofar as design, fabrication, installation, established operating pressure, and testing are concerned. It is intended, however, that the provisions of this code shall be applicable to the operation, maintenance, and up-rating of existing installations.

805 UNITS AND DEFINITIONS

805.01 Index of Definitions

805.1 Pressure Terms

Pressure unless otherwise stated is expressed in pounds per square inch above atmospheric pressure, i.e., gauge pressure. (Abbreviation - psig)

805.11 Design pressure is the maximum operating pressure permitted by this code, as determined by the design procedures applicable to the materials and locations involved.

805.12 Maximum allowable test pressure is the maximum internal fluid pressure permitted by this code for testing for the materials and locations involved.

805.13 Maximum actual operating pressure is the maximum operating pressure existing in a piping system during a normal annual operating cycle.

805.14 Maximum allowable operating pressure is the maximum pressure at which a piping system may be operated in accordance with the provisions of this code. It is the pressure which is used in determining the setting of pressure relieving or pressure limiting devices installed to protect the system from accidental over-pressuring. (See 841, 843, 844 and 845)

805.15 Standard service pressure is the gas pressure which a utility undertakes to maintain on its domestic customers' meters. This is sometimes called the normal utilization pressure.

805.2 Pressure Control

805.21 Pressure relief station consists of equipment installed for the purpose of preventing the pressure on a pipeline or distribution system to which it is connected from exceeding by more than an established increment the maximum allowable operating pressure, by venting gas to the atmosphere whenever the pressure tends to rise too high. (See 805.14 and 845.71.) The following kinds of equipment generally are employed to provide this type of protection: liquid seals, dead weight mechanical seals, spring loaded relief valves and back pressure regulators used as relief valves. Included in the station are piping and auxiliary devices, such as valves, control instruments, control lines, the enclosure and ventilating equipment installed in accordance with the pertinent requirements of this code.

805.211 Pressure limiting station consists of equipment installed for the purpose of preventing the pressure on a pipeline or distribution system from exceeding the maximum allowable operating pressure, by controlling or restricting the flow of gas when abnormal conditions develop. (See 805.14 and 845.72.) While normal conditions prevail, the pressure limiting station may exercise

some degree of control of the flow of gas or may remain in the wide open position. Should the pressure on the pipeline or distribution system exceed the normal operating pressure range or setting, due to a malfunctioning regulator or other cause, the pressure limiting station will function, automatically, to prevent the pressure on the pipeline or system from exceeding its maxmum allowable operating value. The following kinds of equipment generally are employed to provide this type of protection: monitoring regulators, series regulators and automatic shut-off devices. Included in the station are piping and auxiliary devices, such as valves, control instruments, control lines, the enclosure and ventilating equipment installed in accordance with the pertinent requirements of this code.

805.22 Pressure regulating station consists of equipment installed for the purpose of automatically reducing and regulating the pressure in the downstream pipeline or main to which it is connected. Included are piping and auxiliary devices such as valves, control instruments, control lines, the enclosure and ventilating equipment.

805.23 Service regulator is a regulator installed on a gas service to control the pressure of the gas delivered to the customer.

805.24 Monitoring regulator is a pressure regulator set in series with another pressure regulator for the purpose of automatically taking over in an emergency the control of the pressure downstream of the station in case that pressure tends to exceed a set maximum.

805.3 Stress is the resultant internal force that resists change in the size or shape of a body acted on by external forces. In this code "stress" is often used as being synonymous with unit stress which is the stress per unit area (psi).

805.31 Operating stress is the stress in a pipe or structural member under normal operating conditions.

805.32 Hoop stress is the stress in a pipe wall, acting circumferentially in a plane perpendicular to the longitudinal axis of the pipe and produced by the pressure of the fluid in the pipe.

805.33 Maximum allowable hoop stress is the maximum hoop stress permitted by this code for the design of a piping system. It depends upon the material used, the location of the pipe, and the operating conditions.

805.34 Secondary stress is stress created in the pipe wall by loads other than internal fluid pressure. For example, backfill loads, traffic loads, beam action in a span, loads at supports and at connections to the pipe.

805.35 Nominal wall thickness (t) is the wall thickness computed by the design equation in 841.1. Under this code pipe may be ordered to this computed wall thickness without adding an allowance to compensate for the underthickness tolerances permitted in approved specifications.

805.4 Temperatures are expressed in degrees Fahrenheit (°F.) unless otherwise stated.

805.41 Ambient temperature is the temperature of the surrounding medium, usually used to refer to the temperature of the air in which a structure is situated or a device operates.

805.42 Ground temperature is the temperature of the earth at pipe depth.

805.43 Cold-springing where used in the code is the fabrication of piping to an actual length shorter than its nominal length; and forcing it into position, so that it is stressed in the erected condition; thus compensating partially for the effects produced by the expansion due to an increase in temperature. Cold spring factor is the ratio of the amount of cold spring provided, to the total computed temperature expansion.

805.5 Welding, Strength of Materials, and Metallurgical Terms

805.51 Welding Nomenclature. Types of welds and names of welded joints are used herein according to their common usage as defined in the American Welding Society Publication "Standard Welding Terms and Their Definitions" (AWS A 3.0).

805.52 Yield strength is the strength at which a material exhibits a specified limiting permanent set, or produces a specified total elongation under load. The specified limiting set or elongation is usually expressed as a percentage of gauge length, and its values are specified in the various material specifications acceptable under this code.

805.53 Tensile strength is the highest unit tensile stress (referred to the original cross-section) a material can sustain before failure (psi).

805.54 Specified minimum yield strength is the minimum yield strength prescribed by the specification under which pipe is purchased from the manufacturer (psi).

805.55 Specified minimum tensile strength is the minimum tensile strength prescribed by the specification under which pipe is purchased from the manufacturer (psi).

805.56 Specified minimum elongation is the minimum elongation (expressed in per cent of the gauge length) in the tensile test specimen, prescribed by the specifications under which the material is purchased from the manufacturer.

805.57 Alloy steel(1) By common custom steel is considered to be alloy steel when the maximum of the range given for the content of alloying elements exceeds one or more of the following limits:

manganese	1.65%
silicon	.60%
copper	.60%

or in which a definite range or a definite minimum quantity of any of the following elements is specified or required within the limits of the recognized field of constructional alloy steels:

aluminum
boron
chromium up to 3.99%
cobalt
columbium
molybdenum
nickel
titanium
tungsten
vanadium
zirconium

or any other alloying element added to obtain a desired alloying effect.

805.58 Carbon steel(2) By common custom steel is considered to be carbon steel when no minimum content is specified or required for aluminum, boron, chromium, cobalt, columbium, molybdenum, nickel, titanium, tungsten, vanadium or zirconium, or any other element added to obtain a desired alloying effect; when the specified minimum for copper does not exceed 0.40%; or when the maximum content specified for any of the following elements does not exceed the percentages noted: manganese 1.65, silicon 0.60, copper 0.60.

In all carbon steels small quantities of certain residual elements, unavoidably retained from raw materials, are sometimes found which are not specified or required, such as copper, nickel, molybdenum, chromium, etc. These elements are considered as incidental and are not normally determined or reported.

805.6 Pipe and Piping Terms

805.61 Pipe is a tubular product made as a production item for sale as such. Cylinders formed from plate in the course of the fabrication of auxiliary equipment are not pipe as defined here.

805.62 Pipeline or transmission line is a pipe installed for the purpose of

Note: (1) From Steel Products Manual, Section 7, American Iron and Steel Institute, January 1952, pp 6 and 7.

(2) From Steel Products Manual, Section 6, American Iron and Steel Institute, August 1952, pp 5 and 6.

transmitting gas from a source or sources of supply to one or more distribution centers or to one or more large volume customers or a pipe installed to interconnect sources of supply. In typical cases pipelines differ from gas mains in that they operate at higher pressures, they are longer, and the distance between connections is greater.

805.63 Gas main or distribution main is a pipe installed in a community to convey gas to individual services or other mains.

805.64 Gas service is the pipe that runs between a main or a pipeline and a customer's meter.

805.65 Low-pressure distribution system is a gas distribution piping system in which the gas pressure in the mains and services is substantially the same as that delivered to the customer's appliances. In such a system a service regulator is not required on the individual services.

805.66 High-pressure distribution system is a gas distribution piping system which operates at a pressure higher than the standard service pressure delivered to the customer. In such a system a service regulator is required on each service to control the pressure delivered to the customer.

805.67 Length is a piece of pipe of the length delivered from the mill. Each piece is called a length regardless of its actual dimension. This is sometimes called "joint" but "length" is preferred.

805.68 Cold expanded pipe is seamless or welded pipe which is formed and then expanded in the pipe mill while cold so that the circumference is permanently increased by at least .50%.

805.69 Gas storage line is a pipeline used for conveying gas between a compressor station and a gas well used for storing gas underground.

805.691 Instrument piping is all piping, valves, and fittings used to connect instruments to main piping, to other instruments and apparatus, or to measuring equipment.

805.692 Control piping is all piping, valves, and fittings used to interconnect air, gas, or hydraulically operated control apparatus or instrument transmitters and receivers.

805.693 Sample piping is all piping, valves, and fittings used for the collection of samples of gas, steam, water, or oil.

805.7 Miscellaneous Terms

805.71 Private rights-of-way as used in this code are rights-of-way that are not located on roads, streets or highways used by the public, or on railroad rights-of-way.

805.72 Operating company as used herein is the individual, partnership, corporation, public agency, or other entity that operates the gas transmission or distribution facilities.

805.73 Proprietary items are items made and marketed by a company having the exclusive right to manufacture and sell them.

805.74 Location class is a geographic area classified according to its approximate population density and its other characteristics that are considered when prescribing types of construction and methods of testing pipelines and mains to be located in the area.

805.75 Construction type is a construction specification for pipelines and mains that fixes the stress levels. (See Table 841.02)

805.76 One mile population density index is a number roughly proportional to

population density, applicable to a specific 1 mile length of pipeline or main and used in some cases to determine design and/or test requirements. See 841.001.

805.77 Ten mile population density index is a number roughly proportional to population density, applicable to a specific 10 mile length of pipeline or main and used in some cases to determine design and/or test requirements. See 841.001.

805.78 Gas as used in this code is any gas or mixture of gases suitable for domestic or industrial fuel and transmitted or distributed to the user through a piping system. The common types are natural gas, manufactured gas, and liquefied petroleum gas distributed as a vapor with or without the admixture of air.

805.8 Miscellaneous Facilities

805.81 Customer's meter is a meter which measures gas delivered to a customer for consumption on his premises.

805.82 Service shut-off is a valve or cock readily accessible and operable by the customer, located in a service pipe between the gas main and the meter.

805.821 Curb shut-off is a buried valve or cock installed in a service pipe at or near the property line and accessible through a valve box and cover and operable by a removable key.

805.83 Pipe container is a gas-tight structure assembled in a shop or in the field from pipe and end closures.

805.84 Pipe-type holder is any pipe-container or group of interconnected pipe-containers installed at one location, and used for the sole purpose of storing gas.

805.85 Bottle as used in this code is a gas-tight structure completely fabricated from pipe with integral drawn, forged, or spun end closures and tested in the manufacturer's plant.

805.86 Bottle-type holder is any bottle or group of interconnected bottles installed in one location, and used for the sole purpose of storing gas.

805.87 Stop valve is a valve installed for the purpose of stopping the flow of fluid in a pipe.

805.88 Hot taps are branch piping connections made to operating pipelines or mains or other facilities while they are in operation. The connection of the branch piping to the operating line and the tapping of the operating line is done while it is under gas pressure.

805.9 Leakage Investigation Terms

805.91 Leakage surveys are systematic surveys made for the purpose of locating leaks in a gas piping system. Three types of surveys are referred to in this code and defined below. The significant difference between the three is the manner in which the presence of a leak is first detected. They all involve verification of the presence of a leak and its location, as for example, by the driving or boring of test holes in the vicinity of the leak and testing the atmosphere in these holes with a combustible gas detector or other suitable device.

805.92 Vegetation surveys are leakage surveys made for the purpose of finding leaks in underground gas piping by observing vegetation.

805.93 Gas detector surveys are leakage surveys made by testing with a combustible gas detector the atmosphere in water meter boxes, street vaults of all types, cracks in pavements and other available locations where access to the soil under pavement is provided.

805.94 Bar test surveys are leakage surveys made by driving or boring holes at regular intervals along the route of an underground gas pipe and testing the atmosphere in the holes with a combustible gas detector or other suitable device.

806 STANDARDS AND SPECIFICATIONS

806.1 Standards and specifications specifically incorporated by reference into this code and the names and addresses of the sponsoring organizations are shown in Appendices A and B. The use of the latest published revision of each standard or specification mentioned in this code is intended.

806.2 Use of Standards and Specifications Incorporated by Reference

Some standards and specifications cited in Appendices A and B are supplemented by specific requirements elsewhere in this code. Users of this code are advised against attempting direct application of any of these standards without carefully observing the code's reference to that standard.

807 STANDARD DIMENSIONS Adherence to American Standard dimensions is strongly recommended wherever practicable. However, paragraphs or notations specifying these and other dimensional standards in this code shall not be mandatory, provided that other designs of at least equal strength and tightness and capable of withstanding the same test requirements are substituted.

CHAPTER I

MATERIALS AND EQUIPMENT

810 MATERIALS AND EQUIPMENT

810.1 It is intended that all materials and equipment that will become a permanent part of any piping system constructed under this code shall be suitable and safe for the conditions under which they are used. All such materials and equipment shall be qualified for the conditions of their use by compliance with certain specifications, standards, and special requirements of this code or otherwise as provided herein.

811 QUALIFICATION OF MATERIALS AND EQUIPMENT

811.1 Materials and equipment fall into five categories insofar as methods of qualification for use under this code are concerned:

(a) Items which conform to standards or specifications listed in this code.

(b) Items that are important from a safety standpoint, of a type for which standards or specifications are listed in this code, but the specific item in question does not conform to a listed standard. Example: Pipe manufactured to a specification not listed in the code.

(c) Items of a type for which standards or specifications are listed in this code but which do not conform to the standards and are relatively unimportant from a safety standpoint because of their small size or because of the conditions under which they are to be used.

(d) Items of a type for which no standard or specification is listed in this code: Example: Gas compressor.

(e) Unidentified or used pipe.

811.2 Prescribed procedures for qualifying each of these five categories are given in the following paragraphs:

811.21 Items which conform to standards or specifications listed in this code (811.1[a]) may be used for appropriate applications, as prescribed and limited by this code, without further qualification.

811.22 Important items which do not conform to specifications or standards listed in this code (811.1[b]) shall be qualified by one of the following means:

811.221 By petitioning the Code Committee for approval. If possible, the material shall be identified with a comparable material, and it should be stated that the material will comply with that specification except as noted. Complete information as to chemical composition and physical properties shall be supplied to the Code Committee, and their approval shall be obtained before this material may be used.

811.222 Materials conforming to specifications which do not vary materially from a listed specification and which meet the minimum requirements of this code with respect to quality of materials and workmanship may be used. This paragraph shall not be construed to permit deviations which would tend to adversely affect weldability or ductility. If the deviations tend to reduce strength, full allowance for the reduction shall be provided for in the design.

811.23 Relatively unimportant items which do not conform to listed standards or specifications (811.1[c]) may be used provided that:

(a) They are tested or investigated and found suitable for the proposed service, and

(b) They are used at unit stresses not greater than 50% of those allowed by this

code for comparable materials, and

(c) Their use is not specifically prohibited by the code.

811.24 Items for which no standards or specifications are listed in this code (811.1 [d]) Materials and equipment not covered by standards or specifications listed in this code may be qualified by the user by investigation and tests (if needed) that demonstrate that the item of material or equipment is suitable and safe for the proposed service, and provided further that the item is recommended for that service from the standpoint of safety, by the manufacturer.

811.25 Reuse of pipe in existing line. Removal of a portion of an operating line, and reuse of the pipe in the same line, or in a line operating at the same, or lower pressure, is permitted, subject only to the restrictions of paragraphs A, F and I in 811.27.

811.26 Used pipe, unidentified new pipe, and pipe purchased under Specification ASTM A120 may be used for low-stress level service (hoop stress less than 6,000 psi) where no close coiling or bending is to be done, provided careful visual examination indicates that it is in good condition, free from split seams or other defects that would cause leakage, and provided further that, if the pipe is to be welded, it shall satisfactorily pass weldability tests prescribed in 811.27 E.

811.27 Used pipe, unidentified new pipe, and pipe purchased under Specification ASTM A120 may be qualified for use at stress levels above 6,000 psi or for service involving close coiling or bending by the procedures and within the limits outlined in the table below.

The letters in the table refer to the corresponding paragraphs following:

	New or Used Pipe Unknown or ASTM A-120 Specification	Used Pipe Known Specification (ASTM A-120 excluded)
Inspection	A	A
Bending Properties	B	
Thickness	C	C
Joint Efficiency	D	D
Weldability	E	
Defects	F	F
Yield Strength	G	
S Value (841.1)	H	
Test	I	I

A. Inspection All pipe shall be cleaned inside and outside, if necessary, to permit good inspection, and shall be visually inspected to insure that it is reasonably round and straight, and to discover any defects which might impair its strength or tightness.

B. Bending Properties For pipe 2 inches and under in nominal diameter, a sufficient length of pipe shall be bent cold through 90 degrees, around a cylindrical mandrel, the diameter of which is twelve times the nominal diameter of the pipe, without developing cracks at any portion and without opening the weld.

For pipe larger than 2 inches in diameter, flattening tests as prescribed in ASTM A53 shall be made and the pipe shall meet the requirements in this test prescribed in ASTM A53. See Appendix G.

The number of tests required to determine bending properties shall be the same as required in G below to determine yield strength.

C. Determination of Wall Thickness Unless the nominal wall thickness is known with certainty, it shall be determined by measuring the thickness at quarter points on one end of each piece of pipe. If the lot of pipe is known to be of uniform grade, size and nominal thickness, measurement shall be made on not less than 10% of the individual lengths, but not less than 10 lengths; thickness of the other lengths may be verified by applying a gauge set to the minimum thickness. Following such measurement, the nominal wall thickness shall be taken as the next commercial wall thickness below the average of all the measurements taken, but in no case more than 1.14 times the least measured thickness.

D. Joint Efficiency If the type of longitudinal joint can be determined with

certainty, the corresponding Longitudinal Joint Factor "E" (Table 841.12) may be used. Otherwise, the factor "E" shall be taken as 0.60 for pipe 4 inches and smaller, or 0.80 for pipe over 4 inches.

E. Weldability shall be determined as follows: A qualified welder shall make a girth weld in the pipe. The weld shall then be tested in accordance with requirements of API Standard 1104. The qualifying weld shall be made under the most severe conditions under which welding will be permitted in the field and using the same procedure as to be used in the field. The pipe shall be considered weldable if the requirements set forth in API Standard 1104 are met. At least one such test weld shall be made for each 100 lengths of pipe in sizes over 4 inches in diameter. On sizes 4 inches and under one test will be required for each 400 lengths of pipe. If, in testing the weld, the requirements of API Standard 1104 cannot be met, the weldability may be established by making chemical tests for carbon and manganese, (see 824.23), and proceeding in accordance with the provisions of ASA B31.1, Section 6, Chapter IV. The number of chemical tests shall be the same as required for circumferential weld tests, stated above.

F. Surface Defects All pipe shall be examined for gouges, grooves and dents, and shall be qualified in accordance with the provisions of 841.24.

G. Determination of Yield Strength When the manufacturer's specified minimum yield strength, tensile strength or elongation for the pipe is unknown, and no physical tests are made, the minimum yield strength for purposes of design shall be taken as not more than 24,000 psi. Alternately, the tensile properties may be established as follows:

Perform all tensile tests prescribed by API Standard 5LX, except that the number of such tests shall be as follows:

Number of Tensile Tests - All Sizes

Lot of	
10 lengths or less	1 Set of tests from each length
11 to 100 lengths	1 Set of tests for each 5 lengths, but not less than 10
Over 100 lengths	1 Set of tests for each 10 lengths, but not less than 20.

All test specimens shall be selected at random.

If the yield-tensile ratio exceeds .85, the pipe shall not be used except as provided in 811.26.

H. S Value For pipe of unknown specification, the yield strength, to be used as S in the formula of 841.1, in lieu of the specified minimum yield strength shall be 24,000 psi, or determined as follows:

Determine the average value of all yield strength tests for a uniform lot. The value of S shall then be taken as the lesser of the following:

(1) 80% of the average value of the yield strength tests.

(2) The minimum value of any yield strength test, provided, however, that in no case shall S be taken as greater than 52,000 psi.

I. Hydrostatic Test New or used pipe of unknown specification and all used pipe the strength of which is impaired by corrosion or other deterioration, shall be re-tested hydrostatically either length by length in a mill type test or in the field after installation before being placed in service, and the test pressure used shall establish the maximum allowable operating pressure subject to limitations described in 841.14 (a) and (b).

812 MARKING

812.1 All valves, fittings, flanges, bolting, pipe and tubing, shall be marked in accordance with the marking sections of the standards and specifications to which reference is made in this code, or in accordance with the requirements of MSS SP-25, Standard Marking System for Valves, Fittings, Flanges and Unions of the Manufacturers Standardization Society of the Valve and Fittings Industry

812.2 Die stamping, if used, shall be done with dies having blunt or rounded edges to minimize stress concentrations.

813 MATERIAL SPECIFICATIONS

813.1 Standard specifications for various materials are listed in Appendices A and B.

813.2 Cold expanded pipe shall meet the mandatory requirements of API Standard 5LX.

814 MATERIALS FOR USE IN COLD CLIMATES Some of the materials conforming to specifications approved for use under this code may not have properties suitable for the lower portion of the temperature band covered by this code. Engineers are cautioned to give attention to the low-temperature properties of the materials used for facilities to be exposed to unusually low ground temperatures or low atmospheric temperatures.

815 EQUIPMENT SPECIFICATIONS Except for the piping components and structural materials listed in Appendices A and B, it is not intended to include in this code complete specifications for equipment. However, certain details of design and fabrication necessarily refer to equipment such as pipe hangers, vibration dampeners, electrical facilities, engines, compressors, etc. Partial specifications for such equipment items are given herein, particularly if they affect the safety of the piping system in which they are to be installed. In other cases where the code gives no specifications for the particular equipment item, the intent is that the safety provisions of the code shall govern insofar as they are applicable, and in any case the safety of equipment installed in a piping system shall be commensurate with that of other parts of the same system.

CHAPTER II

WELDING

820 WELDING

821 GENERAL

821.1 This chapter concerns the arc and gas welding of pipe joints in both wrought and cast steel materials, and more specifically covers butt joints in pipe, valves, flanges and fittings, and fillet welded joints in pipe branches, slip-on flanges, socket weld fittings, etc., as applied in pipelines and connections to apparatus or equipment. When valves or equipment are furnished with welding ends suitable for welding directly into a pipeline, the design, composition, welding, and stress relief procedures must be such that no significant damage will be likely to result from the welding or stress relieving operation. This chapter does not apply to the welding of longitudinal joints in the manufacture of pipe.

821.2 These standards apply to manual shielded metal arc and gas welding, automatic submerged arc welding, and are recommended for other manual and automatic welding where applicable.

821.3 These standards are based on the principle that a welding procedure has been established and qualified for sound and ductile welds. In applying these standards, the welder is required to qualify under the procedure employed. These standards establish the groupings of materials that can be welded under a procedure which has been qualified with any one of the materials included in the group. The changes in material, filler metal, process or procedure that require requalification of either welding procedure or welder are set out in 824.21 (a) or (b).

821.4 The standards of quality for pipelines and mains to operate at 20% or more of the specified minimum yield strength are established under section 829, "Standards of Acceptability" and the methods of non-destructive and destructive examination are set out.

821.5 All the welding done under the standards of this code shall be performed under a specification which at least embodies the requirements of this code. Example of such specification is API Standard 1104, "A Standard for Field Welding of Pipe Lines".

821.6 Welding Terms. Definitions pertaining to welding as used in this code conform to the standard definitions established by the American Welding Society and contained in AWS publication, "Standard Welding Terms and Their Definitions" - AWS A3.0.

822 TYPES OF WELDS

822.1 Butt Welds. Butt joints may be of the single Vee, double Vee, or other suitable type of groove. Joint designs shown in Figure 823-A or applicable combinations of these joint design details are recommended. See Figure 823-B for acceptable preparation for butt welding of pieces of unequal thickness.

822.2 Fillet Welds. Fillet welds may be concave to slightly convex. The size of a fillet weld is stated as the leg length of the largest inscribed right isosceles triangle as shown in Figure 823-C.

822.3 Seal Welds. Seal welding shall be done by qualified welders. Seal welding of threaded joints is permitted but

the seal welds shall not be considered as contributing to the strength of joints.

823 PREPARATION FOR WELDING

823.1 Butt Welds

(a) The welding surfaces shall be clean, and free of material that may be detrimental to the weld.

(b) Welding Groove Details. End preparation as given in Figure 823-A represents present acceptable practice.

(c) Pipe Alignment. The ends of pipe to pipe, or pipe to fitting joints shall be aligned as accurately as practicable giving consideration to existing commercial tolerances on pipe diameters, pipe wall thickness and out of roundness. Alignment shall provide the most favorable condition for the deposition of the root bead and shall be preserved during welding of the root bead.

(d) Root opening of the joint shall be as given in the Procedure Specification employed.

823.2 Fillet Welds. Minimum dimensions for fillet welds used in the attachment of slip-on flanges, for socket welded joints, are shown in Figure 823-C. Similar minimum dimensions for fillet welds used in branch connections are shown in Figures 831-B and 831-C.

824 QUALIFICATION OF PROCEDURES AND WELDERS

824.1 Requirements for Qualification of Procedures and Welders on Piping Systems Operating at Hoop Stresses of Less Than 20% of the Specified Minimum Yield Strength.

824.11 Welders whose work is limited to the application of the oxy-acetylene or manual arc welding processes on piping operating at hoop stresses of less than 20% of the specified minimum yield strength, shall be qualified under any of the references given in 824.21 or in accordance with Appendix F of this code.

824.2 Requirements for Qualification of Procedures and Welders on Pipelines to Operate at Hoop Stresses of 20% or more of the Specified Minimum Yield Strength.

824.21 Welding procedures and welders performing work under this classification must be qualified under one of the following standards:

(a) ASA B31.1, Code for Pressure Piping, Section 6, Chapter IV.

(b) ASME Boiler and Pressure Vessel Code, Section IX.

(c) API Standard 1104, "Standard for Field Welding of Pipe Lines."

824.22 When welders qualified under API Standard 1104 are employed on compressor station piping, their qualifying test shall have been based upon the guided bend test.

824.23 Variables Requiring Separate Qualification of Welding Procedure and Welders. The references given in 824.21 (a) and (b) contain sections entitled "Essential Variables" applicable to welding procedures and also to welders. These shall be followed except that for the purposes of this code all carbon steels which have a carbon content not exceeding 0.32% by ladle analysis, and a carbon equivalent (C + 1/4 Mn) not exceeding 0.65% by ladle analysis, are considered to come under material grouping P1. Alloy steels having weldability and hardenability characteristics demonstrated to be similar to these carbon steels shall be welded, preheated and stress relieved as prescribed herein for such carbon steels. Other alloy steels shall be welded, preheated, and stress relieved as prescribed in ASA B31.1, Section 6, Chapter IV.

824.24 Welder Requalification Requirements. Welder requalification tests shall be required if there is some specific reason to question a welder's ability or the welder is not engaged in a given process of welding (i.e., arc or gas) for a period of six months or more.

824.25 Qualification Records. Records of

the tests that establish the qualification of a welding procedure shall be maintained as long as that procedure is in use. The operating company or contractor shall, during the construction involved, maintain a record of the welders qualified, showing the date and results of tests.

825 WELDING PROCEDURE - GENERAL

825.1 The welding procedure followed during the qualifying tests shall be recorded in detail, and shall be adhered to during subsequent construction.

825.2 Welding shall not be done when the quality of the completed weld would be likely to be impaired by the prevailing weather conditions including, but not limited to, airborne moisture, blowing sand, or high wind. Wind shields may be used when practicable.

826 PREHEATING

826.1 Carbon steels having a carbon content in excess of 0.32% (ladle analysis) or a carbon equivalent (C + 1/4 Mn) in excess of 0.65% (ladle analysis) shall be preheated as prescribed in ASA B31.1, Section 6, Chapter IV. Preheating may also be advisable for steels having lower carbon or carbon equivalent, when conditions exist that either limit the welding technique that can be used, or that tend to adversely affect the quality of the weld.

826.2 When welding dissimilar materials having different preheating requirements, the material requiring the higher preheat shall govern.

826.3 Preheating may be accomplished by any suitable method, provided that it is uniform and that the temperature does not fall below the prescribed minimum during the actual welding operations.

826.4 The preheating temperature shall be checked by the use of temperature indicating crayons, thermocouple pyrometers or other suitable method to assure that the required preheat temperature is obtained prior to and maintained during the welding operation.

827 STRESS RELIEVING

827.1 Carbon steels having a carbon content in excess of 0.32% (ladle analysis) or a carbon equivalent (C + 1/4 Mn) in excess of 0.65% (ladle analysis) shall be stress relieved as prescribed in ASA B31.1, Section 6, Chapter IV. Stress relieving may also be advisable for steels having lower carbon or carbon equivalent when adverse conditions exist which too rapidly cool the weld.

827.2 Welds in all carbon steels shall be stress relieved when the wall thickness exceeds 1-1/4 inches.

827.3 When the welded joint connects parts that are of different thicknesses but of similar materials, the thickness to be used in applying the rules in 827.1 and 827.2 shall be:

(a) The thicker of the two pipes joined.

(b) The thickness of the pipe run or header in case of branch connections, slip-on flanges or socket weld fittings.

827.4 In welds between dissimilar materials, if either material requires stress relieving, the joint shall require stress relieving.

827.5 All welding of connections and attachments shall be stress relieved when the pipe is required to be stress relieved by the rules of 827.3 with the following exceptions:

(a) Fillet and groove welds not over 1/2 inch in size (leg) that attach connections not over 2-inch pipe size.

(b) Fillet and groove welds not over 3/8 inch in groove size which attach supporting members or other non-pressure attachments.

827.6 Stress Relieving Temperature

(a) Stress relieving shall be performed at a temperature of 1100° F. or over for carbon steels, and 1200° F. or over for

ferritic alloy steels. The exact temperature range shall be stated in the procedure specification.

(b) When stress relieving a joint between dissimilar metals having different stress relieving requirements, the material requiring the higher stress relieving temperature shall govern.

(c) The parts heated shall be brought slowly to the required temperature and held at that temperature for a period of time proportioned on the basis of at least 1 hour per inch of pipe wall thickness, but in no case less than 1/2 hour, and shall be allowed to cool slowly and uniformly.

827.7 Methods of Stress Relieving

(a) Heating the complete structure as a unit.

(b) Heating a complete section containing the weld or welds to be stress relieved before attachment to other sections of work.

(c) Heating a part of the work by heating slowly a circumferential band containing the weld at the center. The width of the band which is heated to the required temperature shall be at least 2 inches greater than the width of the weld reinforcement. Care should be used to obtain a uniform temperature around the entire circumference of the pipe. The temperature shall diminish gradually outward from the ends of this band.

(d) Branches, or other welded attachments for which stress relief is required, may be locally stress relieved by heating a circumferential band around the pipe on which the branch or attachment is welded with the attachment at the middle of the band. The width of the band shall be at least 2 inches greater than the diameter of the weld joining the branch or attachment to the header. The entire band shall be brought up to the required temperature and held for the time specified.

827.8 Equipment for Local Stress Relieving

(a) Stress relieving may be accomplished by: electric induction, electric resistance, fuel-fired ring burners, fuel-fired torch or other suitable means of heating provided that a uniform temperature is obtained and maintained during the stress relieving.

(b) The stress relieving temperature shall be checked by the use of thermocouple pyrometers or other suitable equipment to be assured that the proper stress relieving cycle has been accomplished.

828 WELDING INSPECTION AND TESTS

828.1 Inspection of Welds on Piping Systems Intended to Operate at Less Than 20% of the Specified Minimum Yield Strength. The quality of welding should be checked visually on a sampling basis, and if there is any reason to believe that the weld is defective, it shall be removed from the line and tested in accordance with the specification or it may be subject to a non-destructive test as outlined in 828.2.

828.2 Inspection and Tests of Welds on Piping Systems Intended to Operate at 20% or More of the Specified Minimum Yield Strength.

(a) The quality of welding should be checked by non-destructive tests or by removing completed welds as selected and designated by the operating company. Non-destructive testing may consist of radiographic examination, magnetic particle testing, or other acceptable methods. The trepanning method of non-destructive testing is prohibited.

(b) When radiographic examination is employed, the procedure set forth in API Standard 1104 (Standard for Field Welding of Pipe Lines) shall be followed; and the number and location of welds examined shall be at the discretion of the operating company.

(c) Completed welds which have been removed for inspection shall, to be acceptable, successfully meet the testing requirements outlined under the welder qualification procedure, and in addition, shall meet the standards of acceptability contained in 829.

829 STANDARDS OF ACCEPTABILITY OF WELDS ON PIPELINES INTENDED TO OPERATE AT 20% OR MORE OF THE SPECIFIED MINIMUM YIELD STRENGTH. (These requirements are identical with the requirements of API 1104.)

829.1 Inadequate Penetration and Incomplete Fusion. Any individual inadequate penetration or incomplete fusion shall not exceed 1 inch in length. In any 12-inch length of weld, the total length of inadequate penetration or incomplete fusion shall not exceed 1 inch. The total length of the inadequate penetration or incomplete fusion in any two succeeding 12-inch lengths shall not exceed 2 inches and individual defects shall be separated by at least 6 inches of sound weld metal.

829.2 Burn-Through Areas. Any individual burn-through area shall not exceed 3/4 inch in length. In any 12-inch length of weld, the total length of burn-through area shall not exceed 1-1/2 inches. The total length of burn-through area in any two succeeding 12-inch lengths shall not exceed 3 inches, and individual defects shall be separated by at least 6 inches of sound weld metal.

829.3 Elongated Slag Inclusions. Any elongated slag inclusion shall not exceed 2 inches in length or 1/16 inch in width. In any 12-inch length of weld, the total length of elongated slag inclusions shall not exceed 2 inches. The total length of elongated slag inclusions in any two succeeding 12-inch lengths, shall not exceed 4 inches, and individual defects shall be separated by at least 6 inches of sound weld metal. Parallel slag lines shall be considered as individual defects if they are wider than 1/32 inch.

829.4 Isolated Slag Inclusions. The maximum width of any isolated slag inclusion shall not exceed 1/8 inch. In any 12-inch length of weld, the total length of isolated slag inclusions shall not exceed 1 inch, nor shall there be more than four isolated slag inclusions of the maximum width of 1/8 inch in this length. Any two such inclusions shall be separated by 2 inches of sound weld metal. In any 24-inch length of weld, the total length of isolated slag inclusions shall not exceed 2 inches.

829.5 Gas Pockets. The maximum dimensions of any individual gas pocket shall not exceed 1/8 inch. Maximum distribution of gas pockets shall not exceed that shown in Figures 3 and 4 of API Standard 1104.

829.6 Cracks. No welds containing cracks, regardless of size or location shall be acceptable until such welds have been repaired in conformance with 829.9.

829.7 Accumulation of Discontinuities. Any accumulation of discontinuities having a total length of more than 2 inches in a weld length of 12 inches is unacceptable. Any accumulation of discontinuities which total more than 10% of the weld length of a joint is unacceptable.

829.8 Undercutting. Undercutting adjacent to the cover bead on the outside of the pipe shall not exceed 1/32 inch in depth and 2 inches in length. Undercutting adjacent to the root bead on the inside of the pipe shall not exceed 2 inches in length.

829.9 Repair of Defects.

(a) Except as provided in (g) below, defective welds shall be repaired or removed from the pipeline at the request of the company representative. The company may authorize repairs of defects in the root and filler beads, but any weld that shows evidence of repair work having been done without authorization by the company may be rejected.

(b) Minor cracks in the surface and filler beads may be repaired when so authorized by the company, but any crack penetrating the root bead or the second bead shall be cause for complete rejection of the weld. The entire weld shall then be cut from the pipe line and replaced. Minor cracks shall

be defined as cracks visible in the surface bead and not over 2 inches in length.

(c) Before repairs are made, injurious defects shall be removed by chipping, grinding, or oxygen gouging to clean metal. All slag and scale shall be removed by wire brushing.

(d) It is recommended that all such areas be preheated before the repair weld is started.

(e) Repaired areas shall be carefully inspected and radiographed when considered necessary.

(f) No further repairs shall be allowed in repaired areas.

(g) Repairs may be made to pin holes and undercuts in the final bead without authorization, but must meet with the approval of the company.

CHAPTER III

PIPING SYSTEM COMPONENTS AND FABRICATION DETAILS

830 PIPING SYSTEM COMPONENTS AND FABRICATION DETAILS

830.1 General

The purpose of this chapter is to provide a set of standards for piping systems covering:

(1) Specifications for, and selection of, all items and accessories entering into the piping system, other than the pipe itself.

(2) Acceptable methods of making branch connections.

(3) Provisions to be made to care for the effects of temperature changes.

(4) Approved methods for support and anchorage of piping systems, both exposed and buried.

This chapter does not include:

(a) Pipe materials (see Chapter I).

(b) Welding procedures (see Chapter II).

(c) Design of pipe (see Chapter IV).

(d) Installation and testing of piping systems (see Chapter IV).

831 PIPING SYSTEM COMPONENTS.

All components of piping systems, including valves, flanges, fittings, headers, special assemblies, etc., shall be designed to withstand operating pressures, and other specified loadings, with unit stresses not in excess of those permitted for comparable material in pipe in the same location and type of service. Components shall be selected that are designed to withstand the field test pressure to which they will be subjected, without failure or leakage, and without impairment of their serviceability.

831.1 Valves

831.11 Valves shall be used only in accordance with the service recommendation of the manufacturer. Valves shall conform to American Standards governing minimum wall thickness, materials and dimensions, and may be used in accordance with pressure-temperature ratings contained in the following standards:

ASA B16.5	- Steel Pipe Flanges and Flanged Fittings
API 6D	- Specification for Iron and Steel Gate, Plug, and Check Valves for Pipe Line Service
MSS SP-44	- Steel Pipe Line Flanges
ASA B16.24	- Brass or Bronze Flanges and Flanged Fittings.

831.12 Screw-end valves shall be threaded according to the American Standard for Pipe Threads (ASA B2.1) or API Specification for Line Pipe (5L) or API Specification for Threads in Valves, Fittings and Flanges (6A).

831.13 Pressure-reducing devices shall conform to the requirements of this code for valves in comparable service conditions.

831.2 Flanges

831.21 Flange Types and Facings

(a) The dimensions and drilling for all line or end flanges shall conform to the following standards:

ASA B16 Series	- (For Iron and Steel)
MSS SP-44	- Steel Pipe Line Flanges
Appendix H	- Light-Weight Steel Flanges
ASA B16.24	- Brass or Bronze Flanges and Flanged Fittings.

Flanges cast or forged integral with pipe, fittings or valves will be permitted in sizes and for the maximum service ratings covered by the Standards listed above, subject to the facing, bolting and gasketing requirements of this paragraph and 831.22 and 831.23.

(b) Screwed companion flanges which comply with the B16 group of ASA Standards will be permitted in sizes and for maximum service ratings covered by these standards.

(c) Lapped flanges will bepermitted in sizes and pressure standards established in the American Standard ASA B16.5.

(d) Slip-on welding flanges will be permitted in sizes and pressure standards established in American Standard ASA B16.5 and MSS SP-44. Slip-on flanges of rectangular section may be substituted for hubbed slip-on flanges provided the thickness is increased as required to produce equivalent strength as determined by calculations made in accordance with Section VIII, Unfired Pressure Vessels, of the ASME Boiler and Pressure Vessel Code.

(e) Welding neck flanges will be permitted in sizes and pressure standards established in American Standard ASA B16.5 and MSS SP-44. The bore of the flange should correspond to the inside diameter of the pipe used. For permissible welding end treatment see Fig. 823-B.

(f) Cast iron and steel flanges shall have contact faces finished in accordance with MSS Standard Finishes for Contact Faces of Connecting-End Flanges of Ferrous Valves and Fittings, SP-6.

(g) Non-ferrous flanges shall have contact faces finished in accordance with American Standard ASA B16.24.

(h) 25 psi and Class 125 cast-iron integral or screwed companion flanges may be used with a full face gasket or with a flat ring gasket extending to the inner edge of the bolt holes. When using a full-face gasket, the bolting may be of heat-treated carbon steel (ASTM A-261), or alloy steel (ASTM A-193). When using a ring gasket, the bolting shall be of carbon steel equivalent to ASTM A-307, Grade B without heat treatment other than stress relief.

(i) When bolting together two Class 250 integral or screwed companion cast-iron flanges, having 1/16-inch raised faces, the bolting shall be of carbon steel equivalent to ASTM A-307 Grade B, without heat treatment other than stress relief.

(j) 150 psi steel flanges may be bolted to Class 125 cast-iron flanges. When such construction is used, the 1/16-inch raised face on the steel flange shall be removed. When bolting such flanges together using a flat ring gasket extending to the inner edge of the bolt holes, the bolting shall be of carbon steel equivalent to ASTM A-307 Grade B, without heat treatment other than stress relief. When bolting such flanges together using a full face gasket, the bolting may be heat treated carbon steel (ASTM A-261) or alloy steel (ASTM A-193).

(k) 300 psi steel flanges may be bolted to Class 250 cast-iron flanges. Where such construction is used, the bolting shall be of carbon steel, equivalent to ASTM A-307 Grade B, without heat treatment other than stress relief. Good practice indicates that the raised face on the steel flange should be removed, but also in this case, bolting shall be of carbon-steel equivalent to ASTM A-307 Grade B.

831.22 Bolting

(a) Bolts or bolt studs shall extend completely through the nuts. American Standard ASA B1.1 for Screw Threads, Coarse Thread Series shall govern bolt and nut threads for carbon steel bolting per ASTM A-307 Grade B, and American Standard ASA B1.4 for Screw Threads for High-Strength Bolting shall govern bolt, bolt-stud and nut threads for carbon steel bolting per ASTM A-261 and alloy steel bolting per ASTM A-193. Bolt heads shall conform to the regular square head or heavy hexagon dimensions and nuts shall conform to the

heavy hexagon dimensions of American Standard for Wrench-Head Bolts and Nuts (ASA B18.2). For all flange joints where pressure exceeds 300 psi and temperatures are in excess of ordinary atmospheric temperature, alloy steel bolting material equivalent to ASTM A-193 is recommended, but high strength carbon steel bolting material per ASTM A-261 may be used. Carbon steel bolting per ASTM A-307 Grade B may be used for pressures 300 pounds or lower where the temperature does not exceed 450°. Alloy steel bolting material (ASTM A-193) shall be used for insulating flanges, and for flanged piping in compressor stations, where flanges require a rating exceeding 300 pounds according to ASA B16.5. Nuts shall be in accordance with ASTM Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service, ASTM A-194. Nuts cut from bar stock in such a manner that their axis will be parallel to the direction of rolling of the bar may be used in all sizes for joints in which one or both flanges are cast iron and for joints with steel flanges where the pressure does not exceed 250 psi; they shall not be used for joints in which both flanges are steel and the pressure exceeds 250 psi, except for nut sizes 1/2 inch and smaller, which are permissible in any case.

(b) 1/8 inch undersize bolting may be used on insulating flanges provided that alloy steel bolting material (ASTM A-193) is used.

831.23 Gaskets

(a) Material for gaskets shall be capable of withstanding the maximum pressure and of maintaining its physical and chemical properties, at any temperature to which it might reasonably be subjected in service.

(b) Gaskets used under pressure and at temperatures above 250°F. shall be of non-combustible material. Metallic gaskets shall not be used with 150 lb. standard or lighter flanges.

(c) Asbestos composition gaskets may be used as permitted in the American Standard for Steel Pipe Flanges and Flanged Fittings (ASA B16.5). This type of gasket may be used with any of the various flange facings except small male and female, or small tongue and groove.

(d) The use of metal or metal-jacketed asbestos gaskets (either plain or corrugated) is not limited as to pressure provided that the gasket material is suitable for the service temperature. These types of gaskets are recommended for use with the small male and female or the small tongue and groove facings. They may also be used with steel flanges with any of the following facings: lapped, large male and female, large tongue and groove, or raised face.

(e) Full-face gaskets shall be used with all bronze flanges, and may be used with 25 psi or Class 125 cast iron flanges. Flat ring gaskets with an outside diameter extending to the inside of the bolt holes may be used with cast iron flanges, with raised face steel flanges, or with lapped steel flanges.

(f) In order to secure higher unit compression on the gasket, metallic gaskets of a width less than the full male face of the flange may be used with raised face, lapped or large male and female facings. Width of gasket for small male and female or for tongue and groove joints shall be equal to the width of the male face or tongue.

(g) Rings for ring joints shall be of dimensions established in ASA B16.20. The material for these rings shall be suitable for the service conditions encountered and shall be softer than the flanges.

(h) The insulating material shall be suitable for the temperature, moisture and other conditions where it will be used.

831.3 Fittings Other Than Valves and Flanges

831.31 Standard Fittings

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

(b) Steel butt-welding fittings (not flanged) shall comply with the American Standard for Steel Butt-Welding Fittings (ASA B16.9) and shall have pressure and

temperature ratings based on stresses for pipe of the same or equivalent material. To insure adequacy of fitting design, the actual bursting strength of fittings shall at least equal the computed bursting strength of pipe of the designated material and wall thickness. Mill hydrostatic testing of factory made steel butt-welding fittings is not required, but all such fittings shall be capable of withstanding a field test pressure equal to the test pressure established by the manufacturer, without failure or leakage, and without impairment of their serviceability.

(c) Steel socket-welding fittings shall comply with American Standard for Steel Socket-Welding Fittings (ASA B16.11).

831.32 Special Fittings. When special cast, forged, wrought, or welded fittings are required to dimensions differing from those of regular shapes specified in the applicable ASA and MSS Standards, the provisions of 807 shall apply.

831.33 Branch Connections.

(a) Welded branch connections on steel pipe must meet the design requirements of 831.4 and 831.5.

(b) Threaded taps in cast iron pipe are permitted, without reinforcement, to a size not more than 25% of the nominal diameter of the pipe, except that 1-1/4 inch taps are permitted in 4 inch pipe. Larger taps shall be covered by a reinforcing sleeve.

(c) Mechanical fittings may be used for making hot taps on pipelines and mains; provided they are designed for the operating pressure of the pipeline or main, and are suitable for the purpose.

831.34 Special Components Fabricated by Welding.

(a) This section covers piping system components other than assemblies consisting of standard pipe and fittings joined by circumferential welds.

(b) All welding shall be performed using procedures and operators that are qualified in accordance with the requirements of 824.

(c) Branch connections shall meet the design requirements of 831.4 and 831.5.

(d) The design of other components shall be in accordance with recognized engineering practice and applicable requirements of this code. When the strength of such components cannot be computed or determined with reasonable accuracy under the provisions of this code, the allowable working pressure shall be established as prescribed by Par. UG101, Section VIII.

(e) Prefabricated units, other than regularly manufactured butt-welding fittings, which employ plate and longitudinal seams as contrasted with pipe that has been produced and tested under one of the specifications listed in this code, shall be designed, constructed and tested under requirements of the ASME Boiler and Pressure Vessel Code. It is not intended to apply ASME Code requirements to such partial assemblies as split rings or collars or other field welded details.

(f) Orange-peel bull plugs and orange-peel swages are prohibited on systems operating at stress levels of 20% or more of the specified minimum yield strength of the pipe material. Fish tails and flat closures are permitted for 3 inch diameter pipe and smaller, operating at less than 100 psi. Fish tails on pipe larger than 3 inch diameter are prohibited. Flat closures larger than 3 inch diameter shall be designed according to Section VIII, Unfired Pressure Vessels, of the ASME Boiler and Pressure Vessel Code.

(g) Every prefabricated unit produced under this section of the code shall successfully withstand a pressure test without failure, leakage, distress or distortion other than elastic distortion, at a pressure equal to the test pressure of the system in which it is installed, either before installation or during the system test. When such units are to be installed in existing systems, they shall be pressure tested before installation, if feasible; otherwise, they shall withstand a leak test at the operating pressure of the line.

831.4 Reinforcement of Welded Branch Connections

831.41 General Requirements. All welded branch connections shall meet the following requirements:

(a) When branch connections are made to pipe in the form of a single connection or in a header or manifold as a series of connections, the design must be adequate to control the stress levels in the pipe within safe limits. The construction shall take cognizance of the stresses in the remaining pipe wall due to the opening in the pipe or header, the shear stresses produced by the pressure acting on the area of the branch opening, and any external loadings due to thermal movement, weight, vibration, etc. The following paragraphs provide design rules for the usual combinations of the above loads, except excessive external loads.

(b) The reinforcement required in the crotch section of a welded branch connection shall be determined by the rule that the metal area available for reinforcement shall be equal to or greater than the required area as defined in this paragraph and in Figure 831-A in the Appendix.

(c) The required cross-sectional area A_R is defined as the product of d times t:

$$A_R = d \times t$$

where, d = the length of the finished opening in the header wall measured parallel to the axis of the run.

t = the nominal header wall thickness required by Section 841.1 of this code for the design pressure and temperature.

When the pipe wall thickness includes an allowance for corrosion or erosion, all dimensions used shall be those that will result after the anticipated corrosion or erosion has taken place.

(d) The area available for reinforcement shall be the sum of:

(1) The cross sectional area resulting from any excess thickness available in the header thickness (over the minimum required for the header as defined in 831.41 [c] above) and which lies within the reinforcement area as defined in 831.41 (e) below.

(2) The cross-sectional area resulting from any excess thickness available in the branch wall thickness over the minimum thickness required for the branch and which lies within the reinforcement area as defined in 831.41 (e) below.

(3) The cross-sectional area of all added reinforcing metal including weld metal, which is welded to the header wall and lies within the reinforcement area as defined in 831.41 (e) below.

(e) The area of reinforcement is shown in Figure 831-A in the Appendix and is defined as a rectangle whose length shall extend a distance "d" on each side of the transverse centerline of the finished opening and whose width shall extend a distance of 2-1/2 times the header wall thickness on each side of the surface of the header wall, except that in no case shall it extend more than 2-1/2 times the thickness of the branch wall from the outside surface of the header or of the reinforcement, if any.

(f) The material of any added reinforcement shall have an allowable working stress at least equal to that of the header wall, except that material of lower allowable stress may be used if the area is increased in direct ratio of the allowable stresses for header and reinforcement material respectively.

(g) The material used for ring or saddle reinforcement may be of specifications differing from those of the pipe, provided the cross-sectional area is made in correct proportion to the relative strength of the pipe and reinforcement materials at the operating temperatures and provided it has welding qualities comparable to those of the pipe. No credit shall be taken for the additional strength of material having a higher strength than that of the part to be reinforced.

(h) When rings or saddles are used which cover the weld between branch and header, a vent hole shall be provided in the ring or saddle to reveal leakage in the weld between branch and header and to provide venting during welding and heat treating operations. Vent holes should be plugged during service to prevent crevice corrosion between pipe and reinforcing member, but no plugging material should be used that would be capable of sustaining pressure within the crevice.

(i) The use of ribs or gussets shall not be considered as contributing to rein-

forcement of the branch connection. This does not prohibit the use of ribs or gussets for purposes other than reinforcement, such as stiffening.

(j) The branch shall be attached by a weld for the full thickness of the branch or header wall plus a fillet weld "W_1", as shown in Figures 831-B and 831-C in the Appendix. The use of concave fillet welds is to be preferred to further minimize corner stress concentration. Ring or saddle reinforcement (Figure 831-C) shall be attached as shown by the figure. When a full fillet is not used it is recommended that the edge of the reinforcement be relieved or chamfered at approximately 45° to merge with the edge of the fillet.

(k) Reinforcement rings and saddles shall be accurately fitted to the parts to which they are attached. Figures 831-B and 831-C illustrate some acceptable forms of reinforcement.

(l) Branch connections attached at an angle less than 85° to the run become progressively weaker as the angle becomes less. Any such design must be given individual study and sufficient reinforcement must be provided to compensate for the inherent weakness of such construction. The use of encircling ribs to support the flat or re-entering surfaces is permissible, and may be included in the strength calculations. The designer is cautioned that stress concentrations near the ends of partial ribs, straps or gussets may defeat their reinforcing value.

831.42 Special Requirements. In addition to the requirements of 831.41, branch connections must meet the special requirements given in the following Table 831.421.

TABLE 831.421
Reinforcement of Welded Branch Connections
Special Requirements

Ratio of Design Hoop Stress to Minimum Specified Yield Strength in the Header	Ratio of Nominal Branch Diameter to Nominal Header Diameter		
	Less than 25%	25 to 50%	50% and more
Less than 20 percent	G	G	H
20 to 50 percent	I D	I	I H
50% and more	C D E	B E	A E F

A. Smoothly contoured wrought steel tees of proven design are preferred. When tees cannot be used, the reinforcing member shall extend around the circumference of the header. Pads, partial saddles, or other types of localized reinforcement are prohibited.

B. Smoothly contoured tees of proven design are preferred. When tees are not used, the reinforcing member should be of the complete encirclement type but may be of the pad type, saddle type, or a welding outlet fitting.

C. The reinforcement member may be of the complete encirclement type, pad type, saddle type, or welding outlet fitting type. The edges of reinforcement members should be tapered to the header thickness. It is recommended that legs of fillet welds joining the reinforcing member and header do not exceed the thickness of the header.

D. Reinforcement calculations are not required for openings 2 inch and smaller in diameter; however, care should be taken to provide suitable protection against vibrations and other external forces to which these small openings are frequently subjected.

E. All welds joining the header, branch and reinforcing member shall be equivalent to those shown in Figures 831-B and 831-C.

F. The inside edges of the finished opening shall, whenever possible, be rounded to a 1/8 inch radius. If the encircling member is thicker than the header and is welded to the header, the ends shall be tapered down to the header thickness and continuous fillet welds made.

G. Reinforcement of openings is not mandatory, however, reinforcement may be required for special cases involving pressures over 100 psi, thin wall pipe or severe external loads.

H. If a reinforcement member is required, and the branch diameter is such that a localized type of reinforcement member would extend around more than half the circumference of the header, then a complete encirclement type of reinforcement member shall be used, regardless of the design hoop stress; or a smoothly contoured wrought steel tee of proven design may be used.

I. The reinforcement may be of any type meeting the requirements of 831.41.

831.5 Reinforcement of Multiple Openings

831.51 When two or more adjacent branches are spaced at less than two times their average diameter (so that their effective areas of reinforcement overlap) the group of openings shall be reinforced in accordance with 831.4. The reinforcing metal shall be added as a combined reinforcement, the strength of which shall equal the combined strengths of the reinforcements that would be required for the separate openings. In no case shall any portion of a cross-section be considered to apply to more than one opening, or be evaluated more than once in a combined area.

831.52 When more than two adjacent openings are to be provided with a combined reinforcement, the minimum distance between centers of any two of these openings shall preferably be at least 1-1/2 times their average diameter, and the area of reinforcement between them shall be at least equal to 50% of the total required for these two openings on the cross-section being considered.

831.53 When two adjacent openings as considered under 831.52 have the distance between centers less than 1-1/3 times their average diameter, no credit for reinforcement shall be given for any of the metal between these two openings.

831.54 Any number of closely spaced adjacent openings, in any arrangement may be reinforced as if the group were treated as one assumed opening of a diameter enclosing all such openings.

832 EXPANSION AND FLEXIBILITY

832.1 This section is applicable to above ground piping only and covers all classes of materials permitted by this code up to temperatures no greater than 450° F.

832.2 Amount of Expansion. The thermal expansion of the more common materials used for piping shall be determined from Table 832.21. The expansion to be considered is the difference between the expansion for the maximum expected operating temperature and that for the expected average erection temperature. For materials not included in this table, or for precise calculations, reference shall be made to authoritative source data, such as publications of the National Bureau of Standards.

TABLE 832.21
Thermal Expansion of Piping Materials

Carbon and Low Alloy
High Tensile Steel
and Wrought Iron

Temperature Degree F.	Total expansion in inches per 100 feet above 32° F.
32	0.
60	0.2
100	0.5
125	0.7
150	0.9
175	1.1
200	1.3
225	1.5
250	1.7
300	2.2
350	2.6
400	3.0
450	3.5

832.3 Flexibility Requirements

832.31 Piping systems shall be designed to have sufficient flexibility to prevent thermal expansion or contraction from causing excessive stresses in the piping material, excessive bending or unusual loads

at joints, or undesirable forces or moments at points of connection to equipment or at anchorage or guide points. Formal calculations shall be required only where reasonable doubt exists as to the adequate flexibility of the system.

832.32 Flexibility shall be provided by the use of bends, loops, or offsets; or provision shall be made to absorb thermal changes by the use of expansion joints or couplings of the slip joint type or expansion joints of the bellows type. If expansion joints are used, anchors or ties of sufficient strength and rigidity shall be installed to provide for end forces due to fluid pressure and other causes.

832.33 In calculating the flexibility of a piping system the system shall be treated as a whole. The significance of all parts of the line and all restraints, such as solid supports or guides, shall be considered.

832.34 Calculations shall take into account stress intensification factors found to exist in components other than plain straight pipe. Credit may be taken for the extra flexibility of such components. In the absence of more directly applicable data, the flexibility factors and stress intensification factors shown in Table 1, Appendix D may be used.

832.35 Properties of pipe and fittings for these calculations shall be based on nominal dimensions, and the joint Factor E (841.12) shall be taken as 1.00.

832.36 The total range in temperature shall be used in all expansion calculations, whether piping is cold-sprung or not. In addition to the expansion of the line itself, the linear and angular movements of the equipment to which it is attached shall be considered.

832.37 Cold-springing. In order to modify the effect of expansion and contraction, runs of pipe may be cold sprung. Cold spring may be taken into account in the calculations of the reactions as shown in 833.5 provided an effective method of obtaining the designed cold spring is specified and used.

832.38 Flexibility calculations shall be based on the modulus of elasticity E_c at ambient temperature.

833 COMBINED STRESS CALCULATIONS

833.1 Using the above assumptions, the stresses and reactions due to expansion shall be investigated at all significant points.

833.2 The expansion stresses shall be combined in accordance with the following formula:

$$S_E = \sqrt{S_b^{\,2} + 4S_t^{\,2}}$$

Where $S_b = i\,M_b/Z$ = Resultant bending stress, psi.

$S_t = M_t/2Z$ = Torsional stress, psi.

M_b = Resultant bending moment, lb. in.

M_t = Torsional moment, lb. in.

Z = Section modulus of pipe, in.^{3}.

i = Stress intensification factor.

833.3 The maximum computed expansion stress range, S_E, shall not exceed 0.72S, where S is the specified minimum yield strength, psi.; subject to the further limitation of 833.4.

833.4 The total of the following shall not exceed the specified minimum yield strength, S:

(a) The combined stress due to expansion, S_E

(b) The longitudinal pressure stress

(c) The longitudinal bending stress due to external loads, such as weight of pipe and contents, wind, etc.

The sum of (b) and (c) shall not exceed 75% of the allowable stress in the hot condition (S x F x T, Section 841.1).

833.5 The reactions R' shall be obtained as follows from the reactions R derived from the flexibility calculations:

$R' = (1 - \frac{2}{3} C_S R$, When C_S is less than 0.6
$R' = C_S R$, When C_S is between 0.6 and 1.0
Where
C_S = The cold spring factor varying from zero for no cold spring to one for 100 percent cold spring.
R = Range of reactions corresponding to the full expansion range based on E_C.
E_C = The modulus of elasticity in the cold condition.

R' is maximum reaction for the line after cold-springing.

The reactions so computed shall not exceed limits which the attached equipment or anchorage is designed to sustain.

834 SUPPORTS AND ANCHORAGE FOR EXPOSED PIPING

834.1 General. Piping and equipment shall be supported in a substantial and workmanlike manner, so as to prevent or damp out excessive vibration, and shall be anchored sufficiently to prevent undue strains on connected equipment.

834.2 Provision for Expansion. Supports, hangers and anchors should be so installed as not to interfere with the free expansion and contraction of the piping between anchors. Suitable spring hangers, sway bracing, etc., shall be provided where necessary.

834.3 Materials, Design and Installation. All permanent hangers, supports, and anchors shall be fabricated from durable incombustible materials, and designed and installed in accordance with the good engineering practice for the service conditions involved. All parts of the supporting equipment shall be designed and installed so that they will not be disengaged by movement of the supported piping.

834.4 Forces on Pipe Joints

(a) All exposed pipe joints shall be able to sustain the maximum end force due to the internal pressure, i.e., the design pressure (psi) times the internal area of the pipe (sq. in.); as well as any additional forces due to temperature expansion or contraction, or to the weight of pipe and contents.

(b) If compression or sleeve-type couplings are used in exposed piping, provision shall be made to sustain the longitudinal forces noted in 834.4(a). If such provision is not made in the manufacture of the coupling, suitable bracing or strapping shall be provided; but such design must not interfere with the normal performance of the coupling nor with its proper maintenance. Attachments must meet the requirements of 834.5.

834.5 Attachment of Supports or Anchors

(a) If the pipe is designed to operate at a hoop stress of less than 50% of the specified minimum yield strength, structural supports or anchors may be welded directly to the pipe. Proportioning and welding strength requirements of such attachments shall conform to standard structural practice.

(b) If the pipe is designed to operate at a hoop stress of 50% or more of the specified minimum yield strength, support of the pipe shall be furnished by a member which completely encircles it. Where it is necessary to provide positive attachment, as at an anchor, the pipe may be welded to the encircling member only; the support shall be attached to the encircling member, and not to the pipe. The connection of the pipe to the encircling member shall be by continuous, rather than intermittent, welds.

835 ANCHORAGE FOR BURIED PIPING

835.1 General. Bends or offsets in buried pipe cause longitudinal forces, which must be resisted by anchorage at the bend, by restraint due to friction of the soil, or by longitudinal stresses in the pipe.

835.2 Anchorage at Bends. If the pipe is anchored by bearing at the bend, care shall be taken to distribute the load on the soil so that the bearing pressure is within safe limits for the soil involved.

835.3 Restraint Due to Soil Friction. Where there is doubt as to the adequacy of anchorage by soil friction, calculations should be made.

835.4 Forces on Pipe Joints. If anchorage is not provided at the bend (835.2), pipe joints which are close to the points of thrust origin shall be designed to sustain the longitudinal pullout force. If such provision is not made in the manufacture of the joint, suitable bracing or strapping shall be provided, unless calculations show the joint to be safe.

835.5 Supports for Buried Piping. In pipelines, especially those which are highly stressed from internal pressure, uniform and adequate support of the pipe in the trench is essential. Unequal settlements may produce added bending stresses in the pipe. Lateral thrusts at branch connections may greatly increase the stresses in the branch connection itself, unless the fill is thoroughly consolidated or other provisions made to resist the thrust.

835.51 When openings are made in a consolidated backfill to connect new branches to an existing line, care must be taken to provide firm foundation for both the header and the branch, to prevent both vertical and lateral movements.

835.6 Interconnection of Underground Lines. Underground lines are subjected to longitudinal stresses due to changes in pressure and temperature. For long lines, the friction of the earth will prevent changes in length from these stresses, except for several hundred feet adjacent to bends or ends. At these locations the movement, if unrestrained, may be of considerable magnitude. If connections are made at such a location to a relatively unyielding line, or other fixed object, it is essential that the interconnection shall have ample flexibility to care for possible movement, or that the line shall be provided with an anchor sufficient to develop the forces necessary to limit the movement.