

Terminal Piping Inspection— Inspection of In-Service Terminal Piping Systems

API RECOMMENDED PRACTICE 2611
FIRST EDITION, JUNE 2011



AMERICAN PETROLEUM INSTITUTE

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Downstream Segment

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Foreword

This Standard is intended to provide guidance to terminal personnel for the inspection and repair of existing metallic piping systems at terminal facilities. This Standard is based largely on accepted industry practice for the inspection and repair of terminal piping.

It is the intent of the American Petroleum Institute (API) to keep this publication up-to-date. All terminal piping system Owner/Users are invited to report their experiences in the inspection and repair of piping systems whenever such experiences may suggest a need for revising or expanding the practices set forth in API 2611.

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Shall: As used in a standard, “shall” denotes a minimum requirement in order to conform to the specification.

Should: As used in a standard, “should” denotes a recommendation or that which is advised but not required in order to conform to the specification.

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Suggested revisions are invited and should be submitted to the Standards Department, API, 1220 L Street, NW, Washington, DC 20005, standards@api.org.

Contents

	Page
1 Scope	1
1.1 General	1
1.2 General Application	1
1.3 Specific Applications	3
2 Normative References	4
3 Terms, Acronyms, and Definitions	5
3.1 Definitions	5
3.2 Terms and Acronyms	10
4 Owner/User Inspection Organization	11
4.1 General	11
4.2 Authorized Piping Inspector Responsibilities	11
5 Inspection of Piping	12
5.1 General	12
5.2 General Principles	12
5.3 Preparation for Inspection	13
5.4 Inspection for Specific Types of Corrosion and Cracking	13
5.5 Methods of Inspection	17
6 Frequency and Extent of Inspection of Above Ground Piping	21
6.1 General	21
6.2 Additional Requirements for Insulated Piping Systems	22
7 Frequency and Extent of Inspection of Below Ground Piping	22
7.1 Inspection Protocols	22
7.2 Leak Detection Systems	23
7.3 Cathodic Protection for External Corrosion Control	23
7.4 Indirect (Overline) Surveys for External Corrosion Control	24
7.5 Below Ground Inspection Intervals	25
7.6 Leak Testing Intervals	27
7.7 Inspection Data Evaluation	27
8 Repairs To Piping Systems	27
8.1 Repairs to Coatings	27
8.2 Clamp Repairs	28
8.3 Welded Repairs	28
8.4 Records	28
9 Marine Facilities Inspection/Frequency	28
9.1 Extent of Inspection/Frequency	28
9.2 Transfer Hoses	28
9.3 Metallic Transfer Arms Visual Inspection	28
9.4 Piping and Piping Components Visual Inspection	29
9.5 U.S. Jurisdiction	29
Annex A (normative) Inspector Qualifications	30
Annex B (informative) Summary of Cited Inspections	33
Annex C (informative) Guidance on Pipe Wall Retirement Thickness	34
Annex D (informative) Sample External Inspection Checklist for Process Piping	35

Contents

	Page
Annex E (informative) Sample Inspection Checklists for Above Ground Piping	36
Bibliography	41
Figures	
1 Schematic of Piping Systems for Hydrocarbons and Similar Flammable, Combustible, or Toxic Fluid Services	2
Tables	
1 Deadleg Guidance	14
2 Inspection Location Based on Corrosion Rates	18
3.A Frequency of External Inspection for Buried Pipe	26
3.B Recommended Corrosion Testing Protocols for Buried Pipe	26

Terminal Piping Inspection—Inspection of In-Service Terminal Piping Systems

1 Scope

1.1 General

API 2611 covers the inspection of typical terminal piping systems within terminal boundaries, which includes off-plot piping. Off-plot piping includes, but is not limited to piping between facilities, piping that comes from or goes to a refinery, or other type facility, or piping that may cross a road, ditch or other property outside the confines of a terminal facility.

Piping for transportation of finished fuel products such as gasoline, diesel, lubricating oils, jet fuel and aviation fuel are covered by the scope of this document. Also covered are piping systems for nonfuel-type fluids. The piping for other terminal nonfuel-type fluids typically found in terminals, include asphaltic products, process water, transmix, slop water and biofuels.

The scope of this document does not include piping in a refinery facility, sanitary waste piping, cast iron piping and nonmetallic gravity flow piping systems.

1.2 General Application

The purpose of this document is to align current terminal piping inspection practices with the appropriate and applicable elements of API 570. API 2611 covers the inspection of existing terminal piping systems. Figure 1 illustrates typical piping configurations that are encountered at terminals. In addition, the figure indicates possible delineation of United States Department of Transportation [USDOT] (i.e. ASME B31.4/API 1104, Breakout) and non-USDOT (i.e. ASME B31.3, Storage) facilities. Understanding the Codes to which facilities were constructed can facilitate the evaluation of the piping systems. Minor repairs include the restoration or replacement of piping systems to a safe operating condition. Where local or federal regulations apply, more stringent requirements may be applicable.

Terminal management may choose to comply with the requirements of other piping inspection standards, when appropriate. An example of this might be a terminal located within or adjacent to a refinery where there are already piping inspection programs governed by other standards such as API 570 or company specific programs or when specifically required by regulation.

API 2611 incorporates industry accepted practice for terminals as well as selected principles from API 570. This document addresses the piping and associated failure modes commonly found in terminals with piping systems operating at a maximum process design pressure of 300 psi at ambient temperature (an exception on design temperatures is made for asphaltic products). If any repair or alteration results in a change of design conditions, a rerating per API 570 shall be satisfied. For asphaltic products this document covers the maximum process design pressure of 150 psi at a temperature range of 25 °F to 450 °F (−3.9 °C to 232 °C).

In general, with regard to non-regulated off-plot piping, the terminal Owner/User may elect to base their inspection requirements on API 2611, the more stringent API 570 requirements, a combination of the two, or a combination of selected requirements from API 2611 and API 570 in conjunction with their own set of requirements. Regardless of the source, the Owner/User shall have inspection procedures established, documented and adhered to for their terminal facilities.

With the advent of new products, including the use of various oxygenated fuels; special consideration shall be given to the compatibility of the piping system. Of particular interest are seal materials, gaskets, and other elastomers with additives and oxygenates, such as ethanol or methanol. In addition, consideration shall be given to the possibility of stress corrosion cracking (SCC) agents. Additional information can be found on the topic of SCC in API 939-D.

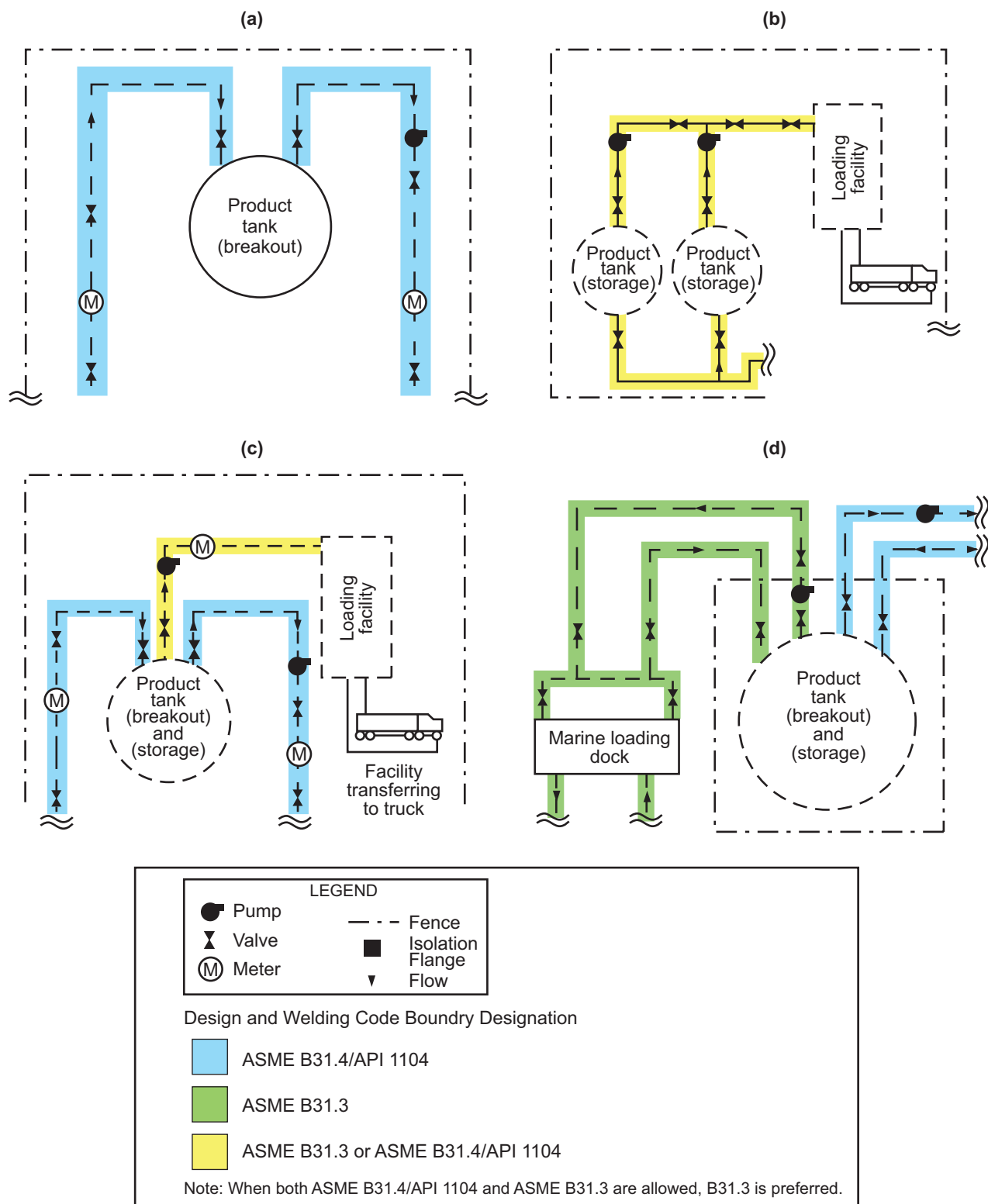


Figure 1—Schematic of Piping Systems for Hydrocarbons and Similar Flammable, Combustible, or Toxic Fluid Services

The following associates Figure 1 (a), (b), (c), and (d) with additional description of the applicability of design, welding, and inspection Codes and Standards, including API 2611, and the regulatory agency having jurisdiction over the piping. The referencing of Standards, other than 2611 in this section, is primarily for the purpose of delineating the application of API 2611. Jurisdiction under a federal pipeline Code (in the U.S., this would be USDOT 49 *CFR* 195) is modeled here for demonstration purposes using the US regulatory environment.

- (a) Regulated Pipeline Inlet and Outlet with Pipeline Breakout Storage Tank: All piping illustrated here should be designed according to ASME B31.4, welded according to API 1104, and federally regulated; as such it is **not** governed by API 2611.
- (b) Pipeline Inlet with Terminal Storage and Connection to Truck Loading Rack: The non-federally regulated piping illustrated here, typically intra-facility and inter-facility transfer lines, or lines running to loading racks, should be designed and welded according to ASME B31.3 or B31.4 and are accordingly governed by API 2611. However, a federally regulated pipeline would be designed according to ASME B31.4 and welded according to API 1104.
- (c) Regulated Pipeline Inlet and Outlet with Commingled Pipeline Breakout and Terminal Storage with Connection to Truck Loading Rack: All pipeline piping inlet and outlet illustrated here is federally regulated, designed according to ASME B31.4 and welded according to API 1104. The piping connecting the tankage to the loading rack should be designed and welded according to ASME B31.3, non-federally regulated and governed by API 2611.
- (d) Marine Facility Inlet and Outlet with Commingled Marine Facility and Pipeline Breakout Storage with Inlet and Outlet Piping federally regulated Pipeline: Piping from the dock to the first valve in a contained area should be designed and welded in accordance with ASME B31.3 and falls within US Coast Guard jurisdiction. Routine inspections may be done in accordance with API 2611. However, in the US all or a portion of the subsequent piping is regulated by the USDOT with its associated additional conditions. Therefore, in compliance with USDOT regulations, the inlet and outlet piping connecting the commingled marine facility and pipeline breakout storage tank should be designed in accordance with ASME B31.4, welded according to API 1104, and regulated by the USDOT in accordance with USDOT 49 *CFR* 195.

Figure 1—Schematic of Piping Systems for Hydrocarbons and Similar Flammable, Combustible, or Toxic Fluid Services (Continued)

API 2611 shall not be used as a substitute for the original construction requirements governing a terminal piping system before it is placed in-service; nor shall it be used in conflict with any prevailing regulatory requirements.

1.3 Specific Applications

Specific applications and exceptions of this document are detailed in 1.3.1 through 1.3.2.

1.3.1 Included Fluid Services

Except as provided in 1.3.2, API 2611 applies to piping systems for hydrocarbons and similar flammable, combustible or toxic fluid services, such as the following:

- a) finished petroleum products (e.g. gasolines, jet fuels and kerosene, heating oils, transmix and liquid petroleum);
- b) finished product additives as defined by jurisdictional regulations;
- c) hydrocarbon vapors (control/recovery systems);
- d) process or contact water (PCW);
- e) asphaltic products;
- f) ethanol and other biofuels.

NOTE None of the products listed in 1.3.1 typically involve environmental cracking. However, fuel ethanol is the exception. There has been reported cracking in piping and piping components that carry fuel ethanol. See API 939-D and API 939-E for more information.

1.3.2 Excluded and Optional Piping Systems

The fluid services and classes of piping systems listed below are excluded from the specific scope of API 2611; however they may be included at the discretion of the Owner/User if required.

- a) Fluid services that are excluded from the specific requirements of API 2611 include the following:

- 1) water (including fire protection systems), steam, steam-condensate, boiler feed water;
 - 2) oil-water treatment systems;
 - 3) and any water downstream of the terminal (oil-water separator piping).
- b) Classes of piping systems that are excluded are as follows.
- 1) Piping systems on movable structures covered by jurisdictional regulations, including piping systems on trucks, ships, barges, and other mobile equipment.
 - 2) Piping systems that are an integral part or component of rotating or reciprocating mechanical devices, such as pumps, compressors, turbines, generators, engines, and hydraulic or pneumatic cylinders where the primary design considerations and/or stresses are derived from the functional requirements of the device.
 - 3) Internal piping or tubing of fired heaters and boilers, including tubes, tube headers, return bends, external crossovers, and manifolds.
 - 4) Pressure vessels, heaters, furnaces, heat exchangers, and other fluid handling or processing equipment, including internal piping and connections for external piping.
 - 5) Plumbing, sanitary sewers, process waste sewers, and storm sewers.
 - 6) Piping or tubing with an outside diameter not exceeding that of NPS $1\frac{1}{2}$.
 - 7) Nonmetallic piping and polymeric or glass-lined piping.
 - 8) Cryogenic piping systems (e.g. liquefied natural gas [LNG]).
 - 9) Piping regulated under USDOT 49 CFR 195.

2 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

API Publication 340, *Liquid Release Prevention and Detection Measures for Aboveground Storage Facilities*

API 570, *Piping Inspection Code: Inspection, Repair, Alteration, and Rerating of In-service Piping Systems*

API Recommended Practice 571, *Damage Mechanisms Affecting Fixed Equipment in the Refining Industry*

API Recommended Practice 574, *Inspection of Piping System Components*

API Recommended Practice 577, *Welding Inspection and Metallurgy*

API Standard 579-1, *Fitness-For-Service*

API Publication 2201, *Procedures for Welding or Hot Tapping on Equipment Containing Flammables*

ASME B31.3 ¹, *Process Piping*

¹ ASME International, 3 Park Avenue, New York, New York 10016-5990, www.asme.org.

ASME B31.4, *Pipeline Transportation Systems for Liquid Hydrocarbons and other Liquids*

ASTM G57 ², *Method for Field Measurement of Soil Resistivity: Using the Wenner Four-electrode Method*

NACE SP0169 ³, *Control of External Corrosion on Underground or Submerged Metallic Piping System*

3 Terms, Acronyms, and Definitions

3.1 Definitions

For the purposes of this document, the following definitions apply.

3.1.1

alteration

Physical change, approved by a piping engineer, having design implications in any component that may affect the pressure containing capability or flexibility of a piping system beyond the scope of its original design.

NOTE The following are not considered alterations: comparable or duplicate replacements and the addition of small-bore attachments that do not require reinforcement or additional support.

3.1.2

applicable code

Requirement(s), requirement section(s), or other recognized and generally accepted engineering Standard or practice to which the piping system was built or which is deemed by the Owner/User or the piping engineer to be most appropriate for the situation.

3.1.3

authorized inspection agency

Defined as any of the following.

- a) An organization representing an insurance company that is licensed or registered to write insurance for piping systems.
- b) An Owner/User of piping systems that has designated a certified company or person to function as the authorized inspector.
- c) An independent organization employed by or under contract to the Owner/User of piping systems that are used only by the Owner.
- d) An independent organization licensed or recognized by the jurisdiction in which the piping system is used and employed by or under contract to the Owner/User.

3.1.4

authorized piping inspector

Employee of an authorized inspection agency who is qualified by experience, training and accredited testing to perform the functions specified in this document.

NOTE Whenever the term inspector is used in this document, it refers to an authorized piping inspector. A nondestructive (NDE) examiner is not required to be an authorized piping inspector.

² ASTM International, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428, www.astm.org.

³ NACE International (formerly the National Association of Corrosion Engineers), 1440 South Creek Drive, Houston, Texas 77218-8340, www.nace.org.

3.1.5**corrosion under insulation**

Generalized corrosion that developed on the outer surface of unprotected piping beneath fully encompassing insulation when moisture is apparent.

3.1.6**deadlegs**

Internal areas of a piping system that are isolated by valves or location having no flow for more than three consecutive months.

3.1.7**defect**

Flaw or other discontinuity noted during inspection of a type or magnitude exceeding the acceptable criteria.

3.1.8**distribution terminal**

See definition for “terminal”.

3.1.9**environmental cracking**

The intergranular or transgranular cracking of a material due to the combined action of tensile stress and a specific environment.

3.1.10**examiner**

Person trained and qualified to provide quality functions of a component manufacturer, fabricator or erector.

3.1.11**guided wave ultrasonic testing**

Nondestructive examination technique that utilizes ultrasonic waves that travel down the length of pipe, screening areas that are otherwise difficult to access.

3.1.12**indication**

Response or evidence resulting from the application of a nondestructive evaluation technique.

3.1.13**in-service**

Piping systems that have been placed in operation, as opposed to new construction prior to being placed in operation.

3.1.14**inspector**

See authorized piping inspector.

3.1.15**jurisdiction**

Legally constituted government administration that may adopt rules relating to terminal piping systems.

3.1.16**liquid-dye penetrant testing**

Nondestructive test used to evaluate a variety of non-porous materials (metals, plastics, or ceramics) by revealing surface discontinuities using a dye and powder system to visually identify surface cracks.

3.1.17**magnetic-particle testing**

Nondestructive test that is used to detect surface and subsurface flaws in ferrous materials.

3.1.18**mils per year**

Standard corrosion rate measurement.

NOTE One mil = 0.001 in.

3.1.19**pipe wall retirement thickness**

The pipe wall thickness at which the pipe should be declared out of service and replaced.

NOTE Determination of the pipe wall retirement thickness is based on the value (t) in ASME B31.3 Para. 304.1.2, in which (t) = pressure design thickness.

3.1.20**nondestructive examination**

Any recognized test procedure that does not compromise the integrity of the object being examined/tested.

3.1.21**on-stream**

Piping containing any amount of process fluid.

3.1.22**Owner/User**

Authority of a terminal piping systems who exercises control over the operation, engineering, inspection, repair, alteration, testing, and rerating of that piping system.

3.1.23**pipe**

Pressure-tight cylinder used to convey a fluid or to transmit a fluid pressure.

NOTE Materials designated “tube” or “tubing” in specifications are treated as pipe when intended for pressure service.

3.1.24**piping circuit**

Section of piping that has all points exposed to an environment of similar corrosivity and that is of similar design and construction material.

NOTE Complex process units or piping systems are usually divided into piping circuits to manage the necessary inspections, calculations, and record keeping. When establishing the boundary of a particular piping circuit, the inspector may also size it to provide a practical package for record keeping and performing field inspection.

3.1.25**piping engineer**

Person or organization qualified by the Owner/User as to their knowledge, capability and experience in the engineering disciplines associated with evaluating mechanical and material characteristics affecting the integrity and reliability of terminal piping components and systems.

3.1.26**piping system**

Assembly of interconnected piping components that is subject to the same set or sets of design conditions and is used to convey, distribute, mix, separate, discharge, meter, control, or snub fluid flows.

NOTE Piping system also includes pipe-supporting elements but does not include support structures, such as structural frames and foundations.

3.1.27

radiographic examination

Non-destructive test that uses an x-radiation source to provide a film image of defects in welds and structures, typically not employed in small bore piping found in terminals because of the need to work on both sides of the object being x-rayed.

3.1.28

repair

Work necessary to restore a piping system to a condition suitable for safe operation at design conditions.

NOTE 1 If any of the restorative changes result in a change of design temperature or pressure, the requirements for rerating also shall be satisfied.

NOTE 2 Any welding, cutting, or grinding operation on a pressure-containing piping component not specifically considered an alteration is considered a repair.

3.1.29

repair organization

Any of the following.

- a) Owner/User of terminal piping systems who repairs or alters its own equipment in accordance with applicable standards or codes.
- b) Contractor whose qualifications are acceptable to the Owner/User of terminal piping systems and who makes repairs or alterations in accordance with applicable standards or codes.
- c) Entity authorized by, acceptable to, or otherwise not prohibited by the jurisdiction and that makes repairs in accordance with applicable standards or codes.

3.1.30

rerating

Change in either the design temperature or the maximum allowable working pressure of a piping system that may consist of an increase, a decrease, or a combination of both.

NOTE Derating below original design conditions is a means to provide increased corrosion allowance.

3.1.31

small-bore piping

Piping that is less than or equal to NPS 2.

3.1.32

soil-to-air interface

Area in which external corrosion may occur on partially buried pipe

NOTE The zone of the corrosion will vary depending on factors such as moisture, oxygen content of the soil, and operating temperature; the zone generally is considered to be from 12 in. (305 mm) below to 6 in. (152 mm) above the soil surface, including pipe running parallel with the soil surface that contacts the soil.

3.1.33

spool

Prefabricated section of piping with ends that are plain-end for field cutting, prepared for welding or flanged.

3.1.34**temperature and pressure in a piping system**

The following definitions refer to only positive pressure (not a vacuum) and positive temperatures (ambient or higher, but not cryogenic). The temperature and pressure specifications are always directly linked together in a process piping system.

3.1.34.1**design pressure**

Pressure of a piping system which shall be not less than the pressure at the most severe condition of coincident internal or external pressure and temperature (minimum or maximum) expected during service.

3.1.34.2**design temperature**

Temperature of a piping system at which, under the coincident pressure, the greatest thickness or highest component rating is required.

3.1.35**temporary repairs**

Short term repairs made to piping systems in order to restore sufficient integrity to continue safe operation until permanent repairs can be scheduled and accomplished within a time period acceptable to the inspector or piping engineer.

3.1.36**terminal**

Facility designed for the receipt, storage and distribution of refined hydrocarbon products (typically motor gasolines, diesel, heating oils, and/or aviation fuels) that usually receives product by pipeline or marine vessel and distributes product by tank truck and/or pipeline.

3.1.37**test circuit**

Segment or extent of a piping system included in a single leak test.

3.1.38**test point**

Area defined by a circle having a diameter not greater than 2 in. (51 mm) for a pipeline diameter not exceeding 10 in. (254 mm) or not greater than 3 in. (76 mm) for larger pipelines.

NOTE Thickness readings may be averaged within this area. A test point shall be within a thickness measurement location.

3.1.39**thickness measurement locations**

Designated areas on piping systems where periodic inspections and thickness measurements are conducted.

3.1.40**trap space**

Any pipe configuration that allows for a water phase to stagnate in low points in a piping section.

3.1.41**ultrasonic examination**

Non-destructive test that uses acoustic energy (2 MHz to 10 MHz) to detect anomalies in pipe material and welds by creating a detection signature.

NOTE The material mass and any anomalies are represented as an electronic signature on a video screen and/or graph.