
Hazardous Liquid PipelinesEngineering Specification

1 SCOPE AND INTENT**1.1 SCOPE**

This Engineering Specification covers the design, materials, fabrication, construction, inspection, testing, operations, maintenance, and safety aspects of hazardous liquid pipeline systems. This Plant Engineering Specification also covers the components of piping systems including, but not limited to pipe, relief devices, valves, fittings, flanges, bolting, and gaskets. Also included are hangars and supports to prevent overstressing the pipeline.

1.1.1 This Plant Engineering Specification includes the requirements in DOT 49CFR195 which are incorporated by reference within this Company specification and shall include all references in DOT 49CFR195. The DOT standard shall be used in conjunction with this Plant Engineering Specification and ANSI/ASME B31.4 for all activities concerning Company liquid transmission pipelines.

1.1.2 This Plant Engineering Specification does not apply to:

- (a) Auxiliary piping such as water, air, steam, lubricating oil, gas, and fuel;
- (b) Pressure vessels, heat exchangers, pumps, meters, and other equipment not in the scope of B31.4;

Approved: _____ Date: _____
Manager Safety, Health and Environmental

Approved: _____ Date: _____
Environmental Manager

- (c) Piping designed for internal pressures:

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- (1) At or below 15 psi [1 bar] gage pressure regardless of temperature;
- (2) Above 15 psi gage pressure if design temperature is below minus 20⁰ F (-30⁰C) or above 250⁰ F (120⁰ C).
- (d) Petroleum refinery, natural gas, gas processing, ammonia, carbon dioxide processing, and bulk plant piping except as covered in paragraph 400.1.1, ASME/ANSI B31.4. These piping systems are covered under ASME/ANSI B31.3.
- (e) Gas transmission and distribution piping [ASME/ANSI B31.8].
- (f) The design and fabrication of proprietary items of equipment, apparatus, or instruments.

1.1.1 Figure 400.1.1 attached to this section is a diagram from ASME/ANSI B31.4-1992 Edition which shows the scope of B31.4. ASME/ANSI B31.4 shall be the governing Code for all Company hazardous DOT liquid pipelines. **The term “Code” as this document refers to ASME/ANSI B31.4.**

1.2 INTENT

- 1.2.1** The intent of this standard is to provide engineering specifications for safe construction, operation, maintenance, and inspection of Company hazardous liquid transmission piping systems. Due to the complex nature of governing national codes, these specifications can not be written with sufficient detail to cover all possibilities concerning safety with liquid transportation systems. Responsible design, construction, operation, and maintenance personnel must have the experience and training to adequately cover all work related problems. All work performed within the scope of this specification shall meet or exceed the requirements in ANSI/ASME B31.4, 1992 Edition, “Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids” and 49CFR-Part 195, “Transportation of Hazardous Liquids By Pipeline”.
- 1.2.2** This specification and the supporting Code documents shall not be retroactive or construed as applying to piping systems installed before effective dates of this specification or its supporting Codes with regard to

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design, materials, construction, assembly, inspection, and testing. All operational Company pipelines and piping systems shall be inspected and tested to the ASME/ANSI B31.4 which was used for the original design and construction.

2 REFERENCES**2.1 ASTM**

- A6 General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use
- A36 Structural Steel
- A53 Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded and Seamless
- A105 Forgings, Carbon Steel, for Piping Components
- A106 Seamless Carbon Steel Pipe for High-Temperature Service
- A134 Pipe, Steel, Electric-Fusion (Arc)-Welded (Sizes NPS 16 and over)
- A181 Forgings, Carbon Steel, for General-Purpose Piping
- A193 Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
- A194 Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service
- A234 Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
- A242 High-Strength Low-Alloy Structural Steel
- A307 Carbon Steel Externally Threaded Standard Fasteners
- A524 Seamless Carbon Steel Pipe for Atmospheric and Lower Temperatures
- A530 General Requirements for Specialized Carbon and Alloy Steel Pipe
- A671 Electric-Fusion-Welded Steel Pipe for Atmospheric and Lower Temperatures

2.2 API

- 5L Line Pipe
- 6D Pipeline Valves (Gate, Plug, Ball and Check), End Closures, Connectors, and Swivels

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- 570 Piping Inspection Code: Inspection, Repair, Alteration, and Rerating of In-Service Piping Systems
- 600 Steel Gate Valves, Flanged and Buttwelding Ends
- 602 Compact Carbon Steel Gate Valves
- 1102 Recommended Practice for Liquid Petroleum Pipelines Crossing Railroads and Highways
- 1104 Standard for Welding Pipelines and Related Facilities
- 1107 Recommended Pipeline Maintenance Welding Practices.
- 1109 Recommended Practice for Marking Liquid Petroleum Pipeline Facilities
- 1110 Recommended Practice for Pressure Testing of Liquid Petroleum Pipelines
- 2200 Repairing Crude Oil, Liquefied Petroleum Gas, and Product Pipelines
- RP 5L1 Recommended Practice for Railroad Transportation of Line Pipe.
- RP 5L5 Recommended Practice for Marine Transportation of Line Pipe.
- RP 5L6 Recommended Practice for Transportation of Line Pipe on Inland Waterways.
- 2.3 NFPA**
- 70 National Electrical Code
- 2.4 MSS**
- SP-6 Standard Finishes for Contact Faces of Pipe Flanges and Connecting End Flanges of Valves and Fittings
- SP-25 Standard Marking System for Valves, Fittings, Flanges, and Unions.
- SP-44 Steel Pipe Line Flanges
- SP-55 Quality Standard for Steel Castings for Valves, Flanges and Fittings, and Other Piping Components
- SP-75 High Test Wrought Butt Welding Fittings
- 2.5 AWS**
- A3.0 Welding Terms and Definitions
- 2.6 NACE**

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RP-01-69	Control of External Corrosion on Underground or Submerged Metallic Piping Systems.
RP-01-75	Control of Internal Corrosion in Steel Pipelines and Piping Systems.
RP-01-77	Mitigation of Alternating Current and Lightning Effects on Metallic Structures and Corrosion Control Systems.
Book Ref.	“Corrosion Data Survey”

2.7 ASME

B1.1	Unified Inch Screw Threads
B1.20.1	Pipe Threads (Except Dryseal)
B16.5	Steel Pipe Flanges and Flanged Fittings
B16.9	Factory-Made Wrought Steel Butt welding Fittings
B16.11	Forged Steel Fittings, Socket-Welding and Threaded
B16.20	Ring-Joint Gaskets and Grooves for Steel Pipe Flanges
B16.34	Steel Valves (Flanged and Butt welding End)
B31G	Manual for Determining the Remaining Strength of Corroded Pipelines.
B31.3	Chemical Plant and Petroleum Refinery Piping
B31.4	Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids
B31.8	Gas Transmission Pipeline Transportation Systems
BPV Code	Boiler and Pressure Vessel Code
	Section VIII, Pressure Vessels
	Section IX, Welding
	Section V, Nondestructive Examination
SI-1	ASME Orientation and Guide for Use of SI (Metric) Units

3 PIPING SYSTEMS DEFINITIONS**3.1 GENERAL TERMS**

- 3.1.1 Barrel;** a unit of volume measurement equal to 42 U.S. standard gallons.
- 3.1.2 Code:** ASME/ANSI B31.4-1992 Edition including addenda to ASME B31.4a-1994, “Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids”. *******Note:** Paragraph references from 400 to 465 in this Company specification indicate the corresponding paragraph in the Code.

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- 3.1.3 Company:** ESI Company (See Operating Company)
- 3.1.4 Component:** any part of a pipeline which may be subjected to pump (line) pressure including, but not limited to, pipe, valves, elbows, tees, flanges, and closures.
- 3.1.5 Hazardous liquid:** petroleum, petroleum products, or anhydrous ammonia.
- 3.1.6 Offshore:** area beyond the line of ordinary high water, along that portion of the coast that is in direct contact with the open seas and beyond the line marking the seaward limit of inland coastal waters.
- 3.1.7 Operating Company:** owner or agent currently responsible for the design, construction, inspection, testing, operation, and maintenance of the piping system. For the purposes of this specification, ESI is the Operating Company and is referred to as “Company” in the specification.
- 3.1.8 Petroleum:** crude oil, natural gas liquids, liquified petroleum gas, and liquid petroleum products.
- 3.1.9 Petroleum product:** flammable, toxic, or corrosive products obtained from distilling and processing of crude oil, unfinished oils, natural gas liquids, blend stocks, and other miscellaneous hydrocarbon compounds.
- 3.1.10 Rural area:** outside the limits of any incorporated or unincorporated city, town, village, or any other designated residential area.
- 3.1.11 Shall:** indicates that a provision is mandatory.
- 3.1.12 Should:** recommended as a good practice.
- 3.1.13 Surge pressure:** pressure produced by a change in velocity of the moving stream that results from shutting down a pump station or pumping unit, closure of a valve, or any other blockage of the moving stream.
- 3.1.14 Toxic product:** “poisonous material” as defined by paragraph 173.132 Class 6, Division 6.1- Definitions, 49CFR.

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3.2 PIPING SYSTEMS

- 3.2.1 Defect:** an imperfection in piping or component materials of sufficient magnitude to warrant rejection.
- 3.2.2 Design pressure:** maximum pressure permitted by Code.
- 3.2.3 Engineering design:** the detailed design developed from operating requirements and conforming to Code requirements, including all necessary drawings and specifications, governing a piping installation.
- 3.2.4 General corrosion:** uniform or gradually varying loss of wall thickness over an area.
- 3.2.5 Girth weld:** a complete circumferential butt weld joining pipe or components.
- 3.2.6 Imperfection:** a discontinuity or irregularity which is detected by inspection.
- 3.2.7 Internal design pressure:** internal pressure used in calculations or analysis for pressure design of a piping component.
- 3.2.8 Line section:** a continuous run of pipe between adjacent pressure pump stations, between a pressure pump station and terminal or breakout tanks, between a pressure pump station and a block valve, or between adjacent block valves.
- 3.2.9 Low stress pipeline:** a hazardous liquid pipeline that is operated in its entirety at a stress level of 20 percent or less of the specified minimum yield strength (SMYS).
- 3.2.10 Maximum allowable operating pressure (MAOP):** maximum pressure at which a hazardous liquid pipeline can be operated with the provisions of ANSI B31.4.
- 3.2.11 Maximum allowable pressure:** See Design Pressure.

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- 3.2.12 Maximum steady state operating pressure:** maximum pressure (sum of static head pressure, pressure required to overcome friction losses, and any back pressure) when the system is operating under steady state conditions.
- 3.2.13 Maximum allowable test pressure:** maximum internal fluid pressure permitted by the Code for a pressure test based upon the material and location involved.
- 3.2.14 Nominal wall thickness:** wall thickness listed in applicable pipe specifications. Wall thickness is subject to tolerances as given in the specification or standard.
- 3.2.15 Overpressure protection:** device or equipment for the purpose of preventing the pressure in a pressure vessel or pipeline from exceeding a predetermined value.
- 3.2.16 Pipe:** a cylindrical tube used for conveying a fluid or transmitting fluid pressure. Types of carbon-steel pipe approved for Company pipelines include: Electrical Resistance Welded (ERW), Double Submerged Arc Welded (DSAW), and Seamless which have been manufactured in accordance with the requirements in API 5L, Line Pipe.
- 3.2.17 Pipeline or pipeline system:** all parts of a pipeline facility through which a hazardous liquid moves in transportation, including, but not limited to, line pipe, valves, and other appurtenances connected to line pipe, pumping units, fabricated assemblies associated with pumping units, metering and delivery stations and associated assemblies, and breakout tanks.
- 3.2.18 Pipeline facility:** new and existing pipe, rights-of-way and any equipment, facility, or building used in the transportation of hazardous liquids.
- 3.2.19 Pipe supporting elements:** pipe supporting elements consist of fixtures and structural attachments as follows:
- 3.2.19.1 Fixtures:** include elements which transfer the load from the pipe or structural attachment to the supporting structure or equipment. They include hanging type fixtures such as hanger rods, spring hangers, sway braces, counterweights, turnbuckles, struts, chains, guides and anchors, and bearing type fixtures such as saddles, bases, rollers, brackets, and sliding supports.

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3.2.19.2 Structural attachments: structural attachments include elements which are welded, bolted, or clamped to the pipe, such as clips, lugs, rings, clamps, clevises, straps, and skirts.

3.2.20 Pitting corrosion: localized corrosion with majority of pipe surface (volume) unaffected.

3.3 PRESSURE RELIEF STATIONS AND REGULATORS

3.3.1 Pressure regulating station: equipment installed for the purpose of automatically reducing and regulating pressure in the section downstream of the station. Included are piping and auxiliary devices such as valves, control instruments, control lines, the enclosure, and ventilation equipment.

3.3.2 Pressure limiting station: equipment which will control gas flow to prevent gas pressure from exceeding a predetermined value.

3.3.3 Pressure relief station: equipment which will vent gas to prevent gas pressure from exceeding a predetermined limit.

3.4 VALVES

3.4.1 Stop valve: valve installed to stop the flow of product in a pipe.

3.4.2 Check valve: valve designed to permit flow in one direction and to close automatically to prevent flow in the reverse direction.

3.5 PIPE AND PIPING TERMS

3.5.1 Pipe: a tubular product formed by three (3) manufacturing methods (Electrical Resistance Welded, Double Submerged Arc Welded (DSAW) [Longitudinal or Spiral Weld], and Seamless. Cylinders formed from plate in the course of fabrication of auxiliary equipment are not pipe for the purposes of this standard.

3.5.2 Cold expanded pipe: seamless or welded pipe which is formed and then expanded in the pipe mill while cold to permanently increase the circumference by at least 0.50%.

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3.6 DIMENSIONAL TERMS

- 3.6.1 Length:** a piece of pipe as delivered from the mill; sometimes referred to as a “joint”.
- 3.6.2 Nominal wall thickness, t :** wall thickness computed by or used in the B31.4 design equation.
- 3.6.3 NPS (nominal pipe size):** a dimensionless designator of pipe which indicates a standard pipe size when followed by an appropriate number (e.g., NPS 12).

3.7 MECHANICAL PROPERTIES

- 3.7.1 Yield strength:** the strength at which a material exhibits a specified limiting permanent set or produces a specified total elongation under load.
- 3.7.2 Tensile strength:** the highest unit tensile stress over the original cross section that a material can sustain before failure.
- 3.7.3 Specified minimum yield strength (SMYS):** minimum yield strength as prescribed by the specification for a given purchase.
- 3.7.4 Specified minimum tensile strength:** minimum tensile strength as required by the specification when purchasing pipe.
- 3.7.5 Specified minimum elongation:** minimum elongation (expressed in percent of the gage length) for a tensile test specimen.

3.8 STEEL PIPE

- 3.8.1 Carbon Steel:** steel is considered to be *carbon steel* when no minimum content is specified or required for aluminum, boron, chromium, molybdenum, nickel, titanium, tungsten, vanadium, zirconium, or any other element added to achieve 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:

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manganese	1.65%
silicon	0.60%
copper	0.60%

3.8.2 Alloy Steel: steel is considered to be *alloy steel* when the maximum concentration for various components exceeds the the limits specified in 3.8.1 of this document.

3.8.3 Pipe Manufacturing Processes: The following types of welded joints are acceptable for pipe manufactured to this specification:

- (a) Electric-resistance-welded pipe
- (b) Double submerged-arc-welded pipe (Longitudinal or Spiral Weld)
- (c) Seamless pipe

4 DESIGN, FABRICATION, OPERATION, AND TESTING TERMS

4.1 GENERAL

Up-rating: the qualifying of an existing pipeline for a higher maximum allowable operating pressure.

4.2 DESIGN

4.2.1 Pressure Terms

4.2.1.1 Pressure: pounds per square inch above atmospheric pressure, abbreviated as psig.

4.2.1.2 Design Pressure: maximum pressure permitted by ANSI B31.4.

4.2.1.3 Maximum Operating Pressure: highest pressure at which a piping system is operated during a normal operating cycle.

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4.2.1.4 Maximum Allowable Operating Pressure (MAOP): maximum pressure at which a gas system may be operated in accordance with the provisions of ANSI B31.4.

4.2.1.5 Maximum allowable steady state pressure: Sum of the static head pressure, pressure required to overcome friction losses, and any required back pressure.

4.2.1.6 Maximum allowable test pressure: maximum internal fluid pressure permitted by the Code for a pressure test based upon the material and location involved.

4.2.1.7 Overpressure protection: device or equipment installed for the purpose of preventing the pressure in a pressure vessel or pipeline from exceeding a predetermined value.

4.2.1.8 Standup pressure test: a leak test.

4.2.2 Temperature Terms

4.2.2.1 Temperatures (expressed in degrees Fahrenheit, °F, unless specifically stated otherwise).

4.2.2.2 Ambient temperature: the temperature of the surrounding medium.

4.2.2.3 Ground temperature: the temperature of the earth at pipe depth.

4.2.3 Stress Terms

4.2.3.1 Stress: the resultant internal force that resists change in the size or shape of a body acted upon by external forces. In the Pipeline Code, stress is often used as being synonymous with unit stress which is the stress per unit area (psi).

4.2.3.2 Operating stress: the stress in a pipe under normal operating conditions.

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4.2.3.3 Hoop stress, S_H : the stress in a pipe of wall thickness, t , acting circumferentially in a plane perpendicular to the longitudinal axis of the pipe and is determined by Barlow's formula:

$$S_H = PD/2t$$

4.2.3.4 Maximum allowable hoop stress: the maximum hoop stress permitted by the Pipeline Code for the design of a piping system.

4.2.3.5 Secondary stress: stress created in the pipe wall by loads other than the internal fluid pressure, e.g., backfill loads, traffic loads, loads caused by natural hazards, beam action in a span, loads at supports, and at connections to the pipe.

5 MATERIALS AND EQUIPMENT

5.1 ACCEPTABLE MATERIALS AND SPECIFICATIONS

The materials which are used on Company hazardous liquid pipeline projects in new construction or maintenance shall conform to the list of piping material specification in Section 2 and Table 423.1, Materials Standards, ASME/ANSI B31.4. As an alternative, materials shall meet the requirements for materials not listed as a part of this specification if qualification procedures are followed without exception.

5.2 MARKING

All valves, fittings, flanges, bolting, pipe, and tubing shall be marked in accordance with the marking section of the standards and specifications to which the items were manufactured or in accordance with the requirements of MSS SP-25.

5.3 MATERIAL SPECIFICATIONS

5.3.1 Steel Pipe

5.3.1.1 For pipe having a specified minimum yield strength of 56,000 psi or greater, fracture toughness tests shall be required in the purchase order.

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5.3.1.2 For mechanical strength, minimum pipe wall thickness for different schedule pipe is as follows:

5.3.1.2.1 NPS 2 and smaller	Schedule 80
5.3.1.2.2 NPS 4	Schedule 40
5.3.1.2.3 NPS 6 and larger	0.250"

5.4 EQUIPMENT SPECIFICATIONS

5.4.1 Fittings

5.4.1.1 General

All fittings NPS 2 and larger shall be butt welding fittings in accordance with ANSI B16.9. Weld fittings should have physical properties equivalent to the pipe to which the fittings will be welded. Heavier wall, lower strength fittings may be used with lighter wall, higher strength pipe with transitions at the ends of the fittings in accordance with the requirements of ANSI B31.4.

5.4.1.2 Elbows

Long radius (1.5D) elbows are recommended for fabricated assemblies. 5D ells shall be installed where instrumented pigs are planned in future operations.

5.4.1.3 Small Fittings

Fittings NPS 1 or smaller should be threaded and shall be seal welded. Fittings should be forged steel and manufactured in accordance with B16.11.

5.4.1.4 Flanges

Flange types, facings, gaskets, and bolting shall be purchased and installed in accordance with the requirements of ANSI B16.5 and this specification.

5.4.1.5 Valves

Pipeline valves must be manufactured to the requirements in API 6D, "Pipeline Valves".

5.4.1.6 Gaskets

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Gaskets conforming to ANSI B16.20 or ANSI B16.21 may be used. Gasket materials shall be resistant to the fluid and the full range of operating temperatures and pressures.

5.5 TRANSPORTATION OF LINE PIPE

If line pipe, transported by railroad, is to be installed in a service where the operating pressure is 20% or more of SMYS, the outer diameter to wall thickness ratio must be 70:1 or less.

5.6 CONDITIONS FOR THE REUSE OF PIPE**5.6.1 Reuse of Steel Pipe**

5.6.1.1 Requirements for the reuse of steel line pipe are summarized in paragraph 405.2.1, ANSI B31.4 with subparagraph (c) showing the necessary qualifications for pipe for use at SMYS above 24,000 psi or for service involving close coiling or bending. Qualification tests include:

- (a) Inspection
- (b) Bending and coiling properties for pipe NPS 2 and smaller
- (c) Determination of wall thickness
- (d) Longitudinal joint factor
- (e) Weldability
- (f) Surface defects
- (g) Determination of yield strength
- (h) S value
- (i) Hydrostatic test

5.6.1.2 Company Engineering Department should be contacted for assistance when the reuse of steel pipe is considered. A cost-effective test program will be developed for each case.

6 WELDING

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6.1 GENERAL

Welding Terms: Definitions pertaining to welding as used in ANSI 31.4 and 49CFR195 have been established by the American Welding Society and are listed in ANSI/AWS A3.0 and API 1104.

6.2 PREPARATION FOR WELDING

6.2.1 Safe Practices in Cutting and Welding - A test to determine the presence of a combustible gaseous mixture should be completed prior to welding.

6.2.2 Welding Processes and Filler Metal - Welding shall be completed by shielded metal arc welding, gas tungsten arc welding, or gas metal arc welding process using a manual, semiautomatic, or automatic welding technique or combination of these techniques. Filler metal shall comply with the requirements of API 1104.

6.2.3 Welding Qualifications - A Welding Procedure Specification (WPS) shall be prepared and qualified by testing prior to field welding in order to demonstrate that welds having suitable mechanical properties can be continuously made. Welding procedures and each welder or welding operator shall be qualified under API 1104, or Section IX of the ASME Boiler and Pressure Vessel Code, whichever is appropriate for the type of welding to be performed. The welding procedure shall specify the preheating and interpass temperature, and postweld heat treatment followed when materials, welding consumables, mechanical restraints, or weather conditions make any or all of them necessary. Forms for completing welding procedures are provided in Section IX, ASME BPV Code and API 1104.

6.2.4 Performance Qualification Records (PQR) - The Welding Procedure Specification (WPS) qualifying tests, the PQR, shall be recorded in detail as required in Section IX, ASME BPV Code and API 1104. Records of the tests that establish the qualification of a welding procedure shall be filed and retained as long as the welding procedure is used by the Company. The welding performance qualification (WPQ) for each welder/welding operator

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showing the date and results of the tests, shall be retained during the construction or maintenance activities.

6.2.5 Butt Welds - Butt welded joints may be single vee, double vee, or other suitable types of groove. Acceptable butt-welded joint design for joining pipe of equal and unequal wall thickness are shown in ASME/ANSI B31.4 Figures 434.8.6 (a)-(1) and 434.8.6 (a)-(2) respectively. Figure 434.8.6 (a)-(2) has an extensive list of requirements which are separated into four area:

1. General Notes
2. Internal Diameters Unequal
3. External Diameters Unequal
4. Internal and External Diameters Unequal

6.2.6 Fillet Welds - Fillet welds may be concave to slightly convex. The size of a fillet weld is the leg length of the largest isosceles triangle.

6.2.7 Seal Welds - Seal welding shall be performed by qualified welders. Seal welding is required for all threaded connections in hazardous liquid service. Seal welds do not contribute to the strength of the joint.

6.2.8 Tack Welds - Tack welding shall be completed by qualified welders.

6.2.9 Material Limitations - ANSI B31.4, paragraph 434.8.3(b) allows materials under grouping P-No. 1 with a carbon content not exceeding 0.32% and a carbon equivalent ($C + 1/4 Mn$) not exceeding 0.65% by ladle analysis. This allowance is an exception to the references in the BPV Code and API 1104.

6.2.10 Welder Requalification Requirements

Welder requalification tests are required in the following instances:

- (a) All welders must be requalified at least once per year.
- (b) Welder has not worked in a given process of welding for a period of six (6) months or more.
- (c) There is some reason to question a welder's ability.

6.2.11 Qualification Records

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6.2.11.1 Welding Procedure Specifications (WPS) and Procedure Qualification Records (PQR) shall be maintained as long as the procedure is in use.

6.2.11.2 During a given construction project, Company and/or contractor will maintain a record of the welders qualified showing the dates and results of the test.

6.2.11.3 All contractors are required to have their Company's WPS and PQR for work in a particular welding operation. Welders that complete the welding operation for the procedure qualification are considered qualified for that procedure. All other welders must be tested.

6.3 PREHEATING

6.3.1 Carbon steels having a carbon content in excess of 0.32% or a carbon equivalent of 0.65% or higher shall be preheated to the temperature in the welding procedure.

6.3.2 Preheat can be applied by any suitable technique provided the application is uniform and the temperature does not fall below the minimum during welding.

6.3.3 Preheat temperature shall be checked by temperature-indicating crayons, thermocouple pyrometers, or any other recognized method.

6.4 STRESS RELIEVING

6.4.1 Maximum Carbon or Carbon Equivalent: Welds in carbon steels having a carbon content in excess of 0.32% (ladle analysis) or a carbon equivalent ($C + \frac{1}{4} Mn$) in excess of 0.65% (ladle analysis) shall be stress relieved as prescribed in BPV Code, Section VIII. Stress relieving may also be advisable for welds in steel having lower carbon or carbon equivalent when adverse conditions exist which cool the weld too rapidly.

6.4.2 Thickness - Required for all welds when thickness exceeds 1-1/4 in.

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6.4.3 Different thickness for parts to be welded - Thicker part governs preheat requirements. Thickness of the pipe or header governs preheat requirements for branch connections, slip-on flanges, or socket weld fittings.

6.4.4 Stress Relieving Temperature

6.4.4.1 1100⁰F or more for carbon steels. Exact temperature range shall be included on the WPS.

6.4.4.2 Part shall be slowly raised to preheat temperature, maintained at that temperature for one (1) hour per inch of thickness (min. time = 1/2 hour), and cooled slowly and uniformly.

6.4.5 Methods of Stress Relieving

- (a) Heat the complete structure.
- (b) Heat welded area prior to attachment to a larger section.
- (c) For pipeline work, uniformly heat a band of the pipe with the weld at the center and temperature maintained at the required level to a distance of 2-inches on each side of the weld reinforcement.
- (d) For branch connections, locally heat at least 2-inches from the attachment weld and maintain temperatures.

6.4.6 Equipment for Local Stress Relieving

6.4.6.1 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.

6.4.6.2 Stress relieving temperature shall be checked by pyrometers or other suitable equipment.

7 DESIGN

7.1 DESIGN CONDITIONS

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7.1.1 The purpose of this section is to provide a set of standards for design of piping systems covering:

7.1.1.1 Specifications and selection for all items and accessories entering into the piping system.

7.1.1.2 Acceptable methods of making branch connections.

7.1.1.3 Provisions for the effects of temperature changes.

7.1.1.4 Approved methods for support and anchorage of piping systems, both exposed and buried.

7.1.2 This section does not include:

7.1.2.1 Pipe materials (See Section 5).

7.1.2.2 Welding procedures (See Section 6).

7.1.2.3 Installation and testing of piping systems (See Section 8).

7.1.3 This Company Engineering Specification with correct interpretation and application of ANSI B31.4 Code supplemented by the requirements in 49CFR195 are intended to be adequate for public safety under all conditions encountered in hazardous liquid pipeline transportation. However, additional stresses in the form of river crossings, offshore and inland coastal water areas, bridges, areas of heavy traffic, long self-supported spans, unstable ground, mechanical or sonic vibration, weight of special attachments, earthquake induced stresses, and thermal stresses must be considered and correctly engineered to minimize safety problems.

7.1.4 Pressure

7.1.4.1 Internal Design Pressure

Pipe and piping components at any point in the piping system shall be designed for an internal design pressure which shall not be less than the maximum steady state operating pressure (MSSOP), i.e., the sum of the static head pressure, pressure required to overcome

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friction losses, and any required back pressure. Pressure rise due to surges and other variations from normal operations is allowed.

7.1.4.2 External Design Pressure

The piping system shall be designed to withstand the maximum possible differential between external and internal pressures to which the components will be exposed.

7.1.5 Temperature

Design temperature is the metal temperature expected in normal operation. The design stress for metal temperatures between -20°F (-29°C) and 250°F (121°C) is constant and not varied in the Code.

7.1.6 Dynamic Effects

The following external factors shall be considered in the design of piping systems:

- (a) Impact either external or internal
- (b) Wind loading
- (c) Known earthquake regions
- (d) Fatigue cracking from vibration or resonance
- (e) Subsidence
- (f) Wave and/or current effects

7.1.7 Weight Effects

The following weight effects combined with loads and forces from other causes shall be taken into account in the design of piping that is exposed, suspended, or not supported continuously.

7.1.7.1 Live Loads

Live loads include the weight of the liquid transported and any other extraneous materials such as ice or snow that adhere to the pipe. The impact of wind, waves, and currents are also considered live loads.

7.1.7.2 Dead Loads

Dead loads include the weight of the pipe, components, coating, backfill, and unsupported attachments to the piping.

7.1.8 Thermal Expansion and Contraction Loads

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Provisions shall be made for the effects of thermal expansion and contraction in all piping systems.

7.1.9 Relative Movement of Connected Components

The effect of relative movement of connected components shall be taken into account in design of piping and pipe supporting elements.

7.2 DESIGN CRITERIA**7.2.1 General**

7.2.1.1 All components of piping systems including valves, flanges, fittings, headers, special assemblies, etc., shall be designed in accordance with the applicable requirements of ASME/ANSI B31.4, good engineering judgment, and design practices to withstand operating pressures and other specified loadings.

7.2.1.2 Components shall be selected that are designed to withstand the specified field test pressure without failure, leakage, or impairment of serviceability.

7.2.2 Pressure-Temperature Ratings for Piping Components**7.2.2.1 Components Having Specific Ratings.**

Pressure ratings for components in temperature service up to 250⁰F shall conform to the requirements for 100⁰F for material standards listed in ASME/ANSI Section II. Metallic trim, packing, seals, and gaskets shall be corrosion-resistant to the piping fluids and temperature-pressure-resistant to the conditions of the fluid.

7.2.2.2 Ratings-Components Not Having Specific Ratings.

Piping components not having established pressure ratings may be qualified for use as specified in paragraphs 404.7 and 423.1(b), ASME/ANSI B31.4.

7.2.2.3 Maximum Steady State Operating Pressure Limitations

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The maximum steady state operating pressure shall not exceed the internal design pressure and pressure ratings for the components used in normal operations.

7.2.2.4 Ratings-Allowances for Variations From Normal Operations.

The level of pressure rise due to surges and other variations from normal operations shall not exceed the internal design pressure at any point in the piping system and equipment by more than 10%.

7.2.2.5 Ratings-Considerations for Different Pressure Conditions.

Piping and valves connecting two lines with different pressures shall be designed for the higher pressure.

7.2.3 Allowable Stresses and Other Stress Limits**7.2.3.1 Allowable Stress Values**

The allowable stress value S to be used for design calculations for new pipe of known specification shall be established as follows:

$$S = 0.72 \times E \times SMYS$$

where 0.72 = design factor based on nominal thickness and
E = weld joint factor.

7.2.3.1.1 Table 402.3.1(a), ASME/ANSI B31.4 is a tabulation of examples of allowable stresses for reference use in transportation piping systems with the scope of this specification.

7.2.3.2 The allowable stress value S to be used for design calculations for used (reclaimed) pipe of known specifications shall be subject to the testing requirements of ASME/ANSI B31.4 paragraphs 437.4.1 (test to 1.25 times the internal design pressure for not less than 4 hours), 437.6.1 (thorough visual inspection with repairs in accordance with paragraph 434.5), 437.6.3 (determination of wall thickness), and 437.6.4 (determination of weld joint factor).

7.2.3.3 The allowable stress value S to be used for design calculations for new or used pipe of unknown or ASTM A120 specifications shall be established in accordance with limitations in paragraph 405.2.1(c)

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subject to the testing requirements of ASME/ANSI B31.4 paragraphs 437.4.1 (test to 1.25 times the internal design pressure for not less than 4 hours), 437.4..3 (leak test @ 1.25 x internal design pressure for pipelines with hoop stress less than 20% SMYS of the pipe), 437.6.1 (visual inspection), 437.6.3 (determination of wall thickness), 437.6.4 (determination of weld joint factor), and 437.6.5 (weldability).

7.2.3.4 The allowable stress value S to be used for design calculations for pipe which has been cold worked to meet SMYS and reheated to 600⁰F (300⁰C) or higher (except welding) shall be 75% of the applicable stress value as determined by paragraphs 7.2.3.1, 7.2.3.2, and 7.2.3.3 of this document.

7.2.3.5 Allowable stress values in shear shall not exceed 45% SMYS for the pipe. Allowable stress values in bearing shall not exceed 90% SMYS.

7.2.3.6 Allowable tensile and compressive stress values for materials used in structural supports and restraints shall not exceed 66% SMYS. Steel materials of unknown specifications may be used for structural supports and restraints, provided a SMYS of 24,000 psi or less is used.

7.2.4 Limits of Calculated Stresses Due to Sustained Loads and Thermal Expansion

7.2.4.1 Internal Pressure Stresses. The calculated stresses due to internal pressure shall not exceed the applicable stress value S except as permitted in paragraph 7.2.3 above.

7.2.4.2 External Pressure Stresses. Stresses due to external pressure shall be considered safe when the wall thickness of the piping components meets the requirements of ASME/ANSI B31.4 paragraphs 403 and 404.

7.2.4.3 Allowable Expansion Stresses. The net longitudinal compressive stress due to the combined effects of temperature and fluid pressure

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increases shall not exceed 90% SMYS in restrained lines. For unrestrained lines the allowable stress shall not exceed 72% SMYS.

7.2.4.4 Additive Longitudinal Stresses. The sum of the longitudinal stresses due to pressure, weight, and other sustained external loadings shall not exceed 75% of the allowable stress specified for S above.

7.2.4.5 Additive Circumferential Stresses Due to Occasional Loads.

- (a) *Operation.* The sum of the longitudinal stresses produced by pressure, live and dead loads, and those produced by occasional loads, such as wind or earthquake shall not exceed 80% SMYS.
- (b) *Test.* Stress due to test conditions are not subject to the limitations in (a) above.

7.2.5 Limits of Calculated Stresses Due to Occasional Loads

7.2.5.1 Operation. The sum of the longitudinal stresses produced by pressure, live and dead loads, and those produced by occasional loads, such as wind or earthquake shall not exceed 80% SMYS of the pipe.

7.2.5.2 Test. Stresses due to test conditions are subject to the limitation of paragraph 7.2.7.2 of this document. It is not necessary to consider other occasional loads, such as wind and earthquake, as occurring concurrently with the live, dead, and test loads existing at the time of test.

7.2.6 Limitations on Design Pressure, P

The design pressure, P, shall not exceed 85% of the mill test pressure, unless the pipe is retested in the field. P may not exceed 85% of the second pressure.

7.2.7 Limitations on Specified Minimum Yield Strength

If the pipe to be installed on a Company pipeline project is not new pipe purchased to API 5L requirements, the value of S may be determined in one of the following methods:

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7.2.7.1 S value for reused pipe which is removed from a pipeline and reinstalled in the same pipeline at another location.

7.2.7.2 For pipe of unknown specification, use an S value of 24,000 psi in lieu of a known SMYS.

7.2.8 Additional Requirements for Nominal Wall Thickness, t.

7.2.8.1 Additional wall thickness may be required for loading due to transportation of the pipe during construction, weight of water during testing, and soil loading and other secondary loads during operation. Consideration should also be given to welding or mechanical joining requirements.

7.2.8.2 The pipe wall thickness shall not be reduced to less than 90% of the design thickness under any circumstances including transportation, construction, operation, and maintenance.

7.2.9 Allowances

7.2.9.1 **Corrosion.** A wall thickness allowance for corrosion is not required if pipe and piping system components are protected against corrosion in accordance with Company Engineering specifications.

7.2.9.2 **Threading and Grooving.** An allowance for thread or groove depth in inches shall be included in ASME/ANSI B31.4 paragraph 404.1.1 when threaded or grooved pipe is allowed in these specifications.

7.2.9.3 **Weld Joint Factors.** Longitudinal or spiral weld joint factors E for various types of pipe are listed in Table 402.4.3 ASME/ANSI B31.4. Company Engineering specifications restrict pipe materials to those with a weld joint factor $E = 1.00$.

7.2.9.4 **Wall Thickness and Defect Tolerances.** Wall thickness and defect tolerances for pipe shall be as specified in applicable pipe specifications.

7.3 CRITERIA FOR PRESSURE DESIGN OF PIPING COMPONENTS

7.3.1 Straight Pipe

7.3.1.1 General

7.3.1.1.1 The *nominal wall thickness* of straight sections of steel pipe shall be equal to or greater than t_n , determined by the following equation:

$$t_n = t + A$$

7.3.1.1.2 The definitions below are used in the equations for the pressure design of straight pipe:

t_n = nominal wall thickness satisfying requirements for pressure and allowances.

t = pressure design wall thickness as calculated in inches (mm) for internal design pressure. Underthickness tolerance and maximum allowable depth of imperfections have been accounted for.

A = sum of allowances for threading and grooving, corrosion, and increase in wall thickness if not used as a protective measure.

P_i = internal design gage pressure.

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

S = applicable allowable stress value, psi (MPa).

7.3.1.2 Straight Pipe Under Internal Pressure

The internal pressure design wall thickness t of steel pipe shall be calculated by the following equations:

$$t = P_i D / 2S \text{ in.} \quad (t = P_i D / 20S) \text{ mm.}$$

7.3.1.3 Straight Pipe Under External Pressure

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

7.3.2 Curved Segments of Pipe**7.3.2.1 Pipe Bends**

The wall thickness of pipe before bending shall be determined the same as straight pipe. Bends shall meet the flattening limitations.

7.3.2.2 Elbows

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

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

7.3.3 Branch Connections

7.3.3.1 Welded branch connections on steel pipe must meet the design requirements of paragraphs 7.2.3, 7.2.4, 7.2.5, and 7.2.6 of this document.

7.3.3.2 Mechanical fittings may be used for making hot taps on pipelines provided the fittings are designed for the operating pressure of the pipeline.

7.3.4 Reinforcement of Welded Branch Connections

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7.3.4.1 General Requirements

Branch connections may be made by means of tees, crosses, integrally reinforced extruded outlet headers, or welded connections, and shall be designed in accordance with this specification and the Pipeline Code.

7.3.4.2 All welded branch connections shall meet the following requirements:

Single branch connections or a series of branch connections in a header assembly must be designed to control the stress levels in the pipe within safe limits. Stresses in the remaining pipe wall due to the opening in the pipe or header, shear stresses produced by the pressure acting on the area of the branch opening, and any external loadings due to the normal movement, weight, vibration, etc., must be considered.

7.3.4.2.1 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. Figure 404.3.1(b)(3), “Reinforced Extruded Outlets” and Figure 404.3.1(d)(2), “Reinforcement of Branch Connections”, ASME/ANSI B31.4 provide appropriate guidance in the interpretation and use of this requirement. Assistance in the use of this requirement can be provided by inspection personnel qualified to National Board Inspection Code or API 510 Pressure Vessel Inspection.

The required cross-sectional area, A_R , Figure 404.3.1(d)(2) ASME/ANSI B31.4, is defined as the product of d times t_h :

$$A_R = dt_h$$

where;

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d = The greater of the length of the finished opening in the header wall measured parallel to the axis of the run or the inside diameter of the branch connection.

t_h = The nominal header wall thickness required for the design pressure and temperature (Do not include corrosion allowance).

T_h = The nominal wall thickness of the header.

7.3.4.2.2 The area available for reinforcement shall be the sum of:

$$A_1 = (T_h - t_h)d :$$

the cross sectional area resulting from excess thickness available in the header thickness [$>t$] which lies within the reinforcement area;

$$A_2 = 2(T_b - t_b) :$$

The cross sectional area resulting from any excess thickness available in the branch wall thickness over minimum thickness required for the branch which lies within the reinforcement area;

A_3 = The cross sectional area of all weld-reinforcing metal which lies within the reinforcement area including solid weld metal attached to the header or branch, or both.

T_b = The nominal wall thickness of the branch.

t_b = The design branch wall thickness required by paragraph 4.4.1.2 of ASME/ANSI B31.4.

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7.3.4.2.3 The area of reinforcement is shown in ASME/ANSI B31.4, Figure 404.3.1(d)(2) and is defined as a dashed-line rectangle whose length shall extend a distance d (as defined in 7.3.4.2.3 above) on each side of the traverse center line 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 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.

7.3.4.2.4 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.

7.3.4.2.5 The material used for ring or saddle reinforcement may be a different specification from the pipe, provided the cross-sectional area is made in direct proportion to the relative strength of the pipe and reinforcement materials at the operating temperatures with comparable welding qualities. No credit shall be taken for the additional strength of material having a higher strength than the part to be reinforced.

7.3.4.2.6 Vent holes shall be provided in rings or saddles which cover the weld between branch and header 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 with heavy grease during operation to prevent crevice corrosion.

7.3.4.2.7 Ribs and gussets shall not be considered to contribute to reinforcement of branch connections, but these attachments may be used as stiffeners.

7.3.4.2.8 The branch shall be attached by a weld for the full thickness of the branch or header wall plus a fillet weld.

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Concave fillet welds are preferred to minimize corner stress concentrations. When a full fillet weld is not used, the edge of the reinforcement should be chamfered at approximately 45 degrees to merge with the edge of the fillet.

7.3.4.2.9 Reinforcement rings and saddles shall be accurately fitted to parts where attached. ASME/ANSI B31.4 Figure 404.3.1(c)(1) shows welding details for openings with complete encirclement types of reinforcement.

7.3.4.2.10 Branch connections attached at an angle less than 85 degrees 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 reentering 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.

7.3.4.3 Extruded outlet headers where no additional nonintegral material is available in the form of rings, pads, or saddles may be used in Company installations provided that the requirements in subparagraphs (1) through (8), paragraph 404.3.1, ASME/ANSI B31.4 are fully satisfied.

7.3.5 Reinforcement of Multiple Openings

7.3.5.1.1 When two or more adjacent branches are spaced at less than two times their average diameter (effective areas of reinforcement overlap), the groups of openings must be reinforced. Reinforcing metal shall be used as combined reinforcement, the strength shall equal the combined strengths of the reinforcements required for the separate openings. No portion of a cross section shall be applied to more than one opening or shall be evaluated more than once in a combined area.

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7.3.5.1.2 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 1.5 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.

7.3.5.1.3 When the distance between centers of two adjacent openings is less than 1 1/3 times their average diameter, no credit for reinforcement shall be given for any metal between the two openings.

7.3.5.1.4 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.

7.3.6 Extruded Outlets

7.3.6.1 The rules in this section apply to steel extruded outlets in which the reinforcement is an integral part of the outlet.

7.3.6.2 An extruded outlet is defined as an outlet where the extruded lip at the outlet has a height above the surface of the run which is equal to or greater than the radius of curvature of the external contoured portion of the outlet (See Figure 404.3.1(b)(3), ANSI B31.4).

7.3.6.3 These rules do not apply to any nozzles or branch connections where additional nonintegral material is applied in the form of rings, pads, or saddles.

7.3.6.4 These rules apply only to cases where the axis of the outlet intersects and is perpendicular to the axis of the run.

Definitions for Figure 404.3.1(b)(3), ASME/ANSI B31.4 are noted in paragraph 404.3.1(b)(4).

7.3.6.5 *Required Area.* The required area is defined as:

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$$A = K t_h D_0$$

where $K = 1.00$ (when $d/D > 0.60$)

$K = 0.6 + 2/3 d/D$ (when $d/D > 0.15, < 0.60$)

$K = 0.70$ (when d/D is equal to or less than 0.15)

The reinforcement area defined in 7.2.6.6 below must not be less than the required area in paragraph 7.3.6.5.

7.3.6.6 Reinforcement Area. The reinforcement area shall be the sum of areas $A_1 + A_2 + A_3$ which are defined as follows:

7.3.6.6.1 Area A_1 is the area lying within the reinforcement zone resulting from any excess thickness available in the run wall, i.e., $A_1 = D_0 (T_h - t_h)$.

7.3.6.6.2 Area A_2 is the area lying within the reinforcement zone resulting from any excess thickness available in the branch pipe wall, i.e., $A_2 = 2L (T_b - t_b)$.

7.3.6.6.3 Area A_3 is the area lying within the reinforcement zone resulting from excess thickness available in the extruded outlet lip, i.e., $A_3 = 2r_o (T_o - T_b)$.

7.3.6.7 The manufacturer shall be responsible for establishing design pressure and temperature and markings on the section containing extruded outlets.

7.3.6.8 Attachments

External and internal attachments to piping shall be designed to prevent or minimize.

7.3.6.8.1 Excessive localized bending stresses.

7.3.6.8.2 Flattening of the pipe.

7.3.6.8.3 Harmful thermal gradients in the pipe wall.

7.3.7 Pressure Design of Flanges

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7.3.7.1 The design of flanges manufactured in accordance with ASME/ANSI B31.4 paragraph 408.1 and the standards in Table 426.1 shall be considered suitable for use at the pressure-temperature ratings in this plant engineering specification.

7.3.7.2 The hubs for welding neck flanges having dimensions complying with ASME/ANSI B16.5 can be inside taper bored if the hubs are to be attached to thin wall pipe. It is recommended that the taper shall not be more abrupt than a ratio of 1:3. MSS SP-44, NPS 26, and larger pipeline flanges are designed for attachment to thin wall pipe and are preferred for this service.

7.3.7.3 Flanges shall be designed in accordance with Appendix II, Section VIII, Division 1, ASME Boiler and Pressure Vessel Code when operating conditions require the use of flanges not covered in ASME/ANSI B31.4 paragraph 408.1 and the standards in Table 426.1.

7.3.7.4 Slip-on flanges of rectangular cross section shall be designed so that flange thickness is increased to provide strength equal to that of the corresponding hubbed slip-on flange covered by ASME/ANSI B16.5, as determined by calculations made in accordance with ASME BPV Code, Section VIII, Division 1.

7.3.8 Reducers

7.3.8.1 Reducer fittings manufactured in accordance with ASME/ANSI B16.5, ASME/ANSI B16.9, or MSS SP-75 shall have pressure-temperature ratings based on the same stress values used in establishing the pressure-temperature limitations for pipe of the same or equivalent material.

7.3.8.2 Smoothly contoured reducers fabricated to the same nominal wall thickness and of the same type of steel as the adjoining pipe shall be considered suitable for use at the pressure-temperature ratings of the adjoining pipe. Seam welds of fabricated reducers shall be inspected

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by radiography or other accepted nondestructive methods (visual inspection accepted).

7.3.8.3 Where appropriate, changes in diameter may be accomplished by elbows, reducing outlet tees, or valves.

7.3.9 Pressure Design of Other Pressure Containing Components

7.3.9.1 This paragraph covers piping system components other than assemblies consisting of pipe and fittings joined by circumferential welds.

7.3.9.2 All welding shall be performed using procedures and welders that are qualified to Section 6 Welding.

7.3.9.3 Branch connections shall meet the design requirements in ASME/ANSI B31.4, paragraphs 404.3.1.

7.3.9.4 Prefabricated units, other than regularly manufactured butt welding fittings, which use plate and longitudinal seams shall be designed, constructed, and tested under requirements of the ASME BPV Code.

7.3.9.5 Every prefabricated unit produced under this part shall be hydrotested to a pressure equal to the test pressure for the system in which the unit will be installed. For installation in existing facilities, the fabricated unit shall withstand a leak test at the operating pressure of the line.

7.4 PIPE

7.4.1 Metallic Pipe

7.4.1.1 New pipe which has been purchased to specifications in the Material Standards, Table 423.1, ASME/ANSI B31.4 may be used in Company projects when subjected to the hydrostatic and leak testing requirements of paragraphs 437.1.4, 437.4.1, and 437.4.3.

7.4.1.2 Used pipe of known specifications listed in the Material Standards, ASME/ANSI B31.4, Table 423.1 may be used in the design and

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construction of Company pipelines if the used pipe passes the testing requirements of ASME/ANSI B31.4 paragraph 437.4.1 (Hydrostatic Testing), 437.6.1 (Visual Examination), 437.6.3 (Determination of Wall Thickness), and 437.6.4 (Determination of Weld Joint Factor).

7.4.1.3 New or used pipe of unknown or ASTM A120 specification may be used to design and construct Company pipelines when:

7.4.1.3.1 The allowable stress value is unknown and the testing requirements in ASME/ANSI B31.4 paragraphs 437.4.1 (Hydrostatic Testing After Construction), 437.4.3 (Leak Testing After Construction), 437.6.1 (Visual Examination), 437.6.3 (Determination of Wall Thickness), 437.6.4 (Determination of Weld Joint Factor), and 437.6.5 (Weldability) are used to establish a 24,000 psi (165 MPa) yield strength.

7.4.1.3.2 If a yield strength above 24,000 psi (165 Mpa) is used to establish an allowable stress value, the testing requirements in ASME/ANSI B31.4 paragraphs 437.4.1 (Hydrostatic Testing After Construction) and paragraphs 437.6.1 (Visual Examination), 437.6.2 (Bending Properties), 437.6.3 (Determination of Wall Thickness), 437.6.4 (Determination of Weld Joint Factor), 437.6.5 (Weldability), 437.6.6 (Determination of Yield Strength), and 437.6.7 (Minimum Yield Strength Value) must be met.

7.4.1.4 Pipe which has been cold worked in order to meet the specified minimum yield strength and is subsequently heated to 600°F (300°C) or higher shall be limited to 75% of the stress value as determined by allowable stress limits in the design equation.

7.4.1.5 External or internal coatings or linings of cement, plastics, or other materials may be used on steel pipe conforming to the requirements of the Code and this specification. These coatings and linings shall not be considered to add strength to the pipe.

7.5 FITTINGS, ELBOWS, BENDS, AND INTERSECTIONS

7.5.1 Steel Butt Welding Fittings.

7.5.1.1 Steel butt welding fittings shall comply with either ASME/ANSI B16.9 or MSS SP-75 and shall have pressure/temperature ratings based on stresses for pipe of the same or equivalent material. The actual bursting strength of fittings shall equal the computed bursting strength of pipe of designated material and wall thickness. Mill hydrotesting is not required for steel butt welding fittings, but the fittings must be capable of withstanding a field pressure test to the manufacturer's test pressure.

7.5.1.2 The minimum metal thickness of flanged or threaded fittings shall not be less than specified for the pressures and temperatures in the applicable American National Standards or the MSS Standard Practice.

7.5.1.3 Steel socket-welding fittings shall comply with ASME/ANSI B16.11.

7.5.1.4 Ductile iron flanged fittings shall comply with the requirements of ASME/ANSI B16.42 or ASME/ANSI A21.14.

7.5.2 Bends, Miters, and Elbows.**7.5.2.1 Bends Made From Pipe**

7.5.2.1.1 Bends may be made by bending the pipe when the bends are designed and made in accordance with the requirements in this plant engineering specification and ASME/ANSI B31.4.

7.5.2.1.2 Field bends may be made on pipe in sizes NPS 14 and larger to a minimum radius of 18D and meet the requirements in this plant engineering specification and ASME/ANSI B31.4. The success of these bending operations are dependent on wall thickness, ductility, ratio of pipe diameter to wall thickness, use of bending mandrel, and skill of bending crew. Test bends shall be made to determine

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that the field bending procedure meets the requirements in this plant engineering specification and ASME/ANSI B31.4.

7.5.2.1.3 The maximum degree of field cold bends in pipe sizes NPS 12 and larger may be determined by the table in paragraph 406.2.1 (b), ASME/ANSI B31.4. Field cold bends may be made with a shorter radius provided all other requirements of the section are met. Wall thickness after bending shall meet minimum requirements of the specification. Circumferential welds in the bend section shall be radiographed.

7.5.2.2 Mitered Bends. Mitered bends are prohibited on all Company pipelines which may require an instrumented pig run in the future. Deflections up to 3 degrees which are caused by misalignment at makeup are not considered miter bends.

7.5.2.3 Factory Made Bends and Elbows.

7.5.2.3.1 Factory made elbows in cross-country pipelines must be formed with a minimum 5D radius to permit unrestricted passage of instrumented pigs.

7.5.2.3.2 Factory-made bends and factory-made wrought-steel elbows may be installed if these components meet all requirements of this plant engineering specification and ANSI/ASME B31.4. These factory made fittings shall have essentially the same mechanical properties and chemical composition as the pipe material.

7.5.2.4 Wrinkle Bends. Wrinkle bends are prohibited on all Company pipelines.

7.5.3 Couplings

Cast, malleable, or wrought iron threaded couplings are prohibited.

7.5.4 Reductions

7.5.4.1 Reductions in line size may be made by the use of smoothly contoured reducers selected in accordance with ASME/ANSI B16.5,

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ASME/ANSI B16.9, or MSS SP-75, or designed as required in the Code.

7.5.4.2 Orange Peel Swages. Orange peel swages are prohibited on all Company pipelines.

7.5.5 Intersections

Intersection fittings and welded branch connections are permitted within the limitations in this Company specification and ASME/ANSI B31.4.

7.5.6 Closures

7.5.6.1 Quick Opening Closures

7.5.6.1.1A quick opening closure is a pressure-containing component which is used for repeated access to the interior of a piping system. Pig trap launcher and receiver barrel closures are examples of quick opening closures. It is not the intent to impose the requirements of a specific design method on the designer and manufacturer of a quick opening closure.

7.5.6.1.2Quick opening closures shall have pressure and temperature ratings equal to, or in excess of the design requirements for the piping system in which it will be installed.

7.5.6.1.3Quick opening closures shall be equipped with safety locking devices in compliance with paragraph UG-35(b), Section VIII, Division 1, ASME BPV Code.

7.5.6.1.4Weld end preparation shall be in accordance with Section 6 of this plant engineering specification and ASME/ANSI B31.4.

7.5.6.2 Closure Fittings

Weld-cap closure fittings shall be designed and manufactured in accordance with ASME/ANSI B16.9 or MSS SP-75.

7.5.6.3 Closure Heads

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7.5.6.3.1 Closure heads such as flat, ellipsoidal, spherical, or conical heads are allowed for use. Heads will be designed in accordance with Section VIII, Division 1, BPV Code. The maximum allowable stresses for materials used in these closure heads shall not exceed 50% SMYS.

7.5.6.3.2 Welds in the construction of closure heads shall be 100% inspected with the requirements in Sections V, VIII, and IX, ASME BPV Code.

7.5.6.3.3 Pressure and temperature ratings for closure heads shall be equal to or greater than the design pressure of the pipeline.

7.5.6.4 Fabricated Closures

7.5.6.4.1 Orange-peel bull plugs and orange-peel swages are prohibited on Company hazardous liquid pipelines.

7.5.6.4.2 Flat closures on pipe larger than NPS 3 shall be designed in accordance with Section VIII, Division 1, ASME BPV Code.

7.5.6.5 Bolted Blind Flange Connections

Bolted blind flanges connections shall conform to bolting requirements in this plant engineering specification and the Code.

7.6 VALVES AND PRESSURE REDUCING DEVICES**7.6.1 General**

7.6.1.1 Valves shall conform to standards and specifications in Tables 423.1, Materials Standards, and Table 426.1, Dimensional Standards, ASME/ANSI B31.4 and ANSI/ASME B31.8 and shall be used only in accordance with the service recommendations of the manufacturer.

7.6.1.2 Valves manufactured in accordance with the following standards may be used in Company pipeline systems:

1. ANSI B16.34 Steel Valves

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2. API 6D

Pipeline Valves

7.6.1.3 Valves having shell (body, bonnet, cover, and/or end flange) components made of cast ductile iron in compliance with ASTM A395 and having dimensions conforming to ASME/ANSI B16.34 and API 6D may be used at pressures not exceeding 80% of the pressure ratings for comparable steel valves at their listed temperature provided operating pressure is less than 1000 psi and no welding has been performed in the valve fabrication.

7.6.1.4 Threaded valves shall be threaded according to API 5L or ANSI B1.20.1.

7.6.2 Pressure reducing devices shall conform to the requirements for valves in comparable service conditions.

7.6.3 Special Valves

Special valves not listed in ASME/ANSI Tables 423.1 and 426.1 shall be permitted, provided that their strength and tightness is equivalent and the valves can withstand the same test requirements as covered in the listed standards. Structural features must satisfy the material specification and test procedures of valves in similar service as shown in the listed standards.

7.7 FLANGES, FACINGS, GASKETS, AND BOLTING

7.7.1 General

Flanged connections shall conform to the requirements of ASME/ANSI B31.4 paragraphs 408.1(Sizes, Materials, Dimensions, Rectangular Cross Section), 408.3 (Facings), 408.4 (Gaskets), and 408.5 (Bolting).

7.7.2 Flange Types and Facings

7.7.2.1 The dimensions and drilling for all line or end flanges shall conform to one of the following standards:

- (a) ASME/ANSI B16.5 Steel Pipe Flanges and
Flanged Fittings
- (b) MSS SP-44 Steel Pipe Line Flanges

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7.7.2.2 The following classes of flanges are permitted with certain restrictions (See Paragraph 408.1.1, Flanges, ASME/ANSI B31.4):

1. Integrally cast or forged flanges for pipe, fittings, or valves
2. Threaded flanges
3. Lapped companion flanges
4. Slip-on flanges
5. Welding neck flange
6. Reducing flanges

7.7.2.3 Cast iron flanges are prohibited, except those which are an integral part of cast iron valves, pressure vessels, and other equipment and proprietary items.

7.7.2.4 Cast iron, ductile iron, and steel flanges shall have contact faces finished in accordance with ASME/ANSI B16.5 or MSS SP-6.

7.7.2.5 Nonferrous flanges shall have contact faces finished to ASME/ANSI B16.34.

7.7.3 Gaskets

7.7.3.1 Standard Gaskets.

7.7.3.1.1 Materials for gaskets shall be corrosion resistant to the full range of corrodents in the fluid and shall be capable of maintaining its physical and chemical properties at any service temperature.

7.7.3.1.2 Gaskets conforming to ASME/ANSI B16.5 or ASME/ANSI B16.21 may be used.

7.7.3.1.3 Metallic gaskets other than ring type shall not be used with ASME/ANSI Class 150 or lighter flanges.

7.7.3.1.4 Gaskets used under pressure and at temperatures above 250°F shall be of noncombustible material. Metallic gaskets shall not be used with Class 150 standard or lighter flanges.

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7.7.3.1.5 Asbestos composition gaskets are prohibited on Company pipelines.

7.7.3.1.6 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. The width of the gasket for small male and female or for tongue and groove joints shall be equal to the width of the male face or tongue.

7.7.3.1.7 Rings for ring joints shall be of dimensions established in ASME/ANSI B16.20. The material for these rings shall be suitable for the service conditions encountered and shall be softer than the flanges.

7.7.3.2 Insulating Gaskets. The insulating gasket material shall be suitable for the pressure, temperature, moisture, corrosives, and other environmental conditions where it will be used. Insulating gaskets shall be purchased as an integral package with the insulation sleeves for the flange bolting material. Gasket, sleeve material and dimension specifications shall be provided by the Company corrosion engineer.

7.7.4 Bolting

7.7.4.1 General

7.7.4.1.1 Bolts or stud bolts shall extend completely through the nuts.

7.7.4.1.2 Nuts shall meet the specifications in ASTM A194 or A325, except that A307 Grade B nuts may be used on ANSI Class 150 and ANSI Class 300 flanges.

7.7.4.2 Bolting for Steel Flanges. Bolting shall conform to ASME/ANSI B16.5.

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7.7.4.3 Bolting for Insulating Flanges. For insulating flanges, 1/8 in. (3 mm) undersize bolting may be used if the alloy-steel bolting material conforms to ASTM A193 or A354 standards.

7.7.4.4 Bolting Steel Flanges to Cast Iron Flanges. Class 150 steel flanges may be bolted to Class 125 cast iron flanges. When such construction is used, the 1/16 in. 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 carbon steel equivalent to ASTM A307 Grade B without heat treatment other than stress relief. When bolting such flanges together using a full-face gasket, the bolting may be alloy steel (ASTM A193).

7.7.4.5 Bolting for Special Flanges. For special design flanges, bolting shall meet the specifications in the applicable section of Section VIII, Division 1, ASME Boiler and Pressure Vessel Code.

7.7.4.6 Forged steel welding neck flanges having an outside diameter and drilling the same as ASME/ANSI B16.1, but with modified flange thickness, hub dimensions, and special facing details, may be used to bolt against flat faced cast iron flanges and may operate at the pressure-temperature ratings given in ASME/ANSI B16.1 for Class 125 cast iron pipe flanges, provided:

7.7.4.6.1 The minimum flange thickness T is not less than that specified for light-weight flanges,

7.7.4.6.2 Flanges are used with nonmetallic full-face gaskets extending to the periphery of the flange, and/or

7.7.4.6.3 The joint design has been proven by test to be suitable for the ratings.

7.7.4.7 Ductile iron flanges shall conform to the requirements of ASME/ANSI B16.42. Bolting requirements for ductile iron flange joints shall be the same as carbon and low alloy steel flanges.

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7.7.4.8 All carbon and alloy-steel bolts, studbolts, and their nuts shall be threaded in accordance with the following thread series and dimension classes as required by ASME/ANSI B1.1.

7.7.4.8.1 All carbon-steel bolts and studbolts shall have coarse threads, Class 2A dimensions, and their nuts with Class 2B dimensions.

7.7.4.8.2 All alloy-steel bolts and studbolts of 1 in. and smaller diameter shall be of the coarse-thread series: nominal diameters 1-1/8 inch and larger shall be 8-thread series. Bolts and studbolts shall have 2A dimensions: nuts shall have 2B dimensions.

7.7.4.9 Bolts shall have American Standard regular square heads or heavy hexagonal heads and shall have American National Standard heavy hexagonal nuts conforming to the dimensions of ASME/ANSI B18.2.1 and B18.2.2.

7.8 USED PIPING COMPONENTS AND EQUIPMENT

Used piping components such as pipe, fittings, elbows, bends, intersections, couplings, reducers, closures, flanges, valves, and equipment may be reused. Pipe, piping components, and equipment intended for reuse shall be cleaned, inspected, and reconditioned, if necessary, to insure that all requirements are met for the intended service and that the equipment is sound and free from defects.

7.8.1 Reuse of piping components shall be contingent on identification of the specification under which the item was originally produced. If the specification cannot be identified, reuse shall be restricted to a maximum allowable operating pressure based on a yield strength of 24,000 psi (165 Mpa) or less.

7.9 SELECTION AND LIMITATION OF PIPING JOINTS

7.9.1 Welded Joints

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Butt welded joints shall be completed in accordance with Chapter V, ASME/ANSI B31.4 and Section 6 of this plant engineering specification.

7.9.2 Flanged Joints

Flanged joints shall meet the requirements of paragraph 408, ASME/ANSI B31.4

7.9.3 Threaded Joints

7.9.3.1 All external pipe threads on piping components shall be taper pipe threads with line pipe threads corresponding to API 5B, or NPT threads in accordance with ANSI/ASME B1.20.1. All internal pipe threads on piping components shall be taper pipe threads. NPS 2 and smaller with design gage pressures not exceeding 150 psi (10 bar) may use straight threads.

7.9.3.2 Least nominal wall thickness for threaded pipe shall be standard wall.

7.9.4 Sleeves, Coupled, and Other Patented Joints

Steel connectors and swivels complying with API 6D may be used. Sleeves, couples, and other patented joints may used provided:

7.9.4.1 A prototype joint has been subject to proof tests to determine the safety of the joints under simulated service conditions. When vibration, fatigue, cyclic conditions, low temperature, thermal expansion, or other severe conditions are expected, the applicable conditions shall be part of the tests.

7.9.4.2 Adequate provision shall be made to prevent separation of the joint and to prevent longitudinal or lateral movement beyond the limits in the joining member.

7.10 EXPANSION AND FLEXIBILITY**7.10.1 General**

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7.10.1.1 This section is applicable to above ground piping only and covers all classes of materials permitted by ASME/ANSI B31.4 up to 450° F. Formal calculations shall be required where reasonable doubt exists as to the flexibility of the system.

7.10.1.2 Piping shall be designed to have sufficient flexibility to prevent excessive stresses in the piping material, excessive bending moments at joints, or excessive forces or moments at points of connection to equipment or at anchorage or guide points. There are fundamental differences in loading conditions for buried, or similarly restrained, portions of pipelines and the aboveground sections not subject to substantial axial restraint. Different limits on allowable longitudinal expansion stresses are necessary to account for these differences.

7.10.1.3 Expansion of aboveground lines may be prevented by anchoring methods. Longitudinal expansion or contraction due to thermal and pressure changes is absorbed by direct axial compression or tension of the pipe; the same as buried pipe. Beam bending stresses shall be included and the possible elastic instability of the pipe and its supports due to longitudinal compressive forces shall be considered.

7.10.2 Flexibility

Means of Providing Flexibility. If expansion is not absorbed by direct axial compression of the pipe, flexibility shall be provided, preferably, by the use of bends, loops, or offsets. Alternatively, but less desirable, thermal strain can be absorbed by expansion joints or couplings of the slip joint, ball joint, or 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.

Amount of Expansion. Expansion calculations are necessary for buried piping if significant temperature changes are expected. Thermal expansion of buried lines may cause movement at points where the line terminates, changes in direction, or changes in size. If these movements cannot be restrained by anchors, the necessary flexibility must be designed into the system.

7.10.3 Properties

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7.10.3.1 Coefficient of Thermal Expansion. The linear coefficient of thermal expansion for carbon and high-strength low-alloy (HSLA) steel may be taken as 6.5×10^{-6} in./in./ $^{\circ}$ F for temperatures up to 250 $^{\circ}$ F (11.7×10^{-6} mm/mm/ $^{\circ}$ C for temperatures up to 120 $^{\circ}$ C).

7.10.3.2 Modulus of Elasticity. The modulus of elasticity for low-carbon steel at ambient conditions is approximately 29×10^6 psi.

7.10.3.3 Poisson's Ratio. Poisson's ratio shall be taken as 0.3 for steel.

7.11 LOADS ON PIPE-SUPPORTING ELEMENTS

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

7.12 DESIGN OF PIPE SUPPORTING ELEMENTS

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

7.12.2 Braces and damping devices may occasionally be required to prevent vibration of piping.

7.12.3 All attachments to the pipe shall be designed to minimize the added stresses in the pipe wall due to the attachment. Nonintegral attachments, such as pipe clamps and ring girders, are preferred where these assemblies will fulfill the supporting or anchoring functions.

7.12.4 If pipe is designed to operate at or close to its allowable stress, all connections welded to the pipe shall be made to a separate cylindrical member which completely encircles the pipe. The encircling member shall be welded to the pipe by continuous circumferential welds.

7.12.5 Applicable sections of MSS SP-58 (materials and design of pipe hangers and supports) and MSS SP-69 (selection and application of pipe hangers and supports) may be used.

7.13 COMBINED STRESS CALCULATIONS

7.13.1 Restrained Pipelines.

7.13.1.1 The net longitudinal compressive stress due to the combined effects of temperature rise and fluid pressure shall be computed by the equation:

$$S_L = E\alpha(T_2 - T_1) - \nu S_h$$

where S_L = longitudinal compressive stress, psi
(Mpa)

S_h = hoop stress due to fluid pressure, psi
(Mpa)

T_1 = temperature at time of installation, $^{\circ}\text{F}$
($^{\circ}\text{C}$)

T_2 = maximum or minimum operating
temperature, $^{\circ}\text{F}$ ($^{\circ}\text{C}$)

E = modulus of elasticity of steel, psi
(Mpa)

α = linear coefficient of thermal
expansion, in./in./ $^{\circ}\text{F}$ (mm/mm/ $^{\circ}\text{C}$)

ν = Poisson's ratio = 0.30 for steel

7.13.1.2 Note the net longitudinal stress becomes compressive for moderate increases of T_2 . This compressive stress adds directly to the hoop stress to increase the equivalent tensile stress available to cause yielding.

7.13.1.3 The equivalent tensile stress shall not be allowed to exceed 90% SMYS, calculated for nominal pipe wall thickness. Beam bending stresses shall be included in the longitudinal stress for those portions of the restrained line which are supported aboveground.

7.13.2 Unrestrained Lines.

7.13.2.1 Stresses due to expansion for those portions of the piping without substantial axial restraint shall be combined in accordance with the following equation:

$$S_E = (S_b^2 + 4S_t^2)^{1/2}$$

where S_E = stress due to expansion

$S_b = [(i_i M_i)^2 + (i_o M_o)^2] / Z$ = equivalent bending stress, psi (Mpa)

M_i = bending moment in plane of member (for members having significant orientation, such as elbows or tees; for tees the moments in the header and branch portions are to be considered separately), in.-lb. (N-m)

M_o = bending moment out of, or transverse to, plane of member, in.-lb. (N-m)

M_t = torsional moment, in.-lb. (N-m)

i_i = stress intensification factor under bending in plane of member [See Figure 419.6.4(c), Flexibility Factor k and Stress Intensification Factor I , ASME/ANSI B31.4]

i_o = stress intensification factor under bending out of, or transverse to, plane of member [See Figure 419.6.4(c), ASME/ANSI B31.4]

Z = section modulus of pipe, in.³ (cm³)

7.13.2.2 The maximum computed stress range (S_E) without regard for fluid pressure stress, based on 100% of the expansion, with modulus of elasticity for the cold condition shall not exceed 72% SMYS.

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7.13.2.3 The sum of longitudinal stresses due to pressure, weight, and other sustained external loadings shall not exceed 54% SMYS (75% x 0.72).

7.13.2.4 The sum of longitudinal stresses produced by pressure, live and dead loads, such as wind or earthquake, shall not exceed 80% SMYS. It is not necessary to consider wind and earthquake to occur at the same time.

7.13.3 Analysis - Basic Assumptions and Requirements

7.13.3.1 The effects of restraints, such as support friction, branch connections, lateral interference, etc. shall be considered in the stress calculations.

7.13.3.2 Calculations shall consider stress intensification factors found to exist in components other than plain straight pipe. Credit may be taken for extra flexibility of such components. In the absence of more directly applicable data, the flexibility factors and stress intensification factors shown in ASME/ANSI B31.4 Figure 419.6.4 (c) may be used.

7.13.3.3 Nominal dimensions of pipe and fittings shall be used in flexibility calculations.

7.13.3.4 Calculations of pipe stresses in loops, bends, and offsets shall be based on the total range from minimum to maximum temperatures. The linear and angular movements of the equipment which are connected to the piping system shall be evaluated.

7.13.3.5 Calculations of thermal forces and moments on anchors and equipment such as pumps, meters, and heat exchangers shall be based on the difference between installation temperature and maximum operating temperature.

8 CONSTRUCTION, ASSEMBLY, AND FABRICATION**8.1 CONSTRUCTION**

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8.1.1 General

New construction, replacement, and maintenance repair of existing systems shall be in accordance with the requirements of this Plant Engineering specification and Chapter V, ASME/ANSI B31.4.

8.1.2 Construction Specifications

All work completed in accordance with this specification will require complete construction specifications which includes this specification, ASME/ANSI B31.4, and 49CFR195. The construction specifications shall cover all phases of the work and shall be in sufficient detail to cover the requirements in the above codes. Construction specifications shall include, but are not limited to, specific details on handling of pipe, equipment, materials, welding, and all construction factors which contribute to safety and sound engineering practice.

8.1.3 Inspection Provisions

8.1.3.1 Company will provide complete inspection coverage for all pipeline construction and maintenance projects. Inspectors will be qualified by both experience and training. Minimum qualifications for inspectors shall be the same qualifications as API 570, "Inspection, Repair, Alteration, and Rerating of In-Service Systems". These requirements include:

8.1.3.1.1 A degree in engineering plus one year of experience in the design, construction, repair, operation, or inspection of piping systems.

8.1.3.1.2 A 2-year certificate in engineering or technology from a technical college plus 2 years of experience in the design, construction, repair, operation, or inspection of piping systems.

8.1.3.1.3 The equivalent of a high school education plus 3 years of experience in the design, construction, repair, operation, or inspection of piping systems.

8.1.3.1.4 Five years of experience inspecting in-service piping systems.

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8.1.3.2 Piping inspection for Company construction projects shall insure quality workmanship with frequent on-site visits. Major responsibilities include:

8.1.3.2.1 Inspect surface of pipe for serious surface defects prior to coating operation.

8.1.3.2.2 Inspect surface of pipe coating prior to lowering-in.

8.1.3.2.3 Inspect fitup of joints prior to welding.

8.1.3.2.4 Inspect root bead prior to first hot pass.

8.1.3.2.5 Inspect completed welds prior to coating.

8.1.3.2.6 Inspect condition of ditch bottom prior to lowering in.

8.1.3.2.7 Inspect fit of pipe in ditch before backfilling.

8.1.3.2.8 Inspect all repairs, replacements, or changes prior to backfilling.

8.1.3.2.9 Supervise and approve nondestructive testing of welds and electrical testing of coating.

8.1.3.2.10 Inspect backfill material prior to use and observe backfill procedure to assure no damage to the coating during backfilling.

8.1.4 Right of Way

Right-of-way objectives include:

8.1.4.1 Minimize the possibility of hazard from future industrial or urban development or encroachment of the right of way.

8.1.4.2 Combine right of way considerations with route selection to minimize present environmental and physical concerns.

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8.1.4.3 Obtain right of way and associated permits.

8.1.4.4 Survey and stake right of way with marking maintained during construction.

8.1.4.5 Clear right of way and remove rocks, vegetation, etc. with minimum damage to the land, prevention of abnormal drainage and soil erosion.

8.1.4.6 Grade right of way immediately after clearing operations.

8.1.4.7 Construct roadway capable of supporting all vehicles and wide enough to allow space for the largest sideboom tractor.

8.1.4.8 Maintain signs, lights, guard rails, etc. in the interest of public safety in constructing pipeline crossings of railroads, highways, streams, lakes, and rivers.

8.1.4.9 Return right of way to "cleared" condition after construction.

8.1.5 Handling, Hauling, Stringing, and Storing

Care shall be exercised in the handling or storing of pipe, casing, coating materials, valves, fittings, and other materials to prevent damage. Adequate precautions shall be taken to damage to yard or mill coatings when hauling, lifting, and placing on the right of way. Pipe shall not be allowed to drop and strike objects which will distort, dent, flatten, gouge, or notch the pipe or damage the coating. Suitable and safe equipment shall be used to lift or lower the coated pipe.

8.1.6 Damage to Fabricated Items and Pipe

8.1.6.1 Fabricated items such as scraper traps, manifolds, pressure vessels, etc. shall be inspected before assembly into the mainline or manifold. Defects shall be repaired in accordance with provisions of the standard or specification applicable to manufacture.

8.1.6.2 Pipe shall be inspected before coating and before assembly into the mainline or manifold. Distortion, buckling, denting, flattening,

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gouging, grooves, notches, and other defects shall be repaired as follows:

8.1.6.2.1Injurious gouges, grooves, or notches shall be removed. These defects may be repaired by the use of weld procedures in API 5L. The defects may be removed by grinding provided the wall thickness is not less than permitted by the governing pipe material specification.

8.1.6.2.2The damage shall be removed as a cylinder if the conditions in the above paragraph cannot be met. Insert patching is prohibited. Weld-on patching, except full encirclement, is not permitted in pipelines intended to operate at a hoop stress of more than 20% SMYS of the pipe.

8.1.6.2.3Notches or laminations on pipe ends shall not be repaired. The damaged end shall be removed as a cylinder and the pipe end properly rebeveled.

8.1.6.2.4Distorted or flattened lengths shall be discarded.

8.1.6.2.5A dent (as opposed to a scratch, gouge, or groove) may be defined as a gross disturbance in the curvature of the pipe wall. A dent containing a stress concentrator, such as a scratch, gouge, groove, or arc burn, shall be removed by cutting out the damaged portion of the pipe as a cylinder.

8.1.6.2.6All dents which affect the curvature of the pipe at a seam or at any girth weld shall be removed as in 8.1.6.2.5 above. All dents which exceed a maximum depth of 1/4 in. (6 mm) in pipe NPS 4 and smaller, or 6% of the nominal pipe diameter in sizes greater than NPS 4, shall not be permitted in pipelines intended to operate at a hoop stress of more than 20% SMYS. Insert patching, weld overlay, or pounding out dents shall not be permitted in pipelines intended to operate at a hoop stress more than 20% SMYS.

8.1.6.2.7Buckled pipe shall be replaced as a cylinder.

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8.1.7 Ditching

8.1.7.1 Depth of ditch shall be appropriate for the route location, surface use of the land, terrain features, and loads imposed by roadways and railroads. All buried pipelines shall be installed below the normal level of cultivation and with a minimum cover not less than the following table:

<u>Location</u>	<u>Normal Excavation</u>
Industrial, commercial, and residential areas	36 in. (0.9m)
River and stream crossings	48 in. (1.2m)
Drainage ditches at roadways and railroads	36 in. (0.9m)
All other areas	30 in. (0.75m)

***If the cover requirements in the above table cannot be met, pipe may be installed with less cover if additional protection is provided to withstand anticipated external loads and to minimize damage to the pipe by external forces.

8.1.7.2 Width and grade of ditch shall provide clearance for lowering of the pipe into the ditch to minimize damage to the coating and to facilitate fitting the pipe to the ditch.

8.1.7.3 Location of underground structures intersecting the ditch route shall be determined prior to construction activities to prevent or minimize damage to foreign structures. A minimum clearance of 12 in. (0.3m) shall be maintained between the outside of any buried pipe or component and the extremity of any other underground structures.

8.1.7.4 Ditching operations shall follow good pipeline practice and consideration of public safety. API RP 1102 will provide additional guidance.

8.1.8 Bends, Elbows, and Miters in Steel Pipelines

8.1.8.1 Changes in direction and elevation may be made by the use of bends and elbows. Design requirements for bends and elbows are provided in Section 7, Design, in this specification.

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8.1.8.2 Wrinkle and miter bends are not allowed on Company pipelines.

8.1.8.3 The maximum degree of field cold bends in pipe sizes NPS 12 and larger may be determined by the table in paragraph 404.2.1, ASME/ANSI B31.4. Field cold bends may be made with a shorter radius provided all other requirements of the section are met. Wall thickness after bending shall meet minimum requirements of the specification. Circumferential welds in the bend section shall be radiographed.

8.1.9 Welding

All welding requirements are summarized in Section 6, Welding, of this specification and paragraph 434.8, Welding, ASME/ANSI B31.4.

8.1.10 Tie In

Gaps left in the continuous line construction at river, canal, highway, or railroad crossings require special consideration for alignment and welding. Sufficient equipment shall be available and care exercised not to force or strain the pipe to proper alignment.

8.1.11 Installation of Pipe in Ditch

8.1.11.1 Lowering of the pipe into the ditch shall be permitted only when a Company Pipeline Inspector is on location. Special emphasis will be placed on pipe condition before and after lowering, and the overall condition of the ditch.

8.1.11.2 Stresses induced into the pipe during construction must be minimized. Pipe shall lay in the ditch with minimum application of outside forces.

8.1.12 Backfilling

8.1.12.1 Backfilling shall be performed to provide firm, continuous support under the pipe.

8.1.12.2 When backfilling with material containing rocks, no rocks shall be closer to the pipe than 12 inches. A "rock-free" cylinder of sand or dirt shall be placed around the pipe maintaining the required 12

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inches of small-particle backfill material. In addition, rock shield are required when the backfill material contains rocks over 4 inches in diameter.

8.1.13 Hot Taps

All hot taps shall be installed by trained and experienced crews in accordance with Company Safety and Health Standards and written engineering specifications and procedures which are unique for each job.

8.1.14 Restoration of Right of Way and Cleanup

These operations shall follow good construction practices and considerations of private and public safety. Cleanup includes removal and disposition of refuse and surplus materials from the right-of-way. Also included in cleanup is leveling the right of way by filling deep ruts and removing or leveling mounds of earth.

8.1.15 Special Crossings**8.1.15.1 Protection of Pipelines From Hazards**

Pipelines which must be installed in locations where high loading may occur due to natural hazards shall be constructed with increased wall thickness, moving soil containment, erosion prevention, and weight/ anchor installation.

8.1.15.2 Water Crossings

Water crossings including underwater construction are covered in paragraph 434.13.1, ASME/ANSI B31.4.

8.1.15.3 Overhead Structures

Overhead structures used to suspend pipelines shall be designed and constructed with good engineering practices and within the restrictions and/or regulations of the governing body with jurisdiction for the pipeline. Detailed plans and specifications shall be prepared. Adequate inspection shall be provided to assure complete adherence to the construction specifications.

8.1.15.4 Bridge Attachments

The use of higher strength light-weight pipe, proper design and installation of hangers, and special protection to prevent damage by

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the elements of bridge and approach traffic shall be considered. Any agreed upon restrictions or precautions shall be contained in the detailed job specifications. Inspectors shall assure the Company that these requirements are met.

8.1.15.5 Railroad and Highway Crossings

8.1.15.5.1 Safety of the general public and the prevention of damage to the pipeline by reason of its location are primary considerations. Construction specifications shall cover the procedure for these crossings based upon the requirements of the specific location.

8.1.15.5.2 Installation of uncased carrier pipe is preferred. Installation of carrier pipe, or casing if used, shall be in accordance with API RP 1102. If casing is used, coated carrier pipe shall be independently supported outside each end of the casing and insulated from the casing throughout the cased section. Casing ends shall be sealed using a durable, electrically nonconductive material in the annular space between the casing and pipe.

8.1.15.5.3 The sum of the circumferential stresses due to internal design pressure and external load for pipe installed under railroads and highways without use of casing shall not exceed the allowable circumferential stresses summarized in paragraph 402.3.2, ASME/ANSI B31.4.

8.1.16 Block and Isolating Valves**8.1.16.1 General**

8.1.16.1.1 Block and isolating valves shall be installed for limiting hazard and damage from accidental discharge and for facilitating maintenance of the piping systems.

8.1.16.1.2 Valves shall be located at accessible points on the pipeline, protected from damage or tampering, and suitably supported to prevent differential settlement or movement of the

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attached piping. An operating device to open or close the block valve shall be protected and accessible only to authorized persons.

8.1.16.2 Mainline Valves

8.1.16.2.1 Mainline block valves shall be installed on the upstream of major river crossings and public water supply reservoirs. Either a block or check valve shall be installed on the downstream side of major river crossings and public water supply reservoirs.

8.1.16.2.2 A mainline block valve shall be installed at mainline pump stations. A block or check valve shall be installed at other locations appropriate for the terrain features. In industrial, commercial, and residential areas where construction activities pose a particular risk of external damage to the pipeline, provisions shall be made for the appropriate spacing and location of mainline valves consistent with the type of liquids being transported.

8.1.16.2.3 A remotely operated mainline block valve shall be provided at remotely controlled pipeline facilities to isolate segments of the pipeline.

8.1.16.3 Pump Station, Tank Farm, and Terminal Valves

8.1.16.3.1 Valves shall be installed on the suction and discharge of pump stations to assure the pipeline can be isolated from the pump station.

8.1.16.3.2 Valves shall be installed on lines entering or leaving tank farms or terminals at convenient locations. The tank farm or terminal may then be isolated from other facilities such as the pipeline, manifolds, or pump stations.

8.1.17 Connections to Main Lines

Where connections to the main line such as branch lines, jump-overs, relief valves, air vents, etc. are made to the main pipeline, these components shall

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be installed in accordance with paragraph 404.3.1, ANSI B31.4 and Branch Connection paragraph in Section 7 of this Plant Engineering Specification. All damaged coating shall be removed and new coating shall be applied on the attachments as well as the pipeline coating that was removed for repair.

8.1.18 Scraper Traps

8.1.18.1 Scraper traps (pig receivers and launchers) shall be installed as required by Company Specifications, Plant Engineering Specifications and DOT Regulation 49CFR195. All pipe, valves, fittings, closures, and appurtenances shall comply with this Plant Engineering Specification, ASME/ANSI B31.4, and 49CFR195.

8.1.18.2 Scraper traps on pipelines shall be designed with sufficient length to run an instrument pig.

8.1.18.3 Receiver traps on mainlines which are connected to piping or manifolding shall be anchored below ground with adequate concrete anchors when required and suitably supported aboveground to prevent transmission of line stresses due to expansion and contraction to connecting facilities.

8.1.18.4 Scraper trap and components shall be assembled in accordance with paragraph 435, Assembly of Piping Components, ASME/ANSI B31.4.

8.1.19 Line Markers

Adequate pipeline location markers indicating caution for the protection of the pipeline, the public, and persons performing work in the area shall be installed over each pipeline during all construction activities. These location markers shall be installed on each side of roads, highways, railroads, and stream crossings. Markers with requirements of regulatory agencies shall be installed on each side of navigable stream crossings. API RP 1109 shall be used for guidance.

8.1.20 Corrosion Control

External and internal corrosion control shall be completed as required in Chapter VIII, Corrosion Control, ASME/ANSI B31.4, Company Specifications, Plant Engineering Specifications, and DOT 49CFR195.

8.1.21 Pump Station, Tank Farm, and Terminal Construction**8.1.21.1 General**

All construction work performed on DOT regulated piping systems associated with pump stations, tank farms, terminals and equipment installations shall be done under construction specifications. Specifications shall cover all phases of the contract work and shall be in sufficient detail to insure that the requirements of this Plant Engineering Specification, ASME/ANSI B31.4, and 49CFR195 shall be met. Construction specifications shall include specific details on soil conditions, foundations and concrete work, steel fabrication and building erection, piping, welding, equipment and materials, and all construction factors contributing to safety and sound engineering practice.

8.1.21.2 Location

Company pump stations, tank farms, or terminals shall be located when possible with safe distances from adjacent properties not under control of the Company to minimize the communication of fire from structures on adjacent properties. Similar consideration shall be given to its relative location from the station manifolds, tankage, maintenance facilities, personnel housing, etc. Sufficient open space shall be left around the building and manifolds to provide access for maintenance equipment and fire fighting equipment. Station, tank farm, and terminal shall be fenced to minimize trespass. Roadways and gates should be located to provide ready access to or egress from the facilities.

8.1.21.3 Building Installation

Buildings shall be located and constructed to comply with detailed plans and specifications. Excavation for and installation of foundations and erection of the building shall be done by craftsmen familiar with the respective phase of the work. All work shall be done in a safe and workmanlike manner. Inspection shall be provided to assure that the requirements of the plans and specifications are met.

8.1.21.4 Pumping Equipment and Prime Movers

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Installation of pumping equipment and prime movers shall be covered by detailed plans and specifications which have taken into account the variables inherent in local soil conditions, utilization, and arrangement of the equipment to provide the optimum in operating ease and maintenance access. Machinery shall be handled and mounted in accordance with recognized millwright practice and shall be provided with protective covers to prevent damage during construction. Manufacturer's recommendations concerning installation details for auxiliary piping, setting, and aligning shall be considered as minimum requirements.

8.1.21.5 Pump Station, Tank Farm, and Terminal Piping

All piping including, but not limited to, main unit interconnections, manifolds, scraper traps, etc. which can be subjected to mainline pressure shall be constructed in accordance with Plant Engineering Specifications (Section 6, Welding), corrosion control requirements in Company specifications, and ASME/ANSI B31.4.

8.1.21.6 Controls and Protective Equipment

Pressure controls and protective equipment, including pressure limiting devices, regulators, controllers, relief valves, and other safety devices as shown on the drawings or required by the specifications shall be installed by competent and skilled workmen. Installation shall be completed with careful handling and minimum exposure of instruments and devices to inclement weather conditions, dust, or dirt to prevent damage. Piping, conduits, or mounting brackets shall not cause the instruments or devices to be distorted or in any significant strain. Instruments and devices shall be installed to enable checks to be done without undue interruptions in operations. After installation, controls and protective equipment shall be tested under conditions approximating actual operations to assure proper installation and function.

8.1.22 Storage and Working Tankage**8.1.22.1 General**

All construction work performed on storage and working tankage and allied equipment, piping, and facilities shall be done under construction specifications. These specifications shall cover all

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phases of the work under contract and shall be in sufficient detail to insure that all requirements are met. Specifications shall include specific details on soil conditions, foundations and concrete work, tank fabrication and erection, piping, welding, equipment and materials, dikes, and all construction factors contributing to safety and sound engineering practices.

8.1.22.2 Location

8.1.22.2.1 Location requirements and considerations are identical to paragraph 8.1.21.2 above.

8.1.22.2.2 Spacing of tankage shall be governed by the requirements of ANSI/NFPA 30.

8.1.22.3 Tanks and Pipe-Type Storage

8.1.22.3.1 Tanks for storage or handling crude oil and liquid petroleum products and liquid alcohols having vapor pressures approximating atmospheric shall be constructed in accordance with ANSI/API 650, API 12B, API 12D, API 12F, or designed and constructed in accordance with accepted good engineering practices.

8.1.22.3.2 Tanks for storage or handling petroleum products and liquid alcohols having vapor gage pressures of 0.5 psi (0.035 bar) but not exceeding 15 psi (1 bar) shall be constructed in accordance with ANSI/API 620.

8.1.22.3.3 Tanks used for storage and handling liquids having vapor gage pressures greater than 15 psi (1 bar) shall be designed and constructed in accordance with design of accredited tank builders and the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 or 2.

8.1.22.4 Foundations

Tank foundations shall be constructed in accordance with plans and specifications which shall take into account local soil conditions, type of tank, usage, and general location.

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8.1.22.5 Dikes or Firewalls

Dikes and firewalls may be required for protection of the pipeline's station, tank farm, terminal or other facilities from damage by fire from adjacent facilities. Tank dikes and firewalls shall be constructed to meet the capacity requirements in ANSI/NFPA 30.

8.1.23 Electrical Installations**8.1.23.1 General**

Electrical installations for lighting, power, and control shall be covered by detailed plans and specifications. Installations shall be in accordance with codes applicable to the specific type of circuitry and classification of areas for electrical installation. Inspection shall be provided and all circuitry shall be tested before operation to assure that the installation was made in workmanlike manner to provide for the continuing safety of personnel and equipment. Installations shall be made in accordance with ANSI/NFPA 70 and API RP 500C.

8.1.23.2 Care and Handling of Materials

All electrical equipment and instruments shall be carefully handled and properly stored or enclosed to prevent damage, deterioration, or contamination during construction. Packaged components are not to be exposed during construction. Equipment susceptible to damage or deterioration by exposure to humidity shall be adequately protected by using appropriate means such as plastic film enclosures, desiccants, or electrical heating.

8.1.23.3 Installation

Installation of electrical materials shall be made by qualified personnel familiar with details of electrical aspects and code requirements for such installation. Care shall be exercised to prevent damage to the insulation of cable and wiring. Partially-complete installations shall be protected from damage during construction. Installation design and specifications shall give consideration to the need for dust and/or moisture-proof enclosures for special gear as relays, small switches, and electronic components. The frames of electric motors or other grounded electrical equipment shall not be used as the ground connection for electrical welding.

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8.1.24 Liquid Metering

8.1.24.1 Positive displacement meters, turbine meters, or equivalent liquid measuring devices and their proving facilities shall be designed and installed in accordance with the API Manual of Petroleum Measurement Standards.

8.1.24.2 Provisions shall be made to permit access to these facilities by authorized personnel only.

8.1.24.3 Assembly of the metering facility components shall be in accordance with paragraph 435, Assembly of Piping Components, ASME/ANSI B31.4.

8.1.25 Liquid Strainers and Filters

8.1.25.1 Strainers and filters shall be designed to the same pressure limitations and subjected to the same test pressures as the piping system in which the equipment is installed. Assemblies shall be supported to prevent undue loading on the connected piping system.

8.1.25.2 Installation and design shall provide for ease of maintenance and servicing without interference with the station operation.

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

8.1.25.4 Assembly of strainers or filters and their components shall be in accordance with paragraph 435, Assembly of Piping Components, ASME/ANSI B31.4

8.2 ASSEMBLY OF PIPING COMPONENTS**8.2.1 General**

Mechanically-complete piping construction shall conform to the requirements of this Plant Engineering Specification and ASME/ANSI B31.4.

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8.2.2 Bolting Procedure

8.2.2.1 All flanged joints shall be fitted up to assure gasket contact faces bear uniformly on the gasket. Bolts shall be made-up with uniform stress.

8.2.2.2 In bolting gasket flanged joints, the gasket shall be properly compressed in accordance with the design principles for the type of gasket used.

8.2.2.3 All bolts or studs shall extend completely through their nuts in the tightened condition.

8.2.3 Pumping Unit Piping

8.2.3.1 Piping to main pumping units shall be designed and supported to minimize stress or load in any component of the system.

8.2.3.2 Design and assembly shall consider the forces of expansion and contraction to minimize these effects within the assembly.

8.2.3.3 All valves and fittings on pumping units shall carry the same pressure ratings as required for pipeline operating pressures.

8.2.3.4 Welding shall be completed in accordance with Section 6 of this specification and paragraph 434.8, ASME/ANSI B31.4.

8.2.3.5 Bolting shall be completed in accordance with paragraph 8.2.2.

8.2.4 Manifolds

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

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

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8.2.4.3 Manifold headers with multiple outlets shall have outlets designed as covered in ASME/ANSI B31.4, paragraphs 404.3.1(b) and 404.3.1(e) as illustrated in Figures 404.3.1(b)(3) and 404.3.1(d)(2), respectively. Jigs may be used to assure alignment of outlets and flanges with other components. The fabricated unit shall be stress relieved, if required, before removal from the jig.

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

8.2.4.5 All welding on manifolds and headers shall conform to paragraph 434.8, ASME/ANSI B31.4.

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

9 INSPECTION AND TESTING

9.1 INSPECTION

9.1.1 General

Construction inspection provisions for pipelines and related facilities shall be adequate to assure compliance with the material, construction, welding, assembly, and testing requirements of this plant engineering specification, ASME/ANSI B31.4, and 49CFR195.

9.1.2 Qualification of Inspectors

9.1.2.1 Inspection personnel shall be qualified by training and experience. Authorized piping inspectors shall have education and experience equal to at least one of the following:

9.1.2.1.1A degree in engineering plus one year of experience in the design, construction, repair, operation, or inspection of piping systems.

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9.1.2.1.2A 2-year certificate in engineering or technology from a technical college plus 2 years of experience in the design, construction, repair, operation, or inspection of piping systems.

9.1.2.1.3 The equivalent of a high school education plus 3 years of experience in the design, construction, repair, operation, or inspection of piping systems.

9.1.2.1.4 Five (5) years of experience inspecting in-service piping systems.

9.1.2.2 Company inspection personnel shall be capable of performing the following inspection services:

9.1.2.2.1 Right of way and grading.

9.1.2.2.2 Ditching.

9.1.2.2.3 Line up and pipe surface inspection.

9.1.2.2.4 Welding.

9.1.2.2.5 Coating and cathodic protection.

9.1.2.2.6 Tie-in and lowering.

9.1.2.2.7 Backfilling and clean up.

9.1.2.2.8 Pressure testing.

9.1.2.2.9 Station construction

9.1.2.2.10 River crossings.

9.1.2.2.11 Electrical installation

9.1.2.2.12 Corrosion control (external and internal).

9.1.3 Type and Extent of Examination Required

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9.1.3.1 Visual**9.1.3.1.1 Material**

9.1.3.1.1.1 All piping components shall be visually inspected to insure that no mechanical damage has occurred during shipment and handling prior to being connected into the piping system.

9.1.3.1.1.2 All pipe shall be visually inspected to identify dents, grooves, gouges, notches, buckling, arc strikes, weld defects, laminations, split ends, and other pipe defects.

9.1.3.1.1.3 On systems where pipe is telescoped by grade, wall thickness, or both, particular care shall be taken to insure proper placement of pipe. Permanent records shall be kept showing the location of each grade, wall thickness, type, specification, and manufacturer of the pipe.

9.1.3.1.2 Construction

9.1.3.1.2.1 Visual inspection for detection of surface defects in the pipe shall be provided for each job just ahead of any coating operation and during the lowering-in and backfill operation.

9.1.3.1.2.2 The pipe swabbing operation shall be inspected for thoroughness to provide a clean surface.

9.1.3.1.2.3 Before welding, the pipe shall be examined for damage-free bevels and proper alignment of the joint.

9.1.3.1.2.4 The stringer bead shall be inspected, particularly for cracks, before subsequent beads are applied.

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9.1.3.1.2.5The completed weld shall be cleaned and inspected prior to coating operations. Irregularities that could protrude through the coating shall be removed.

9.1.3.1.2.6When the pipe is coated, inspection shall be made to determine that the coating machine does not cause harmful gouges or grooves in the pipe surface.

9.1.3.1.2.7Lacerations of the pipe coating shall be inspected prior to repair of coating to see if the pipe surface has been damaged. Damaged coating and pipe shall be repaired before the pipe is lowered in the ditch.

9.1.3.1.2.8All repairs, changes, or replacements shall be inspected before they are covered up.

9.1.3.1.2.9The condition of the ditch shall be inspected before the pipe is lowered in to assure proper protection of pipe and coating. For underwater crossings, the condition of the ditch and fit of the pipe to the ditch shall be inspected when feasible.

9.1.3.1.2.10The fit of the pipe to ditch shall be inspected before the backfilling operations.

9.1.3.1.2.11The backfilling operations shall be inspected for quality and compaction of backfill, placement of material for the control of erosion, and possible damage to the pipe coatings.

9.1.3.1.2.12Cased crossings shall be inspected during installation to determine that the carrier pipe is supported, sealed, and insulated from the casing.

9.1.3.1.2.13River crossings shall have thorough inspection and shall be surveyed and profiled after construction.

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9.1.3.1.2.14 All piping components other than pipe shall be inspected to insure damage-free condition and proper installation.

9.1.3.2 Supplementary Types of Examination

9.1.3.2.1 Testing of field and shop welds shall be made in accordance with Section 6, Welding, this Plant Engineering Specification and paragraph 434.8.5, Welding Quality, ASME/ANSI B31.4.

9.1.3.2.2 Welding defects shall be repaired in accordance with paragraph 434.8.7, Repair and Removal of Weld Defects, ASME/ANSI B31.4 and Section 6, Welding, of this Plant Engineering Specification.

9.1.3.2.3 Coated pipe shall be inspected in accordance with paragraph 461.1.2, Protective Coating, ASME/ANSI B31.4.

9.1.4 Repair of Defects

9.1.4.1 Defects of fabricated items and in pipe wall shall be repaired or eliminated in accordance with paragraph 434.5, Damage to Fabricated Items and Pipe, ASME/ANSI B31.4.

9.1.4.2 Welding defects shall be repaired in accordance with paragraph 434.8.7, Repair or Removal of Defects, ASME/ANSI B31.4 and Section 6, Welding, of this Plant Engineering Specification.

9.1.4.3 Holidays or other damage to coating shall be repaired in accordance with paragraph 461.1.2, Protective Coatings, ASME/ANSI B31.4.

9.2 TESTING**9.2.1 General**

In order to meet requirements of this Plant Engineering Specification, it is necessary that tests be made upon the completed system and upon component parts of the finished system. When reference in this plant engineering specification is made to tests or portions of tests described in

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other codes and specifications, they shall be considered as a part of this specification. Should leaks occur on tests, the line section or component part shall be repaired or replaced and retested in accordance with this Plant Engineering Specification and ASME/ANSI B31.4.

9.2.1.1 Testing of Fabricated Items

9.2.1.1.1 Fabricated items such as scraper traps, manifolds, volume chambers, etc., shall be hydrostatically tested to limits equal to or greater than those required of the completed system. This test may be conducted separately or as a part of the completed system.

9.2.1.1.2 In testing fabricated items before installation, the applicable paragraphs of specifications listed in Table 423.1, Materials Standards, ASME/ANSI B31.4 shall apply.

9.2.1.2 Testing After New Construction**9.2.1.2.1 Systems or Parts of Systems**

9.2.1.2.1.1 All liquid transportation piping systems within the scope of this Plant Engineering Specification, regardless of stress, shall be tested after construction.

9.2.1.2.1.2 Systems to be operated at a hoop stress greater than 20% SMYS shall be hydrostatically tested to 1.25 times the design pressure. Hydrotest pressure shall be maintained for four (4) hours. API RP 1110 may be used for guidance in hydrotesting.

9.2.1.2.1.3 Leak testing in lieu of hydrotest for pipelines operating at less than 20% SMYS is not recommended. This alternative is approved by paragraph 437.1.3(a)(3), ASME/ANSI B31.4.

9.2.1.2.1.4 When testing piping, the test pressure shall not exceed that stipulated in the standards of materials specifications (except pipe) incorporated in this specification by reference and listed in Table 423.1,

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Materials Standards, ASME/ANSI B31.4 for the weakest element in the system, or portion of system, being tested.

9.2.1.2.1.5 Equipment not to be subjected to test pressure shall be disconnected from the piping or otherwise isolated. Valves may be used for isolation if valve including closing mechanism is suitable for the test pressure.

9.2.1.2.2 Testing Tie-Ins

Radiography or other nondestructive testing methods may be used in lieu of hydrotesting to test tie-in welds.

9.2.1.2.3 Testing Controls and Protective Equipment

All controls and protective equipment, including pressure limiting devices, regulators, controllers, relief valves, and other safety devices, shall be tested to determine that they are:

- (a) In good mechanical condition.
- (b) Of adequate capacity, effectiveness, and reliability of operation for the service in which they are used.
- (c) Functioning at the correct pressure.
- (d) And properly installed and protected from foreign materials or other conditions that might prevent proper operation.

9.2.2 Test Pressure

9.2.2.1 Hydrostatic Testing of Internal Pressure Piping

9.2.2.1.1 Portions of piping systems to be operated at a hoop stress greater than 20% SMYS shall be hydrotested to a proof test equivalent at least 1.25 times the internal design pressure. Test pressure shall be maintained for at least four (4) hours.

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9.2.2.1.1 If visual inspection is possible for all pressurized piping component during the four hour test and there is no leakage, these piping components require no further testing.

9.2.2.1.2 On those portions of piping systems where visual inspection is not possible during hydrotest, the proof test shall be followed by a reduced leak test equivalent to 1.1 times the internal design pressure for at least four hours.

9.2.2.1.2 API RP 1110 may be used for guidance for the hydrostatic test.

9.2.2.1.3 Hydrostatic tests should be conducted with water which has been treated for bacteria and corrosion control. Liquid petroleum that does not vaporize may be used if the following conditions are met.

9.2.2.1.3.1 The pipeline section under test is outside populated areas.

9.2.2.1.3.2 Each building within 300 ft (90 m) of the test section is unoccupied while the test pressure is equal to or greater than a pressure which produces a hoop stress of 50% SMYS.

9.2.2.1.3.3 The test section is kept under surveillance by regular patrols during test.

9.2.2.1.3.4 Communication is maintained along the test section.

9.2.2.1.4 Provisions shall be made for relief of excess pressure, if the testing medium will be subject to thermal expansion during the test. Effects of temperature changes shall be taken into account when interpretations are made of the recorded test pressure.

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9.2.2.2 Leak Testing

A one (1) hour hydrostatic or pneumatic leak test may be used for piping systems to be operated at a hoop stress of 20% or less of the SMYS of the pipe. The hydrostatic test pressure shall be not less than 1.25 times the internal design pressure. The pneumatic-test gage-pressure shall be 100 psi (7 bar) or that pressure which would produce a hoop stress of 25% SMYS of the pipe, whichever pressure is least.

9.2.3 Qualification Tests

The following procedures shall be followed without exception if qualification tests are required in other sections of this Plant Engineering Specification and ASME/ANSI B31.4.

9.2.3.1 Visual Examination

Used or new pipe to be laid on Company pipeline projects shall be visually inspected in accordance with paragraph 9.1.3.1.1 of this section and paragraph 436.5.1, ASME/ANSI B31.4.

9.2.3.2 Bending Properties

9.2.3.2.1 For pipe of unknown specification or ASTM A120, bending properties are required if minimum yield strength used for design is above 24,000 psi (165 MPa) and after type of joint has been identified in accordance with paragraph 9.2.3.4 below.

9.2.3.2.2 For pipe NPS 2 and smaller, bending test shall meet the requirements of ASTM A53 or API 5L.

9.2.3.2.3 For pipe larger than NPS 2, flattening tests shall meet the requirements in ASTM A53, API 5L, or API 5 LU.

9.2.3.2.4 The number of tests required to determine bending properties shall be the same as required in paragraph 9.2.3.6 to determine yield strength.

9.2.3.3 Determination of Wall Thickness

9.2.3.3.1 Wall thickness shall be determined by measuring the thickness at quarter points (3, 6, 9, 12 clock positions) on one end of each piece of pipe. Measurement shall be made on not less than 5% of the individual lengths, but not less than 10 lengths, if the lot of pipe is known to be of uniform grade, size, and nominal thickness. Thickness measurement of the other lengths may be verified by applying a gage set to the minimum thickness.

9.2.3.3.2 The nominal wall thickness shall be taken as the next nominal wall thickness below the average of all measurements taken. Thickness limitations are:

9.2.3.3.2.1 Pipe under NPS 20: wall thickness selected must be equal to or less than 1.14 times the least measured thickness.

9.2.3.3.2.2 Pipe NPS 20 and larger: wall thickness selected must be equal to or less than 1.11 times the least measured thickness.

9.2.3.4 Determination of Weld Joint Factor

The weld joint factor E (Table 402.4.3, ASME/ANSI B31.4) may be used if the type of longitudinal or spiral weld joint is known. E shall not exceed 0.60 for pipe NPS 4 and smaller, or 0.80 for pipe over NPS 4.

9.2.3.5 Weldability

9.2.3.5.1 Weldability shall be determined for steel pipe of unknown specifications. A qualified pipe welder shall make a girth weld to join two joints of pipe. Visual and radiographic examinations shall be completed on the weld in accordance with API 1104. Standards of Acceptability-Nondestructive Testing, API 1104 shall be used to determine the weld quality.

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9.2.3.5.2 At least one test weld shall be made and tested for each number of lengths to be used in the Company project as listed below. All test specimens shall be selected at random.

<u>Minimum Number of Test Weld</u>	
<u>Nominal Pipe Size</u>	<u>Number of Lengths per Test</u>
Less than 6	400
6 through 12	100
Larger than 12	50

9.2.3.6 Determination of Yield Strength

9.2.3.6.1 Tensile properties (specified minimum yield strength, minimum tensile strength, and minimum percent elongation) may be established by performing all tensile tests required by API 5L or API 5 LU. All test specimens shall be selected at random. Minimum number of tests per joints of pipe are as follows:

<u>Minimum Number of Test Welds</u>	
<u>Nominal Pipe Size</u>	<u>Number of Lengths per Test</u>
Less than 6	200
6 through 12	100
Larger than 12	50

9.2.3.7 Minimum Yield Strength Value

For pipe of unknown specifications, the minimum yield strength may be determined by averaging the value of all yield strength tests for a test lot. The minimum yield strength shall be taken as the lesser of the following:

9.2.3.7.1 80% of the average value of the yield strength tests.

9.2.3.7.2 The minimum value of any yield strength test, except that no value may exceed 52,000 psi (358 Mpa).

9.2.3.7.3 24,000 psi (165 Mpa) if the average yield-tensile ratio exceeds 0.85.

9.2.4 Records

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Company shall maintain a record relative to design, construction, and testing of each pipeline within the scope of this specification. These records shall include:

9.2.4.1 Materials specifications.

9.2.4.2 Route maps and alignment sheets for “as-built” condition.

9.2.4.3 Location of each pipe size, grade, wall thickness, type of seam (if any, and manufacturer.

9.2.4.4 Coatings and cathodic protection.

These records shall be maintained for the life of the facility.

10 OPERATION AND MAINTENANCE PROCEDURES

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

10.1.1 General

10.1.2 Operations and Maintenance Plans and Procedures

The following operation and maintenance plans and procedures are documented in Company Specifications and Procedures and comply with the requirements in this specification, ASME/ANSI B31.4, and DOT 49CFR195.

10.1.2.1 Written detailed plans and training programs for employees covering operating and maintenance procedures for hazardous liquid pipeline systems during normal operation in accordance with the requirements in this specification. Essential features in the plans for specific portions of the system are outlined in paragraphs 10.2 and 10.3 below.

10.1.2.2 Plan for external and internal corrosion control of new and existing piping systems, including requirements in this specification and other Company specification concerning corrosion control.

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10.1.2.3 Written emergency plan for implementation in the event of system failures, accidents, or other emergencies; training programs for operation and maintenance employees with regard to applicable portions of the plan; establish liaison with appropriate public officials with respect to the plan.

10.1.2.4 Plan for reviewing changes in conditions affecting the integrity and safety of the piping system.

10.1.2.5 Liaison with local authorities and other pipeline operators who issue construction permits to prevent accidents caused by excavators.

10.1.2.6 Procedures to analyze all failures and accidents to determine the cause and to minimize the possibility of recurrence.

10.1.2.7 Record system to administer the plans and procedures.

10.1.2.8 Procedures for abandoning pipelines.

10.1.2.9 Plan and procedure modifications as required.

10.2 PIPELINE OPERATIONS AND MAINTENANCE

10.2.1 Operating Pressure

10.2.1.1 The maximum steady state operating pressure and static head pressure shall not exceed the internal design pressure and pressure ratings for the components.

10.2.1.2 Pressure rise due to surges shall not exceed the internal design pressure at any point in the piping system and associated equipment by more than 10%.

10.2.1.3 A piping system shall be requalified at a higher operating pressure if the higher operating pressure will produce a hoop stress more than 20% of the SMYS of the pipe. The requirements in paragraph 456, ASME/ANSI B31.4 shall be followed without exception to determine the acceptability of the new operating pressure.

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10.2.1.4 If a piping system is derated to a lower operating pressure in lieu of repair or replacement, the new maximum shall be determined in accordance with paragraph 10.2.7 of this specification.

10.2.1.5 If existing pipeline systems have used materials produced under discontinued or superseded standards or specifications, the internal design pressure shall be determined using the allowable stress and design criteria listed in the issue of the applicable code or specification in effect at the time of the original construction.

10.2.2 Communications

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

10.2.3 Markers

10.2.3.1 Markers to properly locate and identify the pipeline system shall be installed on each side of roads, highways, railroads, and stream crossings.

10.2.3.2 Pipeline markers at crossings, aerial markers when used, and other signs shall be installed and maintained in accordance with Company Engineering Specifications. These markers shall show the name of the operating Company and a telephone number. Additional pipeline markers shall be installed along the pipeline in areas of development and growth to protect the system from encroachment. API RP 1109 shall be used for guidance in the installation and maintenance of pipeline markers.

10.2.4 Right of Way Maintenance

10.2.4.1 The right of way should be maintained to assure clear visibility and to give reasonable access to maintenance crews.

10.2.4.2 Access shall be maintained to valve locations.

10.2.4.3 Diversion ditches shall be maintained where needed to protect against washouts of the pipeline and erosion of Company property.

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10.2.5 Patrolling

10.2.5.1 Company shall maintain a periodic pipeline patrol program to observe:

10.2.5.1.1 Surface conditions on and adjacent to the pipeline right of way.

10.2.5.1.2 Indication of leaks.

10.2.5.1.3 Construction activity other than Company.

10.2.5.1.4 Any other factors affecting the safety and operation of Company pipelines.

10.2.5.2 Special attention shall be given to road building, ditch cleanouts, excavations, and other encroachments to the pipeline system.

10.2.5.3 Patrols shall be made at intervals not exceeding two (2) weeks.

10.2.6 Pipeline Repairs**10.2.6.1 General**

Repairs shall be completed in accordance with the Plant Engineering Specification, Pipeline Repair. Repairs shall be performed by trained personnel under qualified supervision who are familiar with the hazards to public safety, using strategically located repair equipment and materials.

10.2.6.2 Disposition of Defects**10.2.6.2.1 Limits and Dispositions of Imperfections**

10.2.6.2.1.1 Gouges and grooves having a depth greater than 12.5% of the nominal wall thickness shall be removed or repaired.

10.2.6.2.2 Dents meeting any of the following conditions shall be removed or repaired:

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- (1) Dents which affect the pipe curvature at the pipe seam or at any girth weld.
- (2) Dents containing a scratch, gouge, or groove.
- (3) Dents exceeding a depth of $\frac{1}{4}$ in. (6 mm) in pipe NPS 4 and smaller, or 6% of the nominal pipe diameter in sizes greater than NPS 4.

10.2.6.2.3 All arc burns shall be removed or repaired.

10.2.6.2.4 All cracks shall be removed or repaired.

10.2.6.2.5 All welds found to have defects as summarized in paragraph 434.8.5(b), ASME/ANSI B31.4 or in the appropriate pipe specification shall be removed and repaired.

10.2.6.2.6 All pipe containing leaks shall be removed or repaired.

10.2.6.2.7 General Corrosion

Pipe shall be replaced if required, repaired if area is small, or operated at a reduced pressure if general corrosion has reduced the wall thickness to less than the design thickness decreased by an amount equal to the manufacturing tolerance applicable to the pipe or component.

10.2.6.2.8 Localized Corrosion Pitting

Pipe shall be repaired, replaced, operated at a reduced pressure if localized corrosion pitting has reduced the wall thickness to less than the design thickness. Paragraph 451.7, Derating a Pipeline to a Lower Pressure, ASME/ANSI B31.4, ASME/ANSI B31G, and Company Plant Engineering Specification- Pipeline Repair shall be used as the Company standards to determine the effect of pipeline pitting on the strength of the line and the requirements to remove, repair, or replace. Excess mechanical grinding shall be treated as pitting.

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10.2.6.2.9 Allowable Pipeline Repairs

Allowable pipeline repairs are summarized in paragraph 451.6, Pipeline Repairs, ASME/ANSI B31.4 and Company Plant Engineering Specification, Pipeline Repair.

10.2.6.2.10 Repair Methods

Repair methods are summarized in paragraph 451.6, Pipeline Repairs, ASME/ANSI B31.4 and Company Plant Engineering Specification, Pipeline Repair.

10.2.6.2.11 Testing Repairs to Pipeline Operating at a Hoop Stress of More Than 20% SMYS of the Pipe**10.2.6.2.11.1 Testing of Replacement Pipe Sections.**

Replacement piping shall be tested as required for a new pipeline. Radiography in lieu of hydrotest is approved for tie-in welds on Company pipeline projects.

10.2.6.2.11.2 Examination of Repair Welds. Welds made during pipeline repairs shall be examined by accepted nondestructive methods or visually examined by a qualified inspector.

10.2.7 Derating a Pipeline to a Lower Operating Pressure

10.2.7.1 Corroded pipe or pipe containing areas repaired by grinding may be derated to a lower operating pressure in lieu of replacement or repair. Except as provided in paragraph 10.2.7.2 below, the lower operating pressure shall be based on paragraph 404.1.2, Design for Straight Pipe Under Internal Pressure, ASME/ANSI B31.4 and the actual remaining wall thickness of the pipe at the point of deepest corrosion or grinding.

10.2.7.2 For pipe containing localized corrosion pitting or areas repaired by grinding where the remaining material in the pipe does not meet the depth and length limits in ASME/ANSI B31.4, paragraph 451.6.2(a)(7), the lower operating pressure may be determined by the equation in ASME/ANSI B31.4, paragraph 451.7(b). The equation shall not be used to determine a lower operating pressure due to

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corrosion or grinding in the girth or longitudinal welds and their associated heat affected zones.

10.2.8 Valve Maintenance

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

10.2.9 Railroads and Highways Crossing Existing Pipelines

10.2.9.1 Company shall reanalyze existing pipelines that are to be crossed by a new road or railroad. If the sum of the circumferential stresses caused by internal pressure and newly imposed loads exceeds 0.72 SMYS by more than 25%, the Company shall install mechanical reinforcement, structural protection, or suitable pipe to reduce the stress or redistribute the external loads acting on the pipeline. API RP 1102 provides methods which may be used to determine the total stress caused by internal pressure and external loads.

10.2.9.2 Installation of uncased carrier pipe is preferred. Adjustments of existing pipelines in service at proposed railroad or highway crossing shall conform to detail contained in API RP 1102. If casing is used, coated carrier pipe shall be independently supported outside each end of the casing and insulated from the casing throughout the cased section. Casing ends shall be sealed using a durable, electrically nonconductive material.

10.2.10 Testing and inspection of replaced pipe sections shall conform to requirements in paragraph 451.6.3, ASME/ANSI B31.4 and Company Plant Engineering Specification, Pipeline Repair.

10.3 STATION, TERMINAL, AND TANK FARM OPERATION AND MAINTENANCE**10.3.1 General**

10.3.1.1 Company shall establish starting, operating, and shutdown procedures for all equipment that is associated with pipeline operations. These procedures shall outline preventative measures

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and systems checks required to insure the proper functioning of all shutdown, control, and alarm equipment.

10.3.1.2 Periodic measurement and monitoring of flow and recording of discharge pressures shall be provided for detection of deviations from the steady state operating conditions of the system.

10.3.2 Controls and Protective Equipment

Controls and protective equipment, including pressure limiting devices, regulators, controllers, relief valves, and other safety devices shall be subjected to systematic periodic inspections and tests, at least annually, to determine that the equipment is:

10.3.2.1 In good mechanical condition;

10.3.2.2 Adequate from the standpoint of capacity and reliability of operation for the service use;

10.3.2.3 Set to function at the correct pressure;

10.3.2.4 Properly installed and protected from foreign materials or other conditions that might prevent proper operation.

10.3.3 Storage Vessels

10.3.3.1 Storage vessels, including atmospheric and pressure tanks, handling the liquid or liquids being transported shall be periodically inspected in accordance with API 653, Inspection of Storage Tanks. Company shall maintain these inspection results with the following items to be inspected:

10.3.3.1.1 Stability of foundation;

10.3.3.1.2 Condition of bottom, shell, stairs, and roof;

10.3.3.1.3 Venting or safety valve equipment;

10.3.3.1.4 Condition of firewalls or tank dikes.

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10.3.3.2 Storage vessels and tanks shall be cleaned in accordance with API Publication 2015.

10.3.4 Storage of Combustible Materials

All flammable or combustible materials in quantities more than required for daily use or other than normally used in pump houses shall be stored in a separate structure built of noncombustible material located a suitable distance from the pump house. All aboveground oil or gasoline storage tanks shall be protected in accordance with ANSI/NFPA 30.

10.3.5 Fencing

Station, terminal, and tank farm areas shall be maintained in a safe condition. These areas shall be fenced and locked, or attended, for the protection of the property and the public.

10.3.6 Signs

10.3.6.1 Suitable signs shall be posted to serve as warnings in hazardous areas.

10.3.6.2 Classified and high voltage areas shall be adequately marked and isolated.

10.3.6.3 Signs shall be displayed indicating Company name and a telephone number.

10.3.7 Prevention of Accidental Ignition

10.3.7.1 Smoking shall be prohibited in all areas of a pump station, terminal, or tank farm where the possible leakage or presence of vapor constitutes a hazard of fire or explosion.

10.3.7.2 Flashlights or hand lanterns, when used, shall be of the approved type.

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10.3.7.3 Welding shall commence only after compliance with paragraph 434.8.1(c), Safe Practices in Cutting and Welding, ASME/ANSI B31.4.

10.3.7.4 Consideration should be given to the prevention of other means of accidental ignition. See NACE RP-01-77 for additional guidance.

10.4 CORROSION CONTROL

Protection of pipe and components from internal and external corrosion, including tests, inspections, and appropriate corrective measures, shall be as prescribed in Chapter VIII, Corrosion Control, ASME/ANSI B31.4 and Plant Engineering Specifications.

10.5 EMERGENCY PLAN

A written emergency plan shall be established for implementation in the event of system failures, accidents, or other emergencies, and shall include procedures for prompt and expedient remedial action providing for the safety of the public and Company personnel, minimizing property damage, protecting the environment, and limiting accidental discharge from the piping system. The plan shall provide training of personnel responsible for the prompt execution of emergency action. Personnel shall be informed concerning the characteristics of the liquid in the piping systems and the safe practices in the handling of accidental discharge and repair of the facilities. Company shall establish scheduled reviews with personnel of procedures to be followed in emergencies annually not exceeding 15 months. Reviews shall be conducted to establish the competence of the emergency plan.

10.5.1 Procedures shall cover:

10.5.1.1 Liaison with state and local civil agencies such as fire departments, police departments, sheriff's offices, and highway patrols, to provide prompt intercommunications for coordinated remedial action;

10.5.1.2 Dissemination of information on location of system facilities;

10.5.1.3 Characteristics of the liquids transported;

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10.5.1.4 Joint preparation of cooperative action as necessary to assure the safety of the public in the event of emergencies.

10.5.2 A line of communication shall be established with residents along the piping system to recognize and report a system emergency to the appropriate Company personnel. This could include supplying a card, sticker, or equivalent with names, addresses, and telephone numbers of Company personnel to be contacted.

10.5.3 In the formulation of emergency procedures for limiting accidental discharge from the piping, Company shall give consideration to:

10.5.3.1 Formulating and placing in operation procedures for an area cooperative pipeline leak notification emergency action system between operating companies having pipeline systems in the area;

10.5.3.2 Reduction of pipeline pressure by ceasing pumping operations on the piping system, opening the system to delivery storage on either side of the leak site, and expeditious closing of block valves on both sides of the leak site;

10.5.3.3 Interim instructions to local authorities prior to arrival of qualified Company personnel at the leak site;

10.5.3.4 Rapid transportation of qualified personnel to the leak site;

10.5.3.5 Minimization of public exposure to injury and prevention of accidental ignition by evacuation of residents and the halting of traffic on roads, highways, and railroads in the affected area;

10.6 RECORDS

For operation and maintenance purposes, the following records shall be properly maintained:

10.6.1 Necessary operational data;

10.6.2 Pipeline patrol records;

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10.6.3 Corrosion records as required under paragraph 464, ASME/ANSI B31.4;

10.6.4 Leak and break records;

10.6.5 Records relating to routine or unusual inspections, such as external or internal line conditions when cutting line or hot tapping;

10.6.6 Pipeline repair records.

10.7 QUALIFYING A PIPING SYSTEM FOR A HIGHER OPERATING PRESSURE

10.7.1 In the event of uprating an existing piping system when the higher operating pressure will produce a hoop stress of more than 20% SMYS of the pipe, the following investigative and corrective measures shall be taken:

10.7.1.1 The design and previous testing of the piping system with its associated equipment and materials shall be reviewed to determine that the proposed increase in maximum steady state operating pressure is safe and in general agreement with the requirements of this specification and the governing Code, ASME/ANSI B31.4;

10.7.1.2 The condition of the piping system shall be determined by leakage surveys and other field inspections, examination of maintenance and corrosion control records, or other suitable means;

10.7.1.3 Repairs, replacements, or alterations in the piping system disclosed to be necessary by steps 10.7.1 and 10.7.2 be made;

10.7.2 The maximum steady state operating pressure may be increased after compliance with 10.7.1 and one of the following provisions:

10.7.2.1 If the physical condition of the piping system indicates the system is capable of withstanding the desired increased maximum steady state operating pressure in accordance with the design requirements of this Platin Engineering Specification and ASME/ANSI B31.4, and the system has been previously tested for a time and pressure equal to or greater than required in paragraphs 437.4.1(a) and (c), Hydrostatic

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Testing of Internal Pressure Piping, ASME/ANSI B31.4 for a new piping system for the proposed higher maximum steady state operating pressure, the system may be operated at the increased maximum steady state operating pressure.

10.7.2.2 If the physical condition of the piping system as determined by 10.7.2.1 indicates that the ability of the system to withstand the increased maximum steady state operating pressure has not been satisfactorily verified, or the system has not been previously tested to the levels required by this Plant Engineering Specification and ASME/ANSI B31.4, the system may be operated at the increased maximum steady state operating pressure if the system shall successfully withstand the test required by ASME/ANSI B31.4 for a new system to operate under the same conditions.

10.7.2.3 In no case shall the maximum steady state operating pressure of a piping system be raised to a value higher than the internal design pressure permitted by this Plant Engineering Specification and ASME/ANSI B31.4 for a new piping system constructed of the same materials. The rate of pressure increase to the higher maximum allowable steady state operating pressure should be gradual to allow sufficient time for periodic observations of the piping system.

10.7.2.4 Records of all investigations, work performed, and pressure tests conducted shall be preserved as long as the facilities remain in service.

10.8 ABANDONING A PIPING SYSTEM

When a piping system is to be abandoned, the Code requires that:

10.8.1 Facilities to be abandoned in place shall be disconnected from all sources of the transported liquid, such as other pipelines, meter stations, control lines, and other equipment.

10.8.2 Facilities to be abandoned in place shall be purged of the transported liquid and vapor with an inert material. The ends of the piping system shall be sealed.